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Solving of Fuzzy Transportation Problem Using Fuzzy Analytical Hierarchy Process (AHP)

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ABSTRACT
Based on research related to solve fuzzy transportation problems that had been proposed and discussed by researchers, it could be concluded that the ranking function is widely used to order fuzzy numbers or convert fuzzy numbers to crisp numbers. The ordering process can indeed make it easier to run the Fuzzy Transportation Algorithm (FTA), but from the convenience it causes failed in interpreting the results of ordering fuzzy numbers. This is because the ordering process of fuzzy numbers still has subjectivity values that cannot be completely eliminated, moreover the ordering can cause incompatible input and output fuzzy numbers resulted. On the other hand, one of the FTA that is often used in solving FTP is LC method which selects the least distribution cost in the FTA table to be used as a base cell. If there is a distribution cost with the equal value, then it is freely chosen. However, free choice will affect the resulted of fuzzy optimal solution. Therefore, the fuzzy LCM as new method is proposed by fuzzy Analytical Hierarchy Process (AHP) to order fuzzy parameters on FTP without converting fuzzy numbers to crisp numbers, then the LC method is used to find IFBS and MODI method to determine the optimal fuzzy solution. To illustrate the new proposed method, the completion of numerical examples is given and the results are reviewed with the results of the existing method. The advantages of the new proposed method can improve the shortcomings of the existing methods, as well as relevant to solving fuzzy transport problems in real life for use by decision makers.
Keywords: *fuzzy numbers, fuzzy transportation problem, fuzzy transportation algorithm, AHP.*

1. INTRODUCTION

Transportation Problem (TP) is one example of the linear programming (LP) application in real life, especially in industry which is related with logistics. In the distribution process of logistic, the company must have good planning to take or make the right decisions, such that the company goal can be met. In general, the company goal is cost minimization of distributing logistics from source or producer to destination or consumers which is the number of logistics produced must not exceed the production capacity or warehouse limits but still meet the minimum demand for each consumer. In reality, the cost of logistical distribution, logistical supply and logistical demand from consumers often results in value uncertainty and also tends to change from time to time. This is caused by technical factors such as engine damage and failures during production as well as non-technical factors such as uncertain weather and changing market conditions. Therefore, the value uncertainty of logistics distribution costs, logistics supply and logistics demand is defined as a Fuzzy Transportation Problem (FTP).

Many reseachers have proposed methods for solving FTP from different approaches such as Amarpreet and Amir [1] proposed to generalize three classical methods to construct initial feasible basic solution which are North West Corner method, Least cost method and Vogel Approximation Method. Further, those methods are called North West Corner Generalized (NWCG), Least cost Generalized (LCG) and Vogel Approximation Generalized Method (VAGM), respectively. They used all generalized methods to determine the Initial Feasible Basic Solution (IFBS) and used Modified Distribution (MODI) method to obtain fuzzy optimal solution. They also used ranking function to order logistics distribution costs in the form of fuzzy trapezoidal numbers. Sudhagar and Ganesan [2] proposed the ranking score method to rank trapezoidal fuzzy number of logistics distribution costs. They offered numerical examples of solving FTP using LC method without generalized to determine IFBS and also MODI method to obtain optimal fuzzy solutions. Ali [3] simplified the ranking function used as in [1] with generalized ranking function to order generalized trapezoidal fuzzy numbers of logistic distribution costs. He also used LC method to find IFBS and MODI method to obtain fuzzy optimal solution. Giarcarlo, et al. [4] proposed robust ranking technique to rank the parameters fuzzy in the form of trapezoidal fuzzy numbers like costs distribution, supplies quantity and demands quantity. They also proposed the Maximum Supply Method with

