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A NEW APPROACH FOR SOLVING TRAPEZOIDAL INTUITIONISTIC FUZZY TRANSPORTATION PROBLEM

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ABSTRACT. In this paper we proposed a new ranking method to find an optimal solution for Intuitionistic fuzzy transportation problem with trapezoidal entries. The ranking method based on signed distance is used to obtain the optimum cost in trapezoidal Intuitionistic fuzzy transportation problem.The solution procedure is illustrated with a numerical example.

1. INTRODUCTION

L.A.Zadeh [1] first introduced the concept of fuzzy set in 1965. However the fuzzy set describes the single membership function which states the support and opposition simultaneously. The concept of an Intuitionistic fuzzy set has been introduced by Attanassov [2, 3]. The major advantage of the Intuitionistic fuzzy set over fuzzy set is that Intuitionistic fuzzy set separate the membership and non-membership function of an element in the set. Thus the Intuitionistic fuzzy set seems to be suitable for dealing with natural attributes of physical phenonmena in complex management situation. Ranking of fuzzy numbers plays an important role in Decision making, optimization etc. For example ordering of fuzzy parameter or comparison of fuzzy numbers makes the decision maker

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to get the decision easily. Numerous methods have been proposed in literature, but there is no unique method for comparing fuzzy numbers. There are different ranking methods which are available in literature.

H.B.Mitchell [6] introduced a method of ranking of Intuitionistic fuzzy numbers, the ranking method of Intuitionistic fuzzy scoring to Intuitionistic fuzzy numbers was introduced by Nayagam *et al.* [5] Grzegorsewski [7] defined two families of metrics in space of Intuitionistic fuzzy numbers and proposed ranking method of Intuitionistic fuzzy numbers based on these metrics. Li [4] proposed a new ranking method based on ratio ranking to the value index and ambiguity index of Intuitionistic fuzzy numbers similar to those for a fuzzy number introduced by Delegado *et al.* [12] . Yao and Wu [10] introduced the ranking fuzzy numbers using signed distance. The limitations and shortcomings were pointed out in existing ranking methods also to overcome the short comings and modifying the existing approach by introducing a new ranking approach of ranking of Intuitionistic fuzzy numbers by Amit Kumar and Manoj Kaur [9]. Nagoorkani and Abbas [8] proposed a new ranking method for finding an optimal solution for triangular Intuitionistic fuzzy transportation problem

This paper is organized as follows: In section 2 we review the basic definitions and arithmetic operations of trapezoidal Intuitionistic fuzzy number. In section 3 a new ranking method of trapezoidal Intuitionistic fuzzy number is proposed. Section 4 provides the Mathematical formulation of Intuitionistic fuzzy transportation problem and applying the Algorithm to solve the Intuitionistic fuzzy transportation problem. In section 5 Numerical example is discussed and in section 6 comparative study is given. Finally in section 7 the conclusion is discussed.

2. Preliminaries

In this section some basic definitions and arithmetic operations are presented [11].

2.1. Basic Definitions.

Definition 2.1. *An Intuitionistic fuzzy set* $\widetilde{A} = \{< x, \mu_{\underset{A}{\sim}}(x), \nu_{\underset{A}{\sim}}(x) >: x \in X\}$ *on the universal set* X *is characterized by a membership function* $\mu_{\underset{A}{\sim}} : X \to [0,1]$ *and a non-membership function* $\nu_{\underset{A}{\sim}} : X \to [0,1]$*. The values* $\mu_{\underset{A}{\sim}}(x)$ *and* $\nu_{\underset{A}{\sim}}(x)$ *represent the degree of membership and the degree of non membership for* $x \in X$ *and always* *satisfies the condition* $\mu_{\widetilde{A}}(x) + \nu_{\widetilde{A}}(x) \leq 1 \; \forall \; x \in X$. *The value* $(1 - \mu_{\widetilde{A}}(x) - \nu_{\widetilde{A}}(x)))$ *represents the degree of hesitation for* $x \in X$.

Definition 2.2. *An Intuitionistic fuzzy set* $\widetilde{A} = \{< x, \mu_{\widetilde{A}}(x), \nu_{\widetilde{A}}(x) >: x \in X\}$ *is called IF-normal, if there are at least two points* $x_0, x_1 \in X$ *such that* $\mu_{\widetilde{A}}(x_0) = 1, \nu_{\widetilde{A}}(x_1) = 1$.

