A new ranking based fuzzy approach for fuzzy transportation problem

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Abstract

In the current scenario of the competitive market, the adversity on the organization finds the better method to create and deliver values and services to the customers as per customer's requirement with in optimal cost and time. The transportation model provides a robust framework to meet these challenges. For solving real life problems, there are several methods to solve transportation problem in fuzzy circumstances. In this paper, a method is suggested to solve fuzzy transportation problem in which trapezoidal fuzzy numbers represent transportation cost, availability, and demand for the product. To illustrate the proposed method, a numerical example is solved and obtained results are associated with the results of existing methods. It is observed that proposed method gives the optimal result in comparison to previously existing method and it is very easy to explain and implement in real life transportation problem for the decision maker.

Keywords

Competitive market,
ranking method,
fuzzy transportation,
robust framework

1 Introduction

A transportation problem permits only those shipments that go directly from a supply point to a demand point. A fuzzy transportation problem is defined as a transportation problem in which the transportation costs, supply, and demand quantities are fuzzy numbers. Most of the existing techniques give only crisp solutions for the fuzzy transportation problem. The aim of fuzzy transportation is to find the least transportation cost of some commodities through a capacitated network when the supply and demand of nodes and the capacity and cost of edges are interpreted as fuzzy numbers. Parameters of the transportation problem consist of the amount of cost, supply, and demand. In the usual form of this query, some parameters are fixed and definitive, but in the real world, the parameters are ambiguous and imprecise.

Singh and Saxena proposed a new method for optimization of cost in fuzzy transportation problem using secure data transfer technique, which gives optimal results as compared to existing methods and also takes less number of iterations [1]. Ebrahimnejad has given a new method for solving the fuzzy transportation problem in which non-negative LR flat, fuzzy numbers applied to the representation of transportation cost, supply and demand [2]. Radhika and Parvathi introduced various types of intuitionistic fuzzification function like triangular, trapezoidal, gaussian, bell-shaped, sigmoidal, S-shaped, Z-shaped functions, which are more useful in the real world [3]. Maliniand and Ananthanarayanan discussed about ranking fuzzy number, which plays an essential role in various problems such as analysis of data, decision-making problems, socio economic systems etc. It is important step in various mathematical models. Fuzzy ranking method provides a magnificent tool for managing the fuzzy transportation problem [4]. Nareshkumar and Kumaraghuru have presented closed, bounded and non-empty feasible region of the transportation problem by using fuzzy trapezoidal numbers and ensures the existence of an optimal solution to a balanced transportation problem. Fuzzy Vogel's Approximation Method (VAM) is used for finding the initial solution of the transportation problem. On the other side, fuzzy modified distribution method is used for determining the optimality of the obtained solution [5]. Narayanamoorthy and Kalyani derived a new technique for solving the fuzzy transportation problem and compared with previously existing method [6]. Khalaf has given for new fuzzy Russell's Approximation method to solve the fuzzy transportation problem when all the cost coefficients are in the form of fuzzy numbers while all demands and supplies are in the form of crisp numbers to find out the initial basic feasible solution [7]. Solaiappan and Jeyaraman investigated the fuzzy transportation problem by using zero termination method. In this way, the transportation cost, supply, and demand are assumed to lie in the interval of values. The Robust Ranking method is used for the arrangement of fuzzy numbers in a particular range. The α-cut method is also used for the formation of a new equation which is used to find out the optimal solution [8]. Rani et. al. have considered the fully fuzzy unbalanced transportation problem in which the total demand is less than the total availability/ production. Dummy destination is used for solving this type of problem [9]. Gani et al. have introduced an improved version of VAM for finding the initial solution for the large-scale transshipment problems [10]. Das have et al. discussed the limitations of the VAM and developed an improved algorithm to solve the transportation problem. The limitation of VAM is that it is not applied when highest penalty cost appears in two or more rows or columns. In this case, VAM does not give any logical solution, so a new algorithm named as a logical development of VAM applied for obtaining a feasible solution [11]. Narayanamoorthy et.

