Integration of MOORA Method With Neutrosophy For Decision Making

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ABSTRACT:

Neutrosophy is an emerging concept in the field of mathematics as we can accommodate the uncertainty nature of a particular problem chosen. In most of the real-world problems, we see that the information available cannot be relied on to the full extent. There always lies an uncertainty because the information keeps varying from time to time. Hence, decision making is at risk when we take into consideration the raw data at hand. Therefore, on integrating the concept of neutrosophy in decision making, we tend to overrule the inconsistency existing in every field.In this paper, we discuss about one of the decision-making techniques in intuitionistic and neutrosophic environment.

Keywords: Neutrosophy, decision making, MOORA, alternatives, attribute.

I. INTRODUCTION

The whole world is filled with choices. Right from the simplest to the complex one, we have a choice for each and every thing that's available. Sometimes, we leave our choice to our thinking and prejudicial knowledge, at times we tend to move towards experiential knowledge and there are times where we put into practice the mathematical concepts to choose the best one and here's where the decision making plays its major role. There are a lot of Multi Criteria Decision Making methods used to choose the relevant alternative when confusions arise as in choosing the best one. Multi Criteria Decision Making is categorized into two: Multi Attribute Decision Making and Multi Objective Decision Making. MCDM is a sub branch of Operations Research that evaluates on choosing the best alternative amidst the existing multiple conflicting alternatives in decision making. Decision making takes its place in all events of man's life. There exists a lot of fields where decision making becomes risky when all alternatives seem to be appealing and hence people tend to approach for MCDM methods to choose the best one inorder to avoid risk factors.

In a decision-making problem, the decision maker must overcome the problem of choosing the best alternative from a given set of existing alternatives. Amidst the multiple criteria, the best and the good one is to be selected and this is done by ranking the alternatives based on certain evaluations. The four components of a multi criteria decision making: alternatives, attributes, weights and goals has to be rightly chosen and the data ought to be collected qualitatively or quantitatively. In accordance with the data collected, analysis is done for the alternatives against the criteria/ attributes based on the weights assigned to the attributes. Eventually, the most preferred best alternative is chosen in this process.

II. LITERATURE REVIEW

The concept of fuzziness and fuzzification of values was first introduced by L.A.Zadeh [16] where concepts regarding vagueness, truthfulness of a value was considered deliberately. Fuzzy logic deals with inconsistent data and brings about a surety in the results we obtain. Decision making in a fuzzy environment was proposed by Bellman and Zadeh [4] in the year 1970. In all walks of life, uncertainty plays a major role. In certain situations, they are ignored whereas in certain situations, they are taken into account. The truthness and falsity of a value was studied by Attanasov [3] and hence fuzzy sets were generalized to Intuitionistic fuzzy sets with membership and non-membership functional values. The inconsistency in the information collected still prevailed and this led to the development of the concept of neutrosophy by FlorentinSmarandache[9]. This included the truth membership, false membership and indeterminacy membership of a particular value. Fuzzy linear programs with trapezoidal fuzzy numbers were studied by Ganesan and Veeramani [7]. Their work was given another perspective by Ebrahimnejad [6] with some new results. Ye [14,15] studied on neutrosophic sets and applied the concept of neutrosophy to decision making by using ranking techniques and aggregation operators. Single valuedneutrosophic sets and numbers with their generalization and application to solve real world problems were studied by Wang et al [12] and Umamageswari et al [11]. Multi Criteria decision making with the help of bipolar intuitionistic fuzzy soft set was studied by Anita et al [1]. MOORA method has found its application in various selection process. Alireza et al [18] has compiled a book on multi criteria decision making models. Perez et al [8] applied MOORA for evaluation of industrial maintenance systems. Dragisa et al [5] studied MOORA method and solved for decision making using interval data. Zaitun et al [17] implemented the concept of MOORA in determining fund recipients. Arvind and Shweta [2] proposed an integrated approach with MOORA, SWARA and WASPAS.