Definition 2.3. *An Intuitionistic fuzzy set* $\widetilde{A} = \{< x, \mu_{\widetilde{A}}(x), \nu_{\widetilde{A}}(x) >: x \in X\}$ *is called IF-convex, if* $\forall x_1, x_2 \in X, \; \lambda \in [0, 1]$.
$\mu_{\widetilde{A}}(\lambda x_1 + (1 - \lambda)x_2) \geq min(\mu_{\widetilde{A}}(x_1), \mu_{\widetilde{A}}(x_2))$
$\nu_{\widetilde{A}}(\lambda x_1 + (1 - \lambda)x_2) \leq max(\nu_{\widetilde{A}}(x_1), \nu_{\widetilde{A}}(x_2))$.

Definition 2.4. *An Intuitionistic fuzzy set* $\widetilde{A} = \{< x, \mu_{\widetilde{A}}(x), \nu_{\widetilde{A}}(x) >: x \in X\}$ *of the real line is called an Intuitionistic fuzzy number if*

(a) $\widetilde{A}$ *is IF - normal.*
(b) $\widetilde{A}$ *is IF - convex.*
(c) $\mu_{\widetilde{A}}$ *is upper semi continuous and* $\nu_{\widetilde{A}}$ *is lower semi continuous.*
(d) $\widetilde{A} = \{(x \in X | \nu_{\widetilde{A}}(x)) < 1\}$ *is bounded.*

Definition 2.5. *An Intuitionistic fuzzy number* $\widetilde{A}$ *defined on the universal set of real numbers* $\mathbb{R}$ *denoted as* $\widetilde{A} = \{a_1', a_1, a_2', a_2, a_3, a_3', a_4, a_4'\}$ *where* $a_1' \leq a_1 \leq a_2' \leq a_2 \leq a_3 \leq a_3' \leq a_4 \leq a_4'$ *is said to be trapezoidal Intuitionistic fuzzy number, if the degree of membership* $\mu_{\widetilde{A}}(x)$ *and the degree of non-membership* $\nu_{\widetilde{A}}(x)$ *are given by*

$$\mu_{\widetilde{A}}(x) = \begin{cases} \frac{x-a_1}{a_2-a_1} & if \quad a_1 \leq x \leq a_2 \\ 1 & if \quad a_2 \leq x \leq a_3 \\ \frac{a_4-x}{a_4-a_3} & if \quad a_3 < x \leq a_4 \\ 0 & otherwise \end{cases}$$

$$\nu_{\widetilde{A}}(x) = \begin{cases} \frac{x-a_1^1}{a_2^1-a_1^1} & if \quad a_1^1 \leq x \leq a_2^1 \\ 0 & if \quad a_2^1 \leq x \leq a_3^1 \\ \frac{a_4^1-x}{a_4^1-a_3^1} & if \quad a_3^1 < x \leq a_4^1 \\ 1 & otherwise \end{cases}$$