al. have accomplished a new algorithm called Fuzzy Russell's method to get the initial basic feasible solution of a fuzzy transportation problem [12]. Shanmugasundari and Ganesan proposed a new method to solve the fuzzy optimal solution by using a fuzzy version of Vogel's and Modified Distribution Method (MODI) method for finding fuzzy basic feasible and fuzzy optimal solution of fuzzy transportation problem without molding them into classical transportation problem [13]. Chauhan and Joshi developed a method in which Ranking method is used to find out the fuzzy optimal solution of balanced fuzzy transportation problem by using fuzzy trapezoidal numbers with the improvement of VAM [14]. Fegade et al. have found out the least shipping cost through a capacitated network when the supply, demand, capacity and the cost of edges are represented trough fuzzy numbers and proposed a ranking method for solving the transportation problem [15]. Mohanaselvi and Ganesan have proposed a new algorithm for the fuzzy feasible solution to an entirely fuzzy transportation problem [16]. Poonam et. al. have presented a ranking technique in which α-optimal solution used for solving the fuzzy transportation problem. The fuzzy demand and supply are in the form of triangular fuzzy numbers [17]. Gani and Assarudeen have used the triangular fuzzy number to find out a solution of the method in which subtraction and division modified, and these modified operators results in exact inverse of the addition and multiplication of numbers [18]. Kumar and Kaur have identified two new methods to find out the fuzzy optimal solution of the unbalanced fuzzy transportation problem. The method is based on fuzzy linear programming formulation and classical transportation method and also proposed a new representation of trapezoidal fuzzy numbers [19]. Samuel and Venkatachalapathy have suggested modified VAM for solving the fuzzy transportation problem. This method is more efficient than any other method [20]. Kaur and Kumar have proposed a new method for solving fuzzy transportation problems through a hypothesis in which the decision maker is uncertain about the precise values of transportation cost, availability, and demand for the product. The trapezoidal fuzzy numbers used in this method for the representation of transportation cost, availability, and demand of the product [21]. Pandian and Natarajan have proposed a new algorithm named as zero point method for obtaining a fuzzy optimal solution for fuzzy transportation problem where all the cost are in the form of fuzzy trapezoidal numbers [22]. Guzel has investigated a fuzzy transportation problem with fuzzy quantities in which the bounded fuzzy triangular numbers and fuzzy transportation cost per unit bounded with upper fuzzy numbers [23]. Abbasbandy and hajjari described about the major role of ranking fuzzy number in decision-making and other various fuzzy application systems. For ranking fuzzy numbers there are several approach have been proposed and in certain cases these approaches have been shown to generate non-intuitive results. A new technique for ranking of trapezoidal numbers which is based on left and right expansion at some α-levels of trapezoidal fuzzy numbers is also introduced [24]. Peidro et al. have discussed the today's global marketplace scenarios in which separate and individual enterprise do not fulfil as individualistic entities preferably as an essential part of a supply chain. A fuzzy mathematical programming model is proposed for supply chain planning which takes supply, demand and process uncertainties. This model has been specified as a fuzzy mixed-integer linear programming model in which data is ill-known and represented by triangular fuzzy numbers. The fuzzy model provides the efficient decision maker with other alternative decision plans for various degree of satisfaction. This model is tested by using data from real automobile supply chain [25]. Chen et al. considered fuzzy transportation problems with fulfilment degree of paths since excluding the cost of transportation of paths, its safety and transportation time etc factor should be considered into account. There are some other factors in transportation such as flexibility in demand and supply of any product should also be considered into account. Furthermore the fuzzy objective about total transportation cost is taken instead of minimizing the total transportation cost precisely. So there are two criteria are considered, one is to maximize the minimum satisfaction degree with respect to the flexibility and fuzzy objective. The other is to maximize the minimum satisfaction degree among path used in transportation. For fulfilment of both criteria, there are some non-dominated resolutions after describing non-domination [26]. Yang and liu explored the settled charge solid transportation issue under fuzzy condition, in which the immediate cost, the settled charges, the supplies, the demands and the movement limits are supposed to be fuzzy factors. Accordingly, a few new models, i.e., expected value model, chance-constrained programming model are built on the premise of credibility theory. From that point onward, the crisp equivalence is also talked about for various models. Keeping in mind the end goal to settle the models, hybrid intelligent algorithm is designed depend on the fuzzy simulation technique and tahu search algorithm [27]. Ganesan and Veeramani concerned with a variety of fuzzy linear programming including symmetric trapezoidal fuzzy numbers. There are some significant and compelling outcomes are acquired which sequentially move to an output of fuzzy linear programming problems without transforming them to crisp linear programming problems [28]. Cadenas and Verdegay outlined the importance and use of fuzzy linear programming models and techniques inside the wide area of soft computing. Its experimental and practical applications can be found in various area of real world. In fuzzy mathematical programming there are some techniques and models developed based on some factors such as fuzzy cost, fuzzy constraints to be analyzed [29]. Chiang described that how to fuzzify crisp transportation problem into fuzzy sense transportation problem while considering the amount of supply and demand from the origin to destination. The use of λ-level fuzzy number and (λ, ρ) interval-valued fuzzy number in the fuzzification of constraints. By using this, the crisp transportation problem is fuzzified in fuzzy sense based statically data [30]. Ammar and Youness stated that the solid transportation problem (STP) emerges when limits are given on three thing properties. Typically, these properties are supply, demand and sort of product or method of transport. The productive arrangements and dependability of multi objective solid transportation issue with fuzzy coefficient and fuzzy supply amount and fuzzy demand amount and fuzzy movements are examined. The idea of fuzzy productive is presented in which the ordinary efficient solution is expended based on the α-level of fuzzy numbers. An important and adequate condition for such a solution is established [31]. Liu and Kao have developed a procedure to find out the fuzzy objective value of the fuzzy transportation problem in which the cost coefficient, supply and demand quantities are fuzzy numbers. There are two different types of queries were discussed in which one belongs to inequality constraints while the other one belongs to equality constraints [32]. Maleki described a strategy to bring together a portion of the current methodology, which is utilizing diverse positioning capacities, which are using different ranking function for solving fuzzy programming problem. Besides there is another technique for tackling linear programming with vagueness in limitations by utilizing any linear ranking function [33]. Maliniand and Ananthanarayanan have presented a new ranking method, in which fuzzy transportation problem converted into a crisp value transportation problem, which can be solved, by MODI method [34].