Minimum Cost (MOMC) algorithm to determine fuzzy optimal solution. Jaikumar [5] proposed new ranking function based on their graded means to rank fuzzy parameters in the form of triangular fuzzy numbers. He also presented an numerical example fully FTP is solved by LC method and MODI method. Venkatachalapathy and Samuel [6] proposed an Alternative Method (AM) to find IFBS and also use ranking function to convert fuzzy optimal value. Dipankar, et al. [7] proposed different operation for subtraction on triangular fuzzy number and ranking function to solve full FTP. These methode subtraction was operated on the classical method of FTP like NWC, LC and VAM were used to find IFBS and also MODI to obtain fuzzy optimal solution. Meanwhile, ranking function used to rank fuzzy optimal value. Nirbhay, et al. [8] presented the new algorithm, namely Minimum Demand-Supply Method to find IFBS and to obtain fuzzy optimal solution. They also used ranking function to order distribution cost, supplies and demand of quantities in the form of trapezoidal fuzzy numbers. Afraa [9] offered an modern method to solve Full FTP by reducing distribution cost. He also used ranking function to rank fuzzy parameters. Pankaj and Dinesh [10] presented dichotomized fuzzyfication technique based on interval data. He also used ranking function to rank triangular fuzzy parameters, then LC used to find IFBS and applied MODI method to obtain fuzzy optimal solution. Balasubramanan and Subramanian [11] solved FTP using ranking function. The authors [12] used total integral ranking to rank fuzzy parameters of full FTP and Fuzzy Transport Algorithm (FTA) to determine fuzzy optimal solution. Sam'an, et al. [13] proposed the modified fuzzy transport algorithm to find fuzzy optimal solution with ranking score method to rank fuzzy parameters and also simple additive weighting to weight fuzzy cost. Maheswari and Ganesan [14] discussed the solving of FTP which in fuzzy parameters in the form pentagonal fuzzy numbers. Dinagar and Christopar [15] proposed fuzzy parameters in the form of generalized quadratical fuzzy number. They used ranking function to rank fuzzy supplies, fuzzy demands and fuzzy objective value, as well as LC method to find IFBS. Kumar, et. al. [16] proposed a Pythagorean fuzzy approach consisting of type 1 to calculate score value of each fuzzy cost, type II use to calculate score value of fuzzy supplies and fuzzy demands. Meanwhile, LC method to find IFBS and MODI method to obtain fuzzy optimal solution.

Based on related works to solve FTP that had been proposed by many researchers, it can be concluded that the ranking function is widely used to order fuzzy number or convert fuzzy number to crisp number. The ordering process can indeed make it easier to run the Fuzzy Transportation Algorithm (FTA), but from the convenience it causes failed in interpreting the results of ordering fuzzy numbers. But this the ordering process of fuzzy numbers still has subjectivity values that cannot be completely eliminated. Moreover, the ordering has caused incompatible input and output fuzzy numbers resulted. On the other hand, one of the FTA that is often used in solving FTP is LC method which selects the least distribution cost in the FTA table to be used as a base cell. If there is a distribution cost with the equal value, then it is freely chosen. However, free choice will affect the resulted of fuzzy optimal solution. Sam'an, et al. [13] provide an alternative gives weight by using the SAW technique for each fuzzy distribution cost that has been converted to crisp numbers, but the alternative is still possible to result the equal distribution costs in the FTA table even though the opportunity is so small. Therefore, the authors present the new of the FTA to order fuzzy parameters on FTP without converting fuzzy numbers to crisp numbers. We use fuzzy Analytical Hierarchy Process (FAHP) to order fuzzy numbers without defuzzification in FTP context. Furthermore. the results and discussion are presented with a numerical example as an illustration

The paper is ordered as follows: Section 2 is the mathematical formulation of fuzzy transport problems. The Fuzzy AHP is presented to order fuzzy parameters by section 3. Then, the new LC method is proposed to determine the value of fuzzy optimal solution from fuzzy transportation problems by section 4. Numerical example is presented in section 5. The conclusion is discussed by section 6.

1.1. Formulation of Fuzzy Transportation Problem

Basically, the model of transportation have parameters like parameter supply quantity (υ_ι), demand quantity ($\nu_\jmath$) and distribution cost ($\omega_{\iota\jmath}$) are represented by crisp numbers. But the reality of the logistics industry, these parameters have a value uncertainty such that the model of transportation problems having uncertainty parameters are called Fuzzy Transportation Problems (FTP). As for the fuzzy parameters are notated $\widetilde{\upsilon_\iota}$, $\widetilde{\nu_\jmath}$ and $\widetilde{\omega_{\iota\jmath}}$. Therefore, the formulation of FTP as follows:

$$\min \widetilde{\Upsilon} \qquad (1)$$

subject to

$$\begin{cases} \sum_{\jmath=1}^{n} \widetilde{\chi_{\iota\jmath}} \leq \widetilde{\upsilon_\iota} & ; \iota = 1,2,\ldots,m \\ \sum_{\iota=1}^{m} \widetilde{\chi_{\iota\jmath}} \leq \widetilde{\nu_\jmath} & ; \jmath = 1,2,\ldots,n \\ \widetilde{\chi_{\iota\jmath}} \leq \tilde{0} & ; \forall \iota, \jmath. \end{cases} \qquad (2)$$

where :