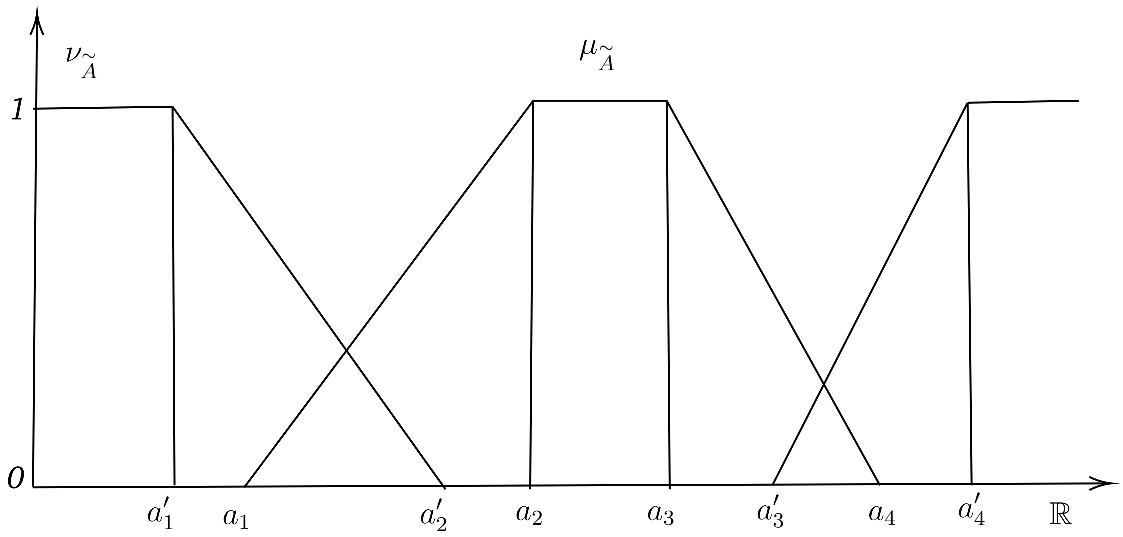

FIGURE 1. Trapezoidal Intuitionistic Fuzzy Number

Definition 2.6. *The ranking approach by [9] is*

$$\begin{aligned} M_{\mu}^{\beta,k}(\widetilde{A}) =&\Bigg(\beta\Big(\frac{k+1}{2}\Big)\int_0^1 r^k(a_2+a_3)dr \\ &+(1-\beta)\Big(\frac{k+1}{2}\Big)\int_0^1 r^k[a_1+(a_2-a_1)r+a_4+(a_3-a_4)rdr]\Bigg) \\ M_{\nu}^{\beta,k}(\widetilde{A}) =& \Bigg(\beta\Big(\frac{k+1}{2}\Big)\int_0^1 r^k(a_2'+a_3')dr \\ &+(1-\beta)\Big(\frac{k+1}{2}\Big)\int_0^1 r^k[a_1'+(a_2'-a_1')r+a_4'+(a_3'-a_4')rdr]\Bigg). \end{aligned}$$

For $\beta = \frac{1}{3}$ and $k = 0$ the index for membership and non membership functions $M_{\mu}^{\frac{1}{3},0}(\widetilde{A})$ and $M_{\nu}^{\frac{1}{3},0}(\widetilde{A})$ are as follows:

$$M_{\mu}^{\frac{1}{3},0}(\widetilde{A}) = \frac{1}{3}\Big(\frac{a_1+2a_2+2a_3+a_4}{2}\Big)$$

and

$$M_{\nu}^{\frac{1}{3},0}(\widetilde{A}) = \frac{1}{3}\Big(\frac{a_1^1+2a_2^1+2a_3^1+a_4^1}{2}\Big),$$

where $\widetilde{A} = \{a_1', a_1, a_2', a_2, a_3, a_3', a_4, a_4'\}$ $\beta \in [0,1]$ is the index of modality that represent the importance of the central value against the extreme values and $\lambda \in [0,1]$ is the degree of optimism of the decision maker.

Definition 2.7. *The ranking approach by [13],* $\mathfrak{R} : F(\mathbb{R}) \to \mathbb{R}$ *which maps each fuzzy number in to the real line;* $F(\mathbb{R})$ *represents the set of all intuitionistic trapezoidal fuzzy numbers. If* $\mathfrak{R}$ *be any linear ranking function, then*

$$\mathfrak{R}(\widetilde{A}) = \left(\frac{b_1 + a_1 + b_2 + a_2 + a_3 + b_3 + a_4 + b_4}{8}\right),$$

where $\widetilde{A} = (a_1, a_2, a_3, a_4), (b_1, b_2, b_3, b_4)$.

Definition 2.8. *The ranking approach for Generalized Trapezoidal Intuitionistic Fuzzy numbers by [14] is the centroid* $G(\overline{x}_0{}', \overline{y}_0{}')$ *of the triangle with vertices* G_1, G_2, G_3 *of the membership part of the trapezoidal intuitionistic fuzzy number* $A = ((a_1, a_2, a_3, a_4), (b_1, b_2, b_3, b_4) : \omega_A, u_A)$ *is*

$$G(\overline{x}_0{}', \overline{y}_0{}') = \left(\frac{2a_1 + 7a_2 + 7a_3 + 2a_4}{18}, \frac{7\omega_A}{18}\right)$$

$$S(\mu_A) = \overline{x}_0{}', \overline{y}_0{}' = \left(\frac{2a_1 + 7a_2 + 7a_3 + 2a_4}{18}\right)\left(\frac{7\omega_A}{18}\right).$$