In this paper, we discuss about the integration of the neutrosophic technique with the MOORA decision making method. In section 3, we put forward the basic definitions about intuitionistic fuzzy set and neutrosophic set. In section 4, we propose the MOORA method in intuitionistic environment and neutrosophic environment. In section 5, the proposed method is proved mathematically by an example and the results are compiled in section 6 so that we select the best alternative using MOORA method with intuitionistic fuzzy and neutrospohic sets

III. PRELIMINARIES

Definition [3]:

Let X be a non-empty fixed set. An intuitionistic fuzzy set (IFS) A_{IF} in X is an object having the form, $A_{IF} = \{<x, \delta_{A_{IF}}(x), \xi_{A_{IF}}(x)/x \in X>\}$, where $\delta_{A_{IF}}(x): X \to [0,1]$ and $\xi_{A_{IF}}(x): X \to [0,1]$. Here $\delta_{A_{IF}}(x)$ represents the membership degree for the element x of the intuitionistic fuzzy set A and $\xi_{A_{IF}}(x)$ denotes the non-membership degree for the element x. Also, we have $0 \leq \delta_{A_{IF}}(x) + \xi_{A_{IF}}(x) \leq 1$ for each $x \in X$.

Definition [10]:

Let $A_{IF} = \{<x, \delta_{A_{IF}}(x), \xi_{A_{IF}}(x)/x \in X>\}$ and $B_{IF} = \{<x, \delta_{B_{IF}}(x), \xi_{B_{IF}}(x)/x \in X>\}$, then $A \subset B$ if and only if $\delta_{A_{IF}}(x) \leq \delta_{B_{IF}}(x)$ and $\xi_{A_{IF}}(x) \leq \xi_{B_{IF}}(x)$for all $x \in X$.

We have the following relations to be true.

$A_{IF} = B_{IF}$iff $A_{IF} \subset B_{IF}$ and $A_{IF} \supset B_{IF}$

$\tilde{A}_{IF} = <x, \xi_{A_{IF}}(x), \delta_{A_{IF}}(x)>$

$\neg A_{IF} = <x, \delta_{A_{IF}}(x), \xi_{A_{IF}}(x)^c>$

$A_{IF} \cup B_{IF} = <x, \delta_{A_{IF}}(x) \cup \delta_{B_{IF}}(x), \xi_{A_{IF}}(x) \cap \xi_{B_{IF}}(x)>$

$A_{IF} \cap B_{IF} = <x, \delta_{A_{IF}}(x) \cap \delta_{B_{IF}}(x), \xi_{A_{IF}}(x) \cup \xi_{B_{IF}}(x)>$

Definition [11]:

Let α_{IF}be a trapezoidal intuitionistic fuzzy number which is of the form $\alpha_{IF}(x) = \{<a, b, c, d>, \delta_\alpha(x), \xi_\alpha(x)\}$ whose membership and non-membership functions are defined as follows:

$$\delta_\alpha(x) = \begin{cases} \frac{x-a}{b-a}\delta_\alpha & a \leq x \leq b \\ \delta_\alpha & b \leq x \leq c \\ \frac{d-x}{d-c}\delta_\alpha & c \leq x \leq d \\ 0 & otherwise \end{cases}$$

$$\xi_\alpha(x)=\begin{cases}\frac{(b-x)+\xi_\alpha(x-a)}{b-a} & a\le x\le b\\ \xi_\alpha & b\le x\le c\\ \frac{(x-c)+\xi_\alpha(d-x)}{d-c} & c\le x\le d\\ 0 & otherwise\end{cases}$$

Also $\delta_\alpha(x)\in[0,1]$ and $\xi_\alpha(x)\in[0,1]$

Definition [13]:

Let $\alpha(x)=\{< a_1,b_1,c_1,d_1>,\delta_\alpha(x),\xi_\alpha(x)\}$ and $\beta(x)=\{< a_2,b_2,c_2,d_2>,\delta_\beta(x),\xi_\beta(x)\}$ be two trapezoidal intuitionistic fuzzy numbers, then we define the following:

$\alpha+\beta=\left[< a_1+a_2,b_1+b_2,c_1+c_2,d_1+d_2>,\left(\delta_\alpha+\delta_\beta-\delta_\alpha\delta_\beta,\xi_\alpha\xi_\beta\right)\right]$

$\alpha\beta=\left[< a_1a_2,b_1b_2,c_1c_2,d_1d_2>,\left(\delta_\alpha\delta_\beta,\xi_\alpha+\xi_\beta-\xi_\alpha\xi_\beta\right)\right]$

$\lambda\alpha=\left[<\lambda a,\lambda b,\lambda c,\lambda d>,1-(1-\lambda_\alpha)^\lambda,\beta^\lambda\right],\lambda\ge 0$

Definition [11] (Neutrosophic Set):

Let X be a universe. A neutrosophic set $\tilde{A}$ in X is defined by a truth membership function $T_{\tilde{A}}(x)$, an indeterminacy membership function $I_{\tilde{A}}(x)$ and falsity membership function $F_{\tilde{A}}(x)$. $T_{\tilde{A}}(x),I_{\tilde{A}}(x),F_{\tilde{A}}(x)$ are real non-standard subsets of $]0^-,1^+[$ and $0^-\le T_{\tilde{A}}(x)\le \sup I_{\tilde{A}}(x)\le F_{\tilde{A}}(x)\le 3^+$

Definition [11]: (Single Valued Neutrosophic Set):

Let X be a universe of discourse. A single valued neutrosophic set $\tilde{A}$ over X is an object having the form

$\tilde{A}=\{\left\langle x,T_{\tilde{A}}(x),I_{\tilde{A}}(x),F_{\tilde{A}}(x)\right\rangle;x\in X\}$ where $T_{\tilde{A}}(x):X\to[0,1]$,

$I_{\tilde{A}}(x):X\to[0,1]$, $F_{\tilde{A}}(x):X\to[0,1]$

with $0\le T_{\tilde{A}}(x)+I_{\tilde{A}}(x)+F_{\tilde{A}}(x)\le 3$ *for all* $x\in X$.

$T_{\tilde{A}}(x),I_{\tilde{A}}(x),F_{\tilde{A}}(x)$ denote the truth membership degree, indeterminacy membership degree and falsity membership degree of x to $\tilde{A}$ respectively.

Definition [11]:

Consider a trapezoidal neutrosophic number $\tilde{A}=((a,b,c,d);w_{\tilde{A}},u_{\tilde{A}},y_{\tilde{A}})$ whose truth membership, indeterminacy membership and falsity membership functions can be respectively defined by

$$\mu_{\tilde{A}}(x) = \begin{cases} \dfrac{(x-a)w_{\tilde{A}}}{b-a} & a \le x \le b \\ w_{\tilde{A}} & b \le x \le c \\ \dfrac{(d-x)w_{\tilde{A}}}{d-c} & c \le x \le d \\ 0 & otherwise \end{cases}$$

$$\nu_{\tilde{A}}(x) = \begin{cases} \dfrac{b-x+u_{\tilde{A}}(x-a)}{b-a} & a \le x \le b \\ u_{\tilde{A}} & b \le x \le c \\ \dfrac{(x-c)+u_{\tilde{A}}(d-x)}{d-c} & c \le x \le d \\ 1 & otherwise \end{cases}$$

$$\lambda_{\tilde{A}}(x) = \begin{cases} \dfrac{b-x+y_{\tilde{A}}(x-a)}{b-a} & a \le x \le b \\ y_{\tilde{A}} & b \le x \le c \\ \dfrac{(x-c)+y_{\tilde{A}}(d-x)}{d-c} & c \le x \le d \\ 1 & otherwise \end{cases}$$

IV. The Proposed IFMOORA method and NMoora method

Multi Objective Optimization method by Ratio Analysis is one of the decision-making techniques in use to carry out assessments based on certain criteria and alternatives decided by the decision maker. This is one of the frequently used methods as its computations are easy and involves easier calculations. MOORA method was first introduced by Brauers in the year 2004. This is a compensatory method where the desirable and undesirable attributes are taken into consideration simultaneously for ranking. Hence it is categorized as an objective method. MOORA method comprises of two components: ratio system approach and the reference point approach. Here we apply the Intuitionistic Fuzzy MOORA (IFMOORA) and the Neutrosophic MOORA (NMOORA) method to overcome the uncertainities.