$\min \widetilde{\Upsilon} = \sum_{\iota=1}^{m} \sum_{\jmath=1}^{n} \widetilde{\chi_{\iota\jmath}} \widetilde{\omega_{\iota\jmath}}$ $\longrightarrow$ fuzzy objective function or value of optimal fuzzy.

$\widetilde{\upsilon_\iota}$ $\longrightarrow$ fuzzy supplies quantities of product at ι^{th} source.

$\widetilde{\nu_\jmath}$ $\longrightarrow$ fuzzy demands quantities of product at $\jmath^{th}$ destination.

$\widetilde{\omega}_{\iota j}$ $\longrightarrow$ unit fuzzy logistic distribution costs from at ι^{th} source to at $\jmath^{th}$ destination.

$\tilde{x}_{ij}$ $\longrightarrow$ approximate units of product quantities that should be delivered from i^{th} source to at j^{th} destination. Noted: if $\sum_{i=1}^{m} \tilde{v}_i \approx \sum_{j=1}^{n} \tilde{v}_j$ then FTP is named balanced FTP, if not it is called not balanced

1.2. Fuzzy Analytical Hierarchy Process

Analytical Hierarchy Process (AHP) algorithm is one of algorithm that is widely used by decision makers, to help solve an assessment problem of several factors. This algorithm was developed by Prof. Thomas L. Saaty as a decision making algorithm for Multi Criteria Decision Making (MCDM). The multi-criteria problem in AHP is simplified in the form of a hierarchy consisting of three main components. That is the objective or destination of decision making, assessment criteria and alternative choices. The steps in the fuzzy AHP algorithm made is as follows:

Algorithm 1

Step 1: Determine fuzzy supplies quantity $\tilde{v}_i$ and fuzzy demands quantity $\tilde{v}_j$ on the fuzzy transportation problem;

Step 2: Making pairwise comparison or pairwise matrix for each fuzzy supplies quantity $\tilde{v}_i$ and fuzzy demands quantity $\tilde{v}_j$. For assessment using the 1-9 Saaty pairwise comparison as shown in Table 1. Next, adds the column pairwise matrix;

Table 1. The Scale of Pairwise Matrix Value

Value	Information
1	$\tilde{v}_i$ as important as $\tilde{v}_j$
3	$\tilde{v}_i$ little more important than $\tilde{v}_j$
5	$\tilde{v}_i$ clearly more important than $\tilde{v}_j$
7	$\tilde{v}_i$ very obviously more important than $\tilde{v}_j$
9	$\tilde{v}_i$ absolutely more important than $\tilde{v}_j$
2,4,6,8	when in doubt between two adjacent values

Step 3: Calculate the criteria weight (priority vector) i.e (1) normalizing the value of each pairwise matrix column by dividing each value in the matrix column with the corresponding column addition results; (2) calculate value of the row average from the results pairwise matrix normalization;

Step 4: Test the consistency of each paired matrix with the formula for each pairwise matrix element multiplied by the priority value of the criteria. The results are added to each row, then the results with each priority value of the criteria λ_1, λ_2, λ_3,..., λ_n. Calculates the maximum value of λ with formula: $\lambda_{max} = \frac{\sum \lambda}{n}$;

Step 5: Calculate the value of the Consistency Index (CI), with formula: CI = $\frac{(\lambda_{max}-n)}{n-1}$;

Step 6: Calculate the Consistency Ratio (CR), using the formula: CR $=\frac{CI}{RI}$. If CR $<$ 0.1, then the comparison value pair up on the criteria matrix which is given consistently. If CR = 0.1, then the value pairwise comparisons on the criteria matrix given is not consistent. So if inconsistent, then charging the values at the paired matrix on the criteria element must be is repeated;

Step 7: Arrange matrix rows between criteria whose contents are the results of the calculation process step 4, step 5, and step 6;

Step 8:The final result is a global priority as a value used by decision makers.