the centroid $G'(\overline{x}_0{}', \overline{y}_0{}')$ *of the triangle with vertices* G'_1, G'_2, G'_3 *of the non-membership part of the trapezoidal intuitionistic fuzzy number*
$A = ((a_1, a_2, a_3, a_4), (b_1, b_2, b_3, b_4) : \omega_A, u_A)$

$$G'(\overline{x}_0{}', \overline{y}_0{}') = \left(\frac{2b_1 + 7b_2 + 7b_3 + 2b_4}{18}, \frac{11 + 7u_A}{18}\right)$$

$$S(\nu_A) = \overline{x}_0{}', \overline{y}_0{}' = \left(\frac{2b_1 + 7b_2 + 7b_3 + 2b_4}{18}\right)\left(\frac{11 + 7u_A}{18}\right).$$

Using the above definitions rank of A *is defined as follows:*

$$\mathfrak{R}(A) = \left(\frac{\omega_A S(\mu_A) + u_A S(\nu_A)}{\omega_A + u_A}\right),$$

where $0 < \omega_A \leq 1,\ 0 < u_A \leq 1$ *and* $0 < \omega_A + u_A \leq 1$

2.2. **Arithmetic Operations on Trapezoidal Intuitionistic Fuzzy Number.**
Let $\widetilde{A} = \{a_1^1, a_1, a_2^1, a_2, a_3, a_3^1, a_4, a_4^1\}$ and $\widetilde{B} = \{b_1^1, b_1, b_2^1, b_2, b_3, b_3^1, b_4, b_4^1\}$ be two Trapezoidal intuitionistic fuzzy numbers then the arithmetic operations on $\widetilde{A}$ and $\widetilde{B}$ are as follows:

(i) Addition:
$\widetilde{A} \oplus \widetilde{B} = (a_1^1 + b_1^1, a_1 + b_1, a_2^1 + b_2^1, a_2 + b_2, a_3 + b_3, a_3^1 + b_3^1, a_4 + b_4, a_4^1 + b_4^1)$.

(ii) Subtraction:
$\widetilde{A} \ominus \widetilde{B} = (a_1^1 - b_4^1, a_1 - b_4, a_2^1 - b_3^1, a_2 - b_3, a_3 - b_2, a_3^1 - b_2^1, a_4 - b_1, a_4^1 - b_1^1)$.

(iii) Multiplication:
$\widetilde{A} \otimes \widetilde{B} = (a_1^1 b_1^1, a_1 b_1, a_2^1 b_2^1, a_2 b_2, a_3 b_3, a_3^1 b_3^1, a_4 b_4, a_4^1 b_4^1)$.

(iv) Scalar Multiplication:
$$\lambda\widetilde{A} = \begin{cases} (\lambda a_1^1, \lambda a_1, \lambda a_2^1, \lambda a_2, \lambda a_3, \lambda a_3^1, \lambda a_4, \lambda a_4^1), \lambda \geq 0 \\ (\lambda a_4^1, \lambda a_4, \lambda a_3^1, \lambda a_3, \lambda a_2, \lambda a_2^1, \lambda a_1, \lambda a_1^1), \lambda \leq 0 \end{cases}$$

3. Ranking of Trapezoidal Instuitionistic Fuzzy Numbers

A Trapezoidal intuitionistic fuzzy number $\widetilde{A} = \{a_1^1, a_1, a_2^1, a_2, a_3, a_3^1, a_4, a_4^1\}$ is defined by its membership and non-membership function as follows:

$$\widetilde{A}_\mu^L(x) = \frac{x - a_1}{a_2 - a_1} \text{ if } a_1 \leq x \leq a_2 \text{ and } \widetilde{A}_\mu^R(x) = \frac{a_4 - x}{a_4 - a_3} \text{ if } a_3 < x \leq a_4$$
$$\widetilde{A}_\nu^L(x) = \frac{x - a_1^1}{a_2^1 - a_1^1} \text{ if } a_1^1 \leq x \leq a_2^1 \text{ and } \widetilde{A}_\nu^R(x) = \frac{a_4^1 - x}{a_4^1 - a_3^1} \text{ if } a_3^1 < x \leq a_4^1$$