4.1 ALGORITHM

Step 1: A selection process is chosen and attributes are decided based on the alternatives. Attributes are then categorized as positive and negative attributes. Quantitative data are collected for each alternative based on the various attributes. In case of qualitative attributes, they are converted into quantitative attributes and the values are written in the form of a decision matrix.

$$X = \begin{bmatrix} x_{11} & x_{12} & . & . & . & x_{1n} \\ . & & & & & \\ . & & & & & \\ x_{i1} & x_{i2} & . & . & . & x_{in} \\ . & & & & & \\ x_{m1} & x_{m2} & . & . & . & x_{mn} \end{bmatrix} i = 1,2\ldots.m, j = 1,2,\ldots.n$$

where x_{ij} stands for the element of the decision matrix for i^{th} alternative in the j^{th} attribute.

The values of the data collected are taken as fuzzified values as intuitionistic fuzzy and neutrosophic values.In this article, we have considered intuitionistic fuzzy values in the first case and Neutrosophic values in the second case.

Case i) In the first case, each value is considered as a trapezoidal intuitionistic fuzzy number. Each trapezoidal intuitionistic fuzzy number has a membership and non-membership value, each ranging from 0 to 1.Using defuzzification methods, the trapezoidal intuitionistic fuzzy number is converted to its crisp form and the process of IFMOORA method is carried out.

Case ii) In the second case, each value is noted down as a trapezoidal neutrosophic number. Each trapezoidal neutrosophic number has its own truth membership, falsity membership and indeterminacy membership. As the concept of neutrosophy is counted, the uncertainity is considered as a major part and hence in real world problems, the uncertainity is overcome by using the neutrosophic techniques.Using defuzzification methods, the trapezoidal neutrosophic number is converted into its crisp form and then normalization of the decision matrix is undertaken.

Step 2:Weights for each attribute is allotted by the decision maker as $w_1, w_2, \ldots\ldots\ldots w_n$ such that $\sum_{j=1}^{n} w_j = 1$

Step 3: From the decision matrix X given, we normalize the decision matrix using the equation given below$X_{ij}^{*} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} {x_{ij}}^2}}, j = 1,2\ldots.n$

Here X_{ij}^{*} represents the normalized value of the decision matrix for the i^{th} alternative in the j^{th} attribute.

Step 4: Taking into consideration, the positive and the negative attributes, the reference points for each attribute is decided from the normalized decision matrix. In the case of a positive attribute, maximum values are chosen and in the case of a negative attribute, minimum values are chosen.

The assessment values of each attribute with respect to their weights and the reference points are obtained through the equation

$$\hat{r_j} = \sum_{j=1}^{s} x_{ij}^{*} w_j - \sum_{j=s+1}^{n} x_{ij}^{*} w_j \ , \quad i = 1,2,\ldots m$$

Here s denotes the number of positive attributes and n-s denotes the number of negative attributes.

Step 5: The alternatives are finally ranked based on the assessment values. The maximum values of $\hat{r_j}$ are obtained for each alternative and they are ranked accordingly.

V. NUMERICAL EXAMPLE:

The example quoted here is taken from a chapter in a book by Alireza[17] .

A board of directors of a factory plans to select the best alternative among the four maintenance contractors A_1, A_2, A_3, A_4. The attributes specified by experts are the number of required work force C_1, machinery maintenance cost C_2, overall cost reduction C_3, contractor contract cost C_4 and contract duration C_5. Additionally, the weights of attributes are equal and are assigned as 0.5.

Here C_3 and C_5 are the positive attributes and $C_{1,}$ C_2, C_4 are the negative attributes.

Case 1: IFMOORA METHOD:

The values of the decision matrix are given as intuitionistic fuzzy number with membership and non-membership functions.