1.3. The New Fuzzy Least Cost Method

The using of ranking functions to convert fuzzy numbers into crisp numbers or defuzzyfication has been discussed by many researchers [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16]. However, the use of the ranking function still has the disadvantage of crisp numbers resulting from ranking failing to interpret fuzzy numbers. It is still subjectivity in the ranking process. On the other hand, the using of fuzzy Least Cost Method (LCM) for finding IFBS of FTP still has deficiencies in the estimation stage for maximum allocations $\tilde{\chi}_{i,j}$ on cells (i,j) having the same $\widetilde{\omega_{ij}}$ ranking . Therefore, The new fuzzy LC method as new proposed method have done obtaining $\widetilde{\omega_{ij}}$ ranking is unequal without converting the fuzzy numbers. The new fuzzy least cost method for finding IFBS is given Algorithm 2 and to finding fuzzy optimal solution is given Algorithm 3.

Algorithm 2

Step 1: Formulate a mathematical model in real life of FTP as on the Eq.(1) and Eq.(2) ;

Step 2: Make Table of FTP (FTPT) from a mathematical model of FTP that contained. $\widetilde{\omega_{ij}}$ as fuzzy transportation cost, $\tilde{v}_i$, and $\tilde{v}_j$ as fuzzy quantities of supplies and demands, respectively;

Step 3: Check whether:

1) if $\sum_{j=1}^{m} \tilde{v}_i = \sum_{i=1}^{n} \tilde{v}_j$ then next step 4;
2) if $\sum_{j=1}^{m} \tilde{v}_i \neq \sum_{i=1}^{n} \tilde{v}_j$ then there are two conditions as follows:

a) $\sum_{j=1}^{m} \widetilde{\upsilon_\iota} > \sum_{\iota=1}^{n} \widetilde{\nu_j}$, insert a fuzzy factitious column that have all its $\widetilde{\omega_{\iota j}}$ as zero triangular fuzzy number or $\widetilde{\omega_{\iota j}}$ = (0,0,0). Let $\sum_{j=1}^{m} \widetilde{\upsilon_\iota} - \sum_{\iota=1}^{n} \widetilde{\nu_j}$ as the fuzzy demand at this factitious object. Next step 4;

b) $\sum_{j=1}^{m} \widetilde{\upsilon_\iota} < \sum_{\iota=1}^{n} \widetilde{\nu_j}$, insert a fuzzy factitious row that have all its $\widetilde{\omega_{\iota j}}$ as zero triangular fuzzy number or $\widetilde{\omega_{\iota j}}$ = (0,0,0). Let $\sum_{\iota=1}^{n} \widetilde{\nu_j} - \sum_{j=1}^{m} \widetilde{\upsilon_\iota}$ as the fuzzy supply at this factitious object. Next step 4;

Step 4: Ordering or ranking fuzzy number of $\widetilde{\omega_{\iota j}}$ by using Algorithm 1;

Step 5: Find the smallest $\widetilde{\omega_{\iota j}}$ in FTPT and determine minimum of $\widetilde{\upsilon_\iota}$ or $\widetilde{\nu_j}$. Next, will come two possibilities are min $(\widetilde{\upsilon_\iota}, \widetilde{\nu_j}) = \widetilde{\upsilon_\iota}$, so make on $\widetilde{\chi_{\iota j}} = \widetilde{\upsilon_\iota}$ where $m \times n$ FTPT of the new least cost. Then, neglect row of ι^{th} to find a new FTPT with $(m-1) \times n$ ordering. Change $\widetilde{\nu_j}$ by $\widetilde{\nu_j} - \widetilde{\upsilon_\iota}$ in the new FTPT. Next step 8. min $(\widetilde{\upsilon_\iota}, \widetilde{\nu_j}) = \widetilde{\nu_j}$, so make on $\widetilde{\chi_{\iota j}} = \widetilde{\nu_j}$ where $m \times n$ FTPT of the new least cost. Then, neglect column of j^{th} to find a new FTPT with $m \times (n-1)$ ordering. Change $\widetilde{\upsilon_\iota}$ by $\widetilde{\upsilon_\iota} - \widetilde{\nu_j}$ in the new FTPT. Next step 8;