The inverse function can be analytically expressed as follows:
$$\widetilde{A}_\mu^{*L}(\alpha) = a_1 + (a_2 - a_1)\alpha, \ \widetilde{A}_\mu^{*R}(\alpha) = a_4 - (a_4 - a_3)\alpha$$

$$\widetilde{A}_\nu^{*L}(\beta) = a_1^1 + (a_2^1 - a_1^1)(1 - \beta), \ \widetilde{A}_\nu^{*R}(\beta) = a_4^1 - (a_4^1 - a_3^1)(1 - \beta)$$

The signed distance of $\widetilde{A}$ is
$$D(\widetilde{A}, \widetilde{0}_1) = \frac{1}{4}\left[\int_0^1 [\widetilde{A}_\mu^{*L}(\alpha) + \widetilde{A}_\mu^{*R}(\alpha)]f(\alpha)d\alpha + \int_0^1 [\widetilde{A}_\nu^{*L}(\beta) + \widetilde{A}_\nu^{*R}(\beta)]g(\beta)d\beta\right]$$
where $f(\alpha)$ and $g(\beta)$ is the weight of Intuitionistic Fuzzy number.

$D(\widetilde{A}, \widetilde{0}_1)$ is the signed distance of $\widetilde{A}$ from fuzzy origin $\widetilde{0}_1$ and $0 \leq \alpha \leq 1, 0 \leq \beta \leq 1$.

$$D(\widetilde{A}, \widetilde{0}_1) = \frac{1}{4}\int_0^1 \big([a_1 + (a_2 - a_1)\alpha] + [a_4 - (a_4 - a_3)\alpha]\big)\alpha d\alpha$$
$$+\frac{1}{4}\int_0^1 \big([a_1^1 + (a_2^1 - a_1^1)(1 - \beta)] + [a_4^1 - (a_4^1 - a_3^1)(1 - \beta)]\big)(1 - \beta)d\beta$$
$$D(\widetilde{A}, \widetilde{0}_1) = \frac{a_1 + a_1^1 + 2a_2^1 + 2a_2 + 2a_3 + 2a_3^1 + a_4 + a_4^1}{24}$$

where $f(\alpha) = \alpha$ and $g(\beta) = 1 - \beta$.

Similarly, for another Trapezoidal intuitionistic fuzzy number

$$\widetilde{B} = \{b_1^1, b_1, b_2^1, b_2, b_3, b_3^1, b_4, b_4^1\}$$
$$D(\widetilde{B}, \widetilde{0}_1) = \frac{b_1 + b_1^1 + 2b_2^1 + 2b_2 + 2b_3 + 2b_3^1 + b_4 + b_4^1}{24},$$

where $D(\widetilde{A}, \widetilde{B})$ is the difference of the two signed distances of two intuitionistic fuzzy sets $\widetilde{A}$ and $\widetilde{B}$ from fuzzy origin $\widetilde{0}_1$.

Case (i): $D(\widetilde{A}, \widetilde{B}) > 0$ iff $D(\widetilde{A}, \widetilde{0}_1) > D(\widetilde{B}, \widetilde{0}_1)$ iff $\widetilde{B} < \widetilde{A}$.

Case (ii): $D(\widetilde{A}, \widetilde{B}) < 0$ iff $D(\widetilde{A}, \widetilde{0}_1) < D(\widetilde{B}, \widetilde{0}_1)$ iff $\widetilde{A} < \widetilde{B}$.

Case (iii): $D(\widetilde{A}, \widetilde{B}) = 0$ iff $D(\widetilde{A}, \widetilde{0}_1) = D(\widetilde{B}, \widetilde{0}_1)$ iff $\widetilde{B} \approx \widetilde{A}$.

4. Mathematical Formulation of Trapezoidal Intuitionistic Fuzzy Transportation Problem

Consider a transportation problem with m Intuitionistic Fuzzy sources and n Intuitionistic Fuzzy destinations. Let $\widetilde{C}_{ij}(i = 1, 2, 3, \ldots, m,\ j = 1, 2, 3, \ldots, n)$ be the cost of transporting one unit of the product from trapezoidal Intuitionistic Fuzzy i^{th} source to trapezoidal Intuitionistic Fuzzy j^{th} destination. Let $\widetilde{a}_i(i = 1, 2, \ldots, m)$ be the trapezoidal Intuitionistic Fuzzy supply at i^{th} source, and let $\widetilde{b}_j(j = 1, 2, \ldots, n)$ be the trapezoidal Intuitionistic Fuzzy demand at j^{th} destination. Let $\widetilde{X}_{ij}$ $(i = 1, 2, 3, \ldots, m,\ j = 1, 2, 3, \ldots, n)$ be the decision variables denoting the transportation amount from trapezoidal Intuitionistic Fuzzy i^{th} source to trapezoidal Intuitionistic Fuzzy j^{th} destination.