A_{IF}=

$$\begin{bmatrix} (3,4,5,7),(0.21,0.78) & (51,52,54,57),(0.18,0.81) & (550,590,600,630),(0.72,0.27) & (80,84,90,95),(0.31,0.68) & (69,72,80,89),(0.70,0.29) \\ (0.1,0.5,1,1.2),(0.04,0.95) & (90,92,97,102),(0.32,0.67) & (170,180,200,230),(0.90,0.09) & (49,51,58,63),(0.20,0.79) & (58,61,65,69),(0.75,0.24) \\ (3,5,7,10),(0.30,0.69) & (65,70,72,78),(0.24,0.75) & (330,360,400,410),(0.81,0.18) & (40,49,60,70),(0.20,0.79) & (75,79,83,89),(0.69,0.30) \\ (7,9,10,15),(0.43,0.56) & (68,70,75,80),(0.25,0.74) & (900,930,1000,1100),(0.54,0.45) & (71,74,80,83),(0.27,0.72) & (30,35,40,45),(0.85,0.14) \end{bmatrix}$$

These intuitionistic fuzzy numbers are converted into crisp form by using the following equation

$D(A_{IF}) = \left(\left(\frac{a+b+c+d}{4}\right) + \left(\frac{m+(1-nm)}{2}\right)\right)$ and are written as follows:

$$D(A_{IF}) = \begin{bmatrix} 4.965 & 53.685 & 593.225 & 87.565 & 78.205 \\ 0.67 & 95.575 & 195.905 & 55.455 & 64.005 \\ 6.555 & 71.495 & 375.815 & 54.955 & 82.195 \\ 10.685 & 73.5 & 983.045 & 77.275 & 38.355 \end{bmatrix}$$

These values are normalized using the equation $X_{ij}^* = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}, j = 1,2....n$ and the normalized decision matrix is :

$$X_{ij}^* = \begin{bmatrix} 0.3677 & 0.3576 & 0.4847 & 0.6233 & 0.5759 \\ 0.0496 & 0.6367 & 0.1600 & 0.3947 & 0.4713 \\ 0.4855 & 0.4763 & 0.3070 & 0.3911 & 0.6052 \\ 0.7915 & 0.4896 & 0.8032 & 0.5500 & 0.2824 \end{bmatrix}$$

The reference points are chosen from the normalized decision matrix by choosing the maximum values for the positive attributes and the minimum values for the negative attributes and are given in Table 5.1.

Table 5.1 Reference points using IFMOORA

Attributes	C_1	C_2	C_3	C_4	C_5
Reference Points	0.0496	0.3576	0.8032	0.3911	0.6052

Using the reference points from Table 5.1, the weights and the values of the normalized decision matrix, we find the assessment values using the equation:

$$\hat{r_j} = \sum_{j=1}^{s} x_{ij}^* w_j - \sum_{j=s+1}^{n} x_{ij}^* w_j \ , \quad i = 1,2,\dots m$$

$$\hat{r_j} = \begin{bmatrix} 0.1590 & 0 & 0.1592 & 0.1161 & 0.0146 \\ 0 & 0.1395 & 0.3216 & 0.0018 & 0.0669 \\ 0.2179 & 0.0593 & 0.2481 & 0 & 0 \\ 0.3709 & 0.066 & 0 & 0.0794 & 0.1614 \end{bmatrix}$$

By specifying the maximum amount of $\hat{r_j}$ for each alternative, we can select the best alternative and is tabulated in Table 5.2.

Table 5.2 Ranking of alternatives using IFMOORA

Alternative	Max $\hat{r}_j$	Rank
A_1	0.1592	4
A_2	0.3216	2
A_3	0.2481	3
A_4	0.3709	1

Hence $A_4 > A_2 > A_3 > A_1$

Therefore, A_4 is the best alternative.