2 Preliminaries

Lotfi A. Zadeh has introduced fuzzy set theory in 1965. Fuzzy set theory has advanced in the variety of ways in various disciplines. There are miscellaneous applications of this theory such as in artificial intelligence, control engineering, computer science, expert system, management science, operation research, medicine, decision theory, pattern recognition, etc.

2.1 FUZZY NUMBER:

A fuzzy number Ã is a fuzzy subset of real number R if its membership function $\mu_{\tilde{A}}$ qualifies the three following properties,

(i) $\mu_{\tilde{A}}(\mathrm{x})$ is a continuous function from R to a closed subset [0, 1];

(ii) $\mu_{\tilde{A}}(\mathrm{x})$ is strictly increasing in the close interval $[a_1, a_2]$;

(iii) $\mu_{\tilde{A}}(\mathrm{x})$ is strictly decreasing on $[a_3, a_4]$ where $a_1 < a_2 < a_3 < a_4$ and $x \in [a_1, a_4]$

Definition-1: A fuzzy number is said to be a convex normalized fuzzy set of the real line R, whose membership function is section wise continuous. We represent the set of fuzzy numbers on R as F(R).

Fuzzy Set: A fuzzy set distinguished by a membership function mapping element of a domain, universe of discourse X to the unit interval [0,1] i.e. $A = \{\mathrm{x}, \mu_{\tilde{A}}(\mathrm{x}); \mathrm{x} \in \mathrm{X}\}$, Here $\mu_{\tilde{A}} : \mathrm{X} \to [0,1]$ is a mapping known as the degree of membership function of the fuzzy set A and μA(x) is known as the membership value of x ε X in the fuzzy set A. These membership categories often represented by real numbers ranging from [0, 1].