Mathematical Model of trapezoidal Intuitionistic Fuzzy Transportation problem is

Minimize $Z = \Sigma_{i=1}^{m} \Sigma_{j=1}^{n} \widetilde{C}_{ij} \otimes \widetilde{X}_{ij}$

subject to $\Sigma_{j=1}^{n} \widetilde{X}_{ij} = \widetilde{a}_i (i = 1, 2, \ldots, m)$

$\Sigma_{i=1}^{m} \widetilde{X}_{ij} = \widetilde{b}_j (j = 1, 2, \ldots, n)$

$\widetilde{X}_{ij} \geq \widetilde{0}$ for all i and j.

$\widetilde{X}_{ij}, \widetilde{C}_{ij}, \widetilde{a}_i, \widetilde{b}_j$ are trapezoidal Intuitionistic Fuzzy numbers.

Algorithm for Proposed Method:

Step 1: Find the total intuitionistic fuzzy supply $\Sigma_{i=1}^{m}\widetilde{a}_i$ and the total intuitionistic fuzzy demand $\Sigma_{j=1}^{n}\widetilde{b}_j$.

Let $\widetilde{a}_i = \{a_1^1, a_1, a_2^1, a_2, a_3, a_3^1, a_4, a_4^1\}$ and $\widetilde{b}_j = \{b_1^1, b_1, b_2^1, b_2, b_3, b_3^1, b_4, b_4^1\}$. Examine the problem whether it is balanced or not.

i.e., $\Sigma_{i=1}^{m}\widetilde{a}_i = \Sigma_{i=1}^{n}\widetilde{b}_j$ or $\Sigma_{i=1}^{m}\widetilde{a}_i \neq \Sigma_{i=1}^{n}\widetilde{b}_j$

If the problem is balanced then go to step 2, otherwise introduce dummy rows or dummy columns with zero intuitionistic fuzzy costs to form a balanced one.

Step 2: Apply VAM method to find the initial basic feasible solution. If $m+n-1$ is equal to number of allocations, then using MODI method find the Intuitionistic fuzzy optimal solution.

Step 3: Using the Proposed ranking method based on signed distance, defuzzify the total intuitionistic optimal fuzzy cost into crisp cost which gives the optimal solution of the problem.

5. Numerical Example

The Trapezoidal Intuitionistic fuzzy (IF) transportation problem with three origins O_1, O_2, O_3 and three destinations D_1, D_2, D_3 is shown in Table 1.

TABLE 1. Trapezoidal IF transportation problem

	D_1	D_2	D_3	IF Supply
O_1	(4,8,10,12, 14,16,24,28)	(0.5,1,2,4, 5,7,17,17.5)	(0,0.5,1,3, 5,7,7.5,8)	(2,3,6,8, 9,10,11,14)
O_2	(0,0.5,1,3, 5,7,7.5,8)	(0.5,0.8,1.5,2, 2.2,2.5,2.8,3.5)	(0.5,1,2,4, 5,7,17,17.5)	(0,0.5,1,3, 5,7,7.5,8)
O_3	(0.5,1,2,4, 5,7,17,17.5)	(2,3,6,8, 9,10,11,14)	(4.5,5,8,11 14,16,17,19.5)	(8,8.5,10,12, 14,16,35.5,36)
IF Demand	(5,6,7,8, 9,10,20,21)	(0.5,1,2,4, 5,7,17,17.5)	(4.5,5,8,11, 14,16,17,19.5)	

Solution: The Trapezoidal Intuitionistic fuzzy transportation problem which we considered is balanced and shown in Table 2.