Case 2: NMOORA METHOD:

The values of the decision matrix are given as neutrosophic number with truth membership, indeterminacy membership and falsity membership functions.

$$A_N=\begin{bmatrix} (3,4,5,7) & (51,52,54,57) & (550,590,600,630) & (80,84,90,95) & (69,72,80,89) \\ (0.1,0.5,1,1.2) & (90,92,97,102) & (170,180,200,230) & (49,51,58,63) & (58,61,65,69) \\ (3,5,7,10) & (65,70,72,78) & (330,360,400,410) & (40,49,60,70) & (75,79,83,89) \\ (7,9,10,15) & (68,70,75,80) & (900,930,1000,1100) & (71,74,80,83) & (30,35,40,45) \end{bmatrix}$$

These neutrosophicnumbers are converted into crisp form by using the following equation

$D(A_N) = \left[a + d + \frac{1}{2}(c - b)\right][T_\alpha - I_\alpha - F_\alpha]$ and the confirmation degree is assumed to be (0.9,0.1,0.1) for this problem.

$$D(A_N) = \begin{bmatrix} 7.35 & 76.3 & 829.5 & 124.6 & 113.4 \\ 1.085 & 136.15 & 287 & 80.85 & 90.3 \\ 9.8 & 100.8 & 532 & 80.85 & 116.2 \\ 15.75 & 150.35 & 1424.5 & 109.9 & 54.25 \end{bmatrix}$$

These values are normalized using the equation $X_{ij}^* = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}, j = 1,2....n$ and the normalized decision matrix is :

$$X_{ij}^*=\begin{bmatrix} 0.3678 & 0.3572 & 0.4724 & 0.6178 & 0.5859 \\ 0.0543 & 0.6374 & 0.1634 & 0.4008 & 0.4665 \\ 0.4904 & 0.4719 & 0.3030 & 0.4008 & 0.6003 \\ 0.7882 & 0.4932 & 0.8113 & 0.5449 & 0.2803 \end{bmatrix}$$

The reference points are chosen from the normalized decision matrix by choosing the maximum values for the positive attributes and the minimum values for the negative attributes and are tabulated in Table 5.3.

Table 5.3 Reference Points using NMOORA

Attributes	C_1	C_2	C_3	C_4	C_5
Reference Points	0.0543	0.3572	0.8113	0.4008	0.6003

Using the reference points, the weights and the values of the normalized decision matrix, we find the assessment values using the equation:

$$\hat{r_j} = \sum_{j=1}^{s} x_{ij}^{*} w_j - \sum_{j=s+1}^{n} x_{ij}^{*} w_j \ , \quad i = 1,2,\ldots m$$

$$\hat{r_j} = \begin{bmatrix} 0.0627 & 0 & 0.0677 & 0.0434 & 0.0028 \\ 0 & 0.0560 & 0.1295 & 0 & 0.0267 \\ 0.0872 & 0.0229 & 0.1016 & 0 & 0 \\ 0.1467 & 0.0272 & 0 & 0.0288 & 0.064 \end{bmatrix}$$

By specifying the maximum amount of $\hat{r_j}$ for each alternative, we can select the best alternative and are given in Table 5.4.

Table 5.4 Ranking of alternatives using NMOORA

Alternative	Max $\hat{r_j}$	Rank
A_1	0.0627	4
A_2	0.1295	2
A_3	0.1016	3
A_4	0.1467	1

Hence $A_4 > A_2 > A_3 > A_1$

Therefore, A_4 is the best alternative.

VI. RESULTS AND CONCLUSION

In the first case, the number was taken as a trapezoidal intuitionistic fuzzy number wherein the degree of acceptance and the degree of rejection is alone considered. That is, how far it can be true and how far it can be false was taken into account and assessment was made in selecting the best alternative using IFMOORA method. Among the four alternatives, i.e., amidst the four maintenance contractors, A_4 was selected as the best alternative when acceptance and rejection degree was considered for each value provided by the decision-maker.

The concept of indeterminacy proposed by Smarandache puts forth the concept of how far the uncertainity can be dealt with. Hence in the second case, the degree of indeterminacy was also taken into consideration and NMOORA method was applied. For each trapezoidal neutrosophic number, the degree of a value not being true and not being false was considered, i.e., the neutrality of falsity and truthness was taken into account and the NMOORA method was applied. In this method too, among the four maintenance contractors, A_4 was selected as the best one.