Definition-2: A Fuzzy set $\tilde{A}$ explained as the set of ordered pairs $(\mathrm{X}, \mu_{\tilde{A}}(\mathrm{x}))$, where X is a component of the universe of discourse U and $\mu_{\tilde{A}}(\mathrm{x})$ is the membership function that imputes to each $\mathrm{X} \in \mathrm{U}$ a real number ∈ [0,1] relating the degree to which X belongs to the set.

Definition-3: A type n fuzzy set is a fuzzy set whose membership values are type $n-1,\ n>1,$ fuzzy sets on $[0,1]$.

Definition-4: For a finite fuzzy set $\tilde{A}$ the cardinality $|\tilde{A}|$ is defined as $|\tilde{A}| = \sum_{x \in X} \mu_{\tilde{A}}(\mathrm{x})$

$\|\tilde{A}\| = \frac{|\tilde{A}|}{X}$ is called the relative cardinality of $\tilde{A}$.

Definition-5: A crisp set is a particular case of fuzzy set in which membership function uses only two values 0 and 1.

2.2 OPERATIONS ON FUZZY SETS

Zadeh explained the following operations for fuzzy set as generalization of crisp sets and of crisp statements

Definition-6: Intersection (Logical AND): The membership function of the intersection of two fuzzy sets $\tilde{A}$ and $\tilde{B}$ is explained as:

$$\mu_{\tilde{A} \cap \tilde{B}}(\mathrm{X}) = \mathrm{Min}(\mu_{\tilde{A}}(\mathrm{X}), \mu_{\tilde{B}}(X)) \forall \mathrm{x} \in \mathrm{X}) .$$

Definition-7: Union (Exclusive OR): The membership function of the union is explained as:

$$\mu_{\tilde{A} \cup \tilde{B}}(\mathrm{X}) = \mathrm{Max}(\mu_{\tilde{A}}(\mathrm{X}), \mu_{\tilde{B}}(X)) \forall \mathrm{x} \in \mathrm{X}) .$$

Definition-8: Complement (Negation): The membership function of the complement is explained as:

$$\mu_{\tilde{A}}(\mathrm{X}) = 1 - \mu_{\tilde{A}}(X) \forall \mathrm{x} \in \mathrm{X} .$$

2.3 FUZZY TRANSPORTATION PROBLEM

In conventional transportation problem, it is expected that the decision maker has correct data about the coefficients having a place of the issue. Although, in real–life circumstances, the transportation cost, demand and supply of an item may not be known exactly due to wild factors. To deal with such circumstances, the fuzzy set theory is applied in the documentation for tackling transportation issues. The fuzziness in a transportation issue might be identified with the trouble of measuring or anticipating the unit transportation cost and the supply or demand. The fuzziness in the supply might be intimated as "the amount accessible is approximately . . ."which shows that there is adaptability in the supply; or that a more noteworthy supply might be conceivable. In the same manner, the decision maker may be fulfilled if the amount got at a goal is an estimated esteem or might have the capacity to acknowledge an amount lower than the objective esteem. The objective outcome is to minimize the total cost of fuzzy transportation problem and the supply and demand constraints are available to each source and destination consequently.

A FTP; in which a decision maker is unverifiable about the exact transportation cost, supply and demand activity might be formulated mathematically.

Consider a transportation problem with x supply nodes and y demand nodes, in that sj > 0 units are provided by supply i and by demand node j the required nodes are dj > 0. Related with each connection (i, j) from supply node i to demand node j, for transportation there is a unit shipping cost C_{ij}. The issue is to decide a feasible method for transportation the accessible add up to fulfill the demand that minimize the aggregate transportation cost.