TABLE 2. Balanced Trapezoidal IF transportation problem

	D_1	D_2	D_3	IF Supply
O_1	(4,8,10,12, 14,16,24,28)	(0.5,1,2,4, 5,7,17,17.5)	(0,0.5,1,3, 5,7,7.5,8)	(2,3,6,8, 9,10,11,14)
O_2	(0,0.5,1,3, 5,7,7.5,8)	(0.5,0.8,1.5,2, 2.2,2.5,2.8,3.5)	(0.5,1,2,4, 5,7,17,17.5)	(0,0.5,1,3, 5,7,7.5,8)
O_3	(0.5,1,2,4, 5,7,17,17.5)	(2,3,6,8, 9,10,11,14)	(4.5,5,8,11 14,16,17,19.5)	(8,8.5,10,12, 14,16,35.5,36)
IF Demand	(5,6,7,8, 9,10,20,21)	(0.5,1,2,4, 5,7,17,17.5)	(4.5,5,8,11, 14,16,17,19.5)	**(10,12,17,23, 28,33,54,58)**

Apply VAM for initial basic feasible solution and MODI method for the intuitionistic fuzzy optimal solution. The intuiti- onistic fuzzy optimal table which we obtained by using arithmetic operations given in section 2 is shown in Table 3.

TABLE 3. Optimum IF transportation table

	D_1	D_2	D_3	IF Supply
O_1	(4,8,10,12, 14,16,24,28)	(0.5,1,2,4, 5,7,17,17.5)	**(2,3,6,8, 9,10,11,14)**	(2,3,6,8, 9,10,11,14)
O_2	(0,0.5,1,3, 5,7,7.5,8)	**(0,0.5,1,3, 5,7,7.5,8)**	(0.5,1,2,4, 5,7,17,17.5)	(0,0.5,1,3, 5,7,7.5,8)
O_3	**(5,6,7,8, 9,10,20,21)**	**(-7.5,-6.5,-5,-1, 2,6,16.5,17.5)**	**(-9.5,-6,-2,2, 6,10,14,17.5)**	(8,8.5,10,12, 14,16,35.5,36)
IF Demand	(5,6,7,8, 9,10,20,21)	(0.5,1,2,4, 5,7,17,17.5)	(4.5,5,8,11, 14,16,17,19.5)	**(10,12,17,23, 28,33,54,58)**

Step 3: The optimum solution is
$x_{13} = (2, 3, 6, 8, 9, 10, 11, 14)$;
$x_{22} = (0, 0.5, 1, 3, 5, 7, 7.5, 8)$;
$x_{31} = (5, 6, 7, 8, 9, 10, 20, 21)$;
$x_{32} = (-7.5, -6.5, -5, -1, 2, 6, 16.5, 17.5)$;

$x_{33} = (-9.5, -6, -2, 2, 6, 10, 14, 17.5)$ and
The total Intuitionistic fuzzy transportation optimal cost
$= (0, 0.5, 1, 3, 5, 7, 7.5, 8) \otimes (2, 3, 6, 8, 9, 10, 11, 14)$
$\oplus(0.5, 0.8, 1.5, 2, 2.2, 2.5, 2.8, 3.5) \otimes (0, 0.5, 1, 3, 5, 7, 7.5, 8)$
$\oplus(0.5, 1, 2, 4, 5, 7, 17, 17.5) \otimes (5, 6, 7, 8, 9, 10, 20, 21)$
$\oplus(2, 3, 6, 8, 9, 10, 11, 14) \otimes (-7.5, -6.5, -5, -1, 2, 6, 16.5, 17.5)$
$\oplus(4.5, 5, 8, 11, 14, 16, 17, 19.5) \otimes (-9.5, -6, -2, 2, 6, 10, 14, 17.5)$.
$= (\mathbf{-55.25, -41.6, -24.5, 76, 203, 377.5, 863, 1093.75})$

Using the **Proposed Ranking Method**, defuzzified Intuitionistic fuzzy transportation optimal cost is **130.1625**.

6. Comparative Study

A comparative study between the proposed method and some of the other existing methods is shown in Table 4.

TABLE 4. Comparative Study

	Ranking Method	Result
1	Proposed Method	130.1625
2	Amitkumar and Kaur [9]	520.6500
3	D. Stephan Dinagar and K. Thiripurasundari [13]	311.4875
4	Nagoorgani A and Mohammed V.N [14]	165.1769

7. Conclusion

In this paper we proposed a new ranking function based on signed distance method to solve the Trapezoidal Intuitionistic Fuzzy transportation problem. From the comparative study (Table 4) we observed that our proposed new ranking method gives better results when compared to some of other existing methods for solving trapezoidal Intuitionistic fuzzy transportation problem. In future, the proposed ranking function may be used to solve various types of Intuitionistic fuzzy optimization problems.

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