However, in both the cases, we get the same ranking of alternatives, even after uncertainty is considered. Hence it is efficient to use this decision-making model to choose the best alternative on the basis of the ratio system and reference point approach. So, we can rely on this selection process to the fullest extent and it is an advantage for the decision maker as the best and the right alternative is selected.

VII. REFERENCES

[1] Anita Shanthi, PrathipaJayapalan, A multi-criteria decision making problem based on score function of bipolar intuitionistic fuzzy soft set, AIP Conference proceedings 2177, 020004, 2019.

[2] Arvind Jayant, Shweta Singh, An integrated approach with MOORA, SWARA and WASPAS methods for selection of 3PLSP, Proceedings of the International Conference on Industrial Engineering & Operations Management, July 26-27, pp. 2497-2509, 2018.

[3]Atanassov,K.T, Intuitionistic fuzzy sets, Fuzzy sets & systems, 20, pp. 87-96, 1986.

[4]Bellman R.E, Zadeh L.A, Decision making in a fuzzy environment, Management Science, 17(1970) B141-164.

[5] Dragisa S, Nedeljko M, Sanja S, Rodoljub J, Extension of Ratio System part of MOORA method for solving decision making problems with interval data, Informatica, 23(1), 141-154, 2012.

[6]Ebrahimnejad A, Some new results in linear programs with trapezoidal fuzzy numbers: finite convergence of the Ganesan and Veeramani's method and a fuzzy revised simplex method, Appl Math Model, 35, pp. 4526-4540, 2011.

[7]Ganesan.K and Veeramani.P, Fuzzy linear programs with trapezoidal fuzzy numbers, Ann Oper Res 143,pp. 305-315,2006.

[8] Perez Dominguez L, Sanchez Mojica KY, Ovalles Pabon LC, Cordero Diaz MC, Application of the MOORA method for evaluation of the industrial maintenance systems, IOP Conf. Series on Applied Sciences and Engineering, 1126, pp. 1-6,2018.

[9]Smarandache F, Neutrosophic Set- a generalization of the intuitionistic fuzzy set, Int Jour of Pure Appl Math, 24,pp. 287-297, 2005.

[10] Stephy Stephen, Mohana K, On Generalized semi, regular closed sets in Intuitionistic topological spaces, Int Jour. Of Mathematical Archive, 9(3), pp. 101-105,2018.

[11]Umamageswari.R.M, Uthra.G, Generalized Single valued neutrosophic trapezoidal numbers and their applications to solve transportation problems, Journal for the study of research, 12(1), pp. 164-170, 2020.

[12]Wang.H, Smarandache F, Zhang YQ, Sunderraman.R, Single valued neutrosophic sets, Multi space and Multi structure, 4, pp. 410-413, 2010.

[13]Wang.J , Zhong Zhang, Aggregation operators on intuitionistic trapezoidal fuzzy number and its application to multi criteria decision making problems, Journal of Systems Eng. And electronics, 20(2),pp. 321-326,2009.

[14]Ye.J, A multi criteria decision making method using aggregation operators for simplified neutrosophic sets, J Intell Fuzzy Syst , 26, pp. 2459-2466,2014.

[15]Ye.J, Trapezoidal neutrosophic sets and its application to multiple attribute decision making, Neural Computing & Appl, 26, pp. 1157-1166,2015.

[16]Zadeh L.A, Fuzzy sets, Information and Control, 8, pp. 338-352,1965.

[17] Zaitun, Mustakim, Insanul Kamila, Siti SyahidatulHelma, Implementation of MOORA method for determining prospective smart Indonesia program funds recipients, Int. Jour. Of ENg.& advanced technology, vol 9(2), pp. 1920-1925,2019.

[18] Alireza Alinezhad, Javad Khalili, New Methods and applications in Multiple Attribute Decision Making (MADM), Int. Series in Operations research and Management Science, Vol 277, 2019.