Let X_{ij} express the number of units, which are, transported from Supply i to Demand j. The mathematical description of the transportation problem is:

$$z = \min \sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij} x_{ij}$$

$$s.t. \quad \sum_{j=1}^{n} x_{ij} \le s_i \qquad i = 1, 2, ...m,$$

$$\sum_{j=1}^{m} x_{ij} \ge d_j \qquad j = 1, 2, ...n,$$

$$x_{ij} \ge 0 \quad \forall i, j$$

3 Trapezoidal fuzzy number

A fuzzy number $\tilde{A} = (a_1, a_2, a_3, a_4)$ is said to be a trapezoidal fuzzy number if its membership function interpreted as follows (Figure 1)

$$\mu_{(\tilde{A})}(x) = \begin{cases} 0, & x < a_1 \\ \dfrac{x - a_1}{a_2 - a_1}, & a_1 \le x \le a_2 \\ 1, & a_2 \le x \le a_4 \\ \dfrac{a_4 - x}{a_4 - a_3}, & a_2 \le x \le a_3 \\ 0, & x > a_4 \end{cases} \quad . \qquad (1)$$

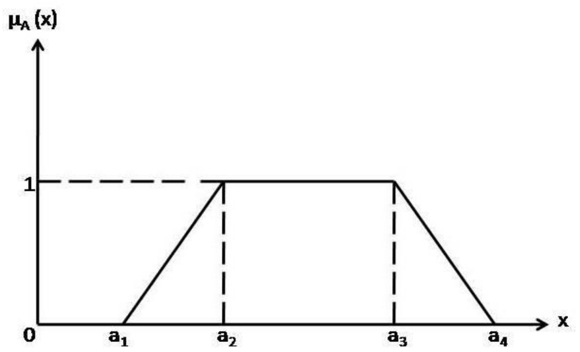

FIGURE 1 Trapezoidal fuzzy number

3.1 PROPERTIES OF TRAPEZOIDAL NUMBER

The following are properties of trapezoidal number:

1. The trapezoidal fuzzy number $\tilde{A} = (a_1, a_2, a_3, a_4)$ is said to be non- negative trapezoidal number Iff $a_1 - a_3 \ge 0$

2. The trapezoidal fuzzy number $\tilde{A} = (a_1, a_2, a_3, a_4)$ is said to be zero trapezoidal fuzzy number Iff $a_1 = 0, a_2 = 0, a_3 = 0, a_4 = 0$

3. Two trapezoidal fuzzy number $\tilde{A} = (a_1, a_2, a_3, a_4)$ and $\tilde{B} = (b_1, b_2, b_3, b_4)$ are said to be equal Iff $a_1 = b_1,\ a_2 = b_2,\ a_3 = b_3,\ a_4 = b_4$.

3.2 ARITHMETIC OPERATORS FOR SOLVING TRAPEZOIDAL FUZZY NUMBER

Let us consider $\tilde{X} = (p_1, q_1, r_1, s_1)$ and $Y = (p_2, q_2, r_2, s_2)$ are two trapezoidal fuzzy numbers then the basic arithmetic operations on $\tilde{X}$ and $\tilde{Y}$ as follows:

(i) Addition

$$\tilde{X} + Y = (p_1 + p_2,\ q_1 + q_2,\ r_1 + r_2,\ s_1 + s_2)$$

(ii) Subtraction

$$\tilde{X} - Y = (p_1 - s_2,\ q_1 - r_2,\ r_1 - q_2,\ s_1 - p_2)$$

(iii) Multiplication $\tilde{X} \bullet Y = (m_1, m_2, m_3, m_4)$

Where

m_1 = minimum $\{p_1p_2, p_1s_2, s_1p_2, s_1s_2\}$

m_2= minimum $\{q_1q_2, q_1r_2, r_1q_2, r_1r_2\}$

m_3 = maximum $\{q_1q_2, q_1r_2, r_1q_2, r_1r_2\}$

m_4 = maximum $\{p_1p_2, p_1s_2, s_1p_2, s_1s_2\}$

EXAMPLE:

Let $\tilde{X}$ and $\tilde{Y}$ are two trapezoidal fuzzy numbers

Where $\tilde{X} = (4,5,6,7)$ and $\tilde{Y} = (6,7,8,9)$ *then,*

(i) $\tilde{X} + \tilde{Y} = (4,5,6,7) + (6,7,8,9)$
$= (4+6,\ 5+7,\ 6+8, 7+9) = (10,12,14,16)$

(ii) $\tilde{X} - \tilde{Y} = (4,5,6,7) - (6,7,8,9) =$
$(4-9, 5-8, 6-7, 7-9) = (-5, -3, -1, -2)$

(iii) $\tilde{X} \bullet \tilde{Y} = (4,5,6,7) \bullet (6,7,8,9) =$
$\begin{pmatrix} min\ (24,\ 36,\ 42,\ 63),\ min\ (35,\ 40,\ 42,\ 48), \\ max\ (35,\ 40,\ 42,\ 48),\ max\ (24,\ 36,\ 42,\ 63) \end{pmatrix}$
$= (24,\ 35,\ 48,\ 63)$

4 Ranking function

We define a ranking function F(R), which maps each fuzzy number into the real line. F(μ) represents the set of all trapezoidal numbers. If R be a ranking function and let $\tilde{a} = (a_1, a_2, a_3, a_4) \in F(\mu)$. Then $R(\tilde{a}) = (a_1 + a_2 + a_3 + a_4)/4$.

For any two trapezoidal Fuzzy number $\tilde{a} = (a_1, a_2, a_3, a_4)$ and $\tilde{b} = (b_1, b_2, b_3, b_4)$ in F(μ) then,

- $\tilde{a} \le \tilde{b} \Leftrightarrow R(\tilde{a}) \le R(\tilde{b})$
- $\tilde{a} \ge \tilde{b} \Leftrightarrow R(\tilde{a}) \ge R(\tilde{b})$
- $\tilde{a} = \tilde{b} \Leftrightarrow R(\tilde{a}) = R(\tilde{b})$

5 Methodology

The steps used for solution of numerical example are given below:

Step1: Balance the given transportation problem if either (total supply > total demand) or (total supply < total demand).

Step 2: Determine the fuzzy penalty cost for each row and column by calculating the negative mean of minimum cost and next to the minimum cost of each row and column i.e. dividing the difference of minimum cost and next to minimum cost by 2.

Step 3: If the minimum cost occurs more than one time in a row and column then choose same transportation cost as minimum cost and next to minimum cost and penalty will become zero.

Step 4: Select the rows or columns with the highest penalty costs (breaking ties arbitrarily or choosing the lowest- cost cell). If there is tie occurs in highest penalty cost, then choose that row or column where cost is minimum.

Step 5: Compute transportation costs for selected rows or columns in step 4 by allocating as much as the possible amount to the feasible cell with the lowest transportation cost.

Step 6: Now adjust all the row and column and cross out satisfied row or column. If satisfied simultaneously then crossed out one of them and assign zero to remaining rows and columns.

Step 7: Repeat steps 2-6 until all requirements have been meet.

Step 8: Compute total transportation cost for the feasible allocations using the original balanced-transportation cost matrix.

5.1 NUMERICAL EXAMPLE

Let us consider the following numerical example

TABLE 1 Trapezoidal fuzzy transportation problem

	1	2	3	4	Supply
1	(1,2,3,4)	(1,3,4,6)	(9,11,12,14)	(5,7,8,11)	(1,6,7,12)
2	(0,1,2,4)	(-1,0,1,2)	(5,6,7,8)	(0,1,2,3)	(0,1,2,3)
3	(3,5,6,8)	(5,8,9,12)	(12,15,16,19)	(7,9,10,12)	(5,10,12,17)
Demand	(5,7,8,10)	(1,5,6,10)	(1,3,4,6)	(1,2,3,4)	

Now, we calculate R(1, 2, 3, 4) by applying ranking method i.e.

$$R(\tilde{a}) = \frac{a_1 + a_2 + a_3 + a_4}{4}$$

$$R(1,2,3,4) = 2.5$$

Similarly, the ranking for the fuzzy costs aij are calculated as:

R(a11)=2.5	R(a12)=3.5	R(a13)=9	R(a14)=7.75	R(a15)=6.5
R(a21)=1.75	R(a22)=0.5	R(a23)=6.5	R(a24)=1.5	R(a25)=1.5
R(a31)=5.5	R(a32)=8.5	R(a33)=15.5	R(a34)=9.5	R(a35)=11
R(a41)=7.5	R(a42)=5.5	R(a43)=3.5	R(a44)=2.5	

Now, after applying ranking technique, the trapezoidal fuzzy transportation problem is:

TABLE 2 Fuzzy transportation problem after applying ranking technique

	1	2	3	4	Supply
1	2.5	3.5	9	7.75	6.5
2	1.75	0.5	6.5	1.5	1.5
3	5.5	8.5	15.5	9.5	11
Demand	7.5	5.5	3.5	2.5	

After applying our Fuzzy VAM, The total fuzzy transportation cost is 116.25.

6 Comparison with existing methods

In the above chosen numerical example i.e. Table-1, suppose the availability i.e. $\tilde{p}_i$ of the product at supply S_1, S_2, S_3 and demand $\tilde{p}_j$ of the product at destination D_1, D_2, D_3, D_4 and the unit transportation cost Cij of the product in each row and column is represented by trapezoidal fuzzy number i.e. shown in Table 1. First, we convert the trapezoidal fuzzy problem i.e. Table 1 into crisp problem i.e. Table 2 by applying ranking function, and then we perform fuzzy modified VAM to find the optimal solution.

Now we compare the result obtained from proposed method to other existing methods i.e. shown in Table 3. and after making the comparison, we found that the result achieved by proposed method is optimal as compared to other existing methods which clearly shown in Table 3.

7 Result analysis

In fuzzy transportation problems, we are applying ranking function and then fuzzy modified VAM used on the obtained problem to find the optimal solution. The result of the fuzzy transportation problem for selected numerical example, obtained by using different proposed method shown in Table 3. The total fuzzy transportation cost for the given fuzzy transportation problem is 116.25.

The comparison of proposed method with existing methods is tabulated below in which it clearly is shown that the proposed method provides the optimal results.

TABLE 3 Comparison with existing method

Method	Optimal Solution
Panadian et al. [21]	132.17
Chauhan S. S., Joshi N. [13]	121
S. Narayanamoorthy, S. Kalyani [5]	121
MODI Method	121
Proposed Method	116.25

7.1 OPTIMAL SOLUTION

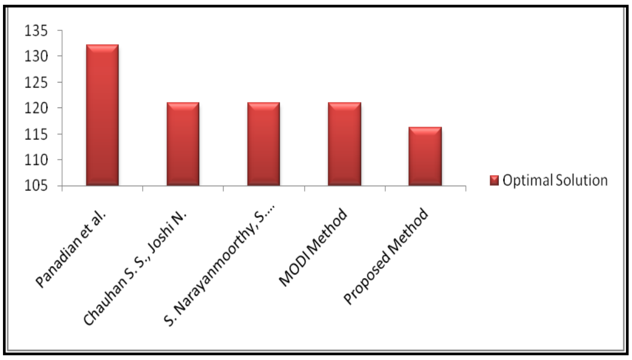

FIGURE 2 Comparison with existing methods

8 Conclusions

In this paper, a new method is proposed to obtain the initial basic feasible solution of the fuzzy transportation problem. The transportation cost, supply and demand are taken as fuzzy trapezoidal numbers which are more realistic and general in nature. The fuzzy transportation problem of trapezoidal number has been converted into crisp transportation problem using a ranking technique. A numerical example shows that the proposed method gives the better results as compared to other methods as shown in comparison table. This process is easy to understand and to implement. The proposed method can also be used for solving other problems occurring in real life like project schedules, assignment problems, linear programming problem, network flow problems, etc.

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