Step 6: Repeat Step 1 of the new FTPT, until is reduced to be a FTPT 1×1 ordering;

Step 7: Make on all $\widetilde{\chi_{\iota j}}$ in cell of $(\iota, j)^{th}$ that are given by FTPT;

Step 8: Resulted of IFBS $\widetilde{\omega_{\iota j}}$ is $\widetilde{\chi_{\iota j}}$ and Eq. (1), respectively

Algorithm 3

Step 1: The IFBS obtained of FTP using new least cost method;

Step 2: Introduce $\widetilde{\kappa_\iota}$ and $\widetilde{\iota_j}$ as variable convenient for every ι^{th} and j^{th}, respectively. In front of ι^{th}, write $\widetilde{\kappa_\iota}$ in row and $\widetilde{\iota_j}$ at the under of j^{th} in column. The simplify calculation, with $j^{th} = \tilde{0}$ is maximum number of allocations row;

Step 3: Determine $\widetilde{\theta_{\iota,j}}$ and ι_j others values by using $\widetilde{\omega_{\iota j}} = \widetilde{\kappa_\iota} + \widetilde{\iota_j}$ for base of cell, then determine $\widetilde{\theta_{\iota,j}} = \widetilde{\omega_{\iota j}} - (\widetilde{\theta_{\iota,j}} + \widetilde{\iota_j})$ of non-base of cells. Next, will come two possibilities as follow;

1) $\widetilde{\theta_{\iota,j}} = \widetilde{\omega_{\iota j}} - (\widetilde{\theta_{\iota,j}} + \widetilde{\iota_j}) \geq \tilde{0}\ \forall \iota, j$ So, the resulted of IFBS is done i.e fuzzy optimal solution has been satisfied;

2) Otherwise, $\exists\ \widetilde{\theta_{\iota,j}} = \widetilde{\omega_{\iota j}} - (\widetilde{\kappa_\iota} + \widetilde{\iota_j}) < \tilde{0}$ So, obtained IFBS do not finished yet i.e fuzzy optimal solution is not optimal. Therefore, the getting of fuzzy optimal solution is chosen a cell of $(\iota, j)^{th}$ that $\widetilde{\theta_{\iota,j}}$ in which rank is smallest negative of $\widetilde{\theta_{\iota,j}}$, then make a horizontal and vertical path closed that starts from unchosen base of cell of $(\iota, j)^{th}$. The path can only replace to angle on base of cell i$(\iota, j)^{th}$ and the path is chosen path must pass through base and non-base cell of $(\iota, j)^{th}$;

Step 4: Give sign $(+)$ and $(-)$ for closed loop started with $(+)$ for chosen non-base cells. After that, determine fuzzy quantity on cells with signs $(+)$ and $(-)$. Consequently, will be obtained new FTPT.

Step 5: Repeat of steps 2, 3 and 4 for new FTPT until $\widetilde{\theta_{\iota,j}} \geq \tilde{0}\ \forall \iota, j$;

Step 6: Determine the value of fuzzy optimal solution or objective function by using Eq. (1).

1.4. *Numerical Example*

Example 1 is a Fuzzy Transport Problem (FTP) in which fuzzy transport cost $\widetilde{\omega_{\iota j}}$ represented by non-normal triangular fuzzy numbers, it is solved by using the new proposed methods and existing method

Example 1

Based on the published paper Liang, et al.[17] about fuzzy transportation problem that shown Table 2.

Table 2. The data of the fuzzy transportation problem Example 1

	Taichung $(\widetilde{\nu_1})$	Chiayi $(\widetilde{\nu_2})$	Kaohsiung $(\widetilde{\nu_3})$	Taipei $(\widetilde{\nu_4})$	Supplies $(\widetilde{\upsilon_\iota})$
Changhua $(\widetilde{\upsilon_1})$	(8,10,10.8;1)	(20.4,22,24;1)	(8,10,10.6;1)	(18.8,20,22;1)	(6.2,8,8.8;1)
Touliu $(\widetilde{\upsilon_2})$	(14,15,16;1)	(18.2,20,22;1)	(10,12,13;1)	(6,8,8,8;1)	(12,14,16;1)
Hsinchu $(\widetilde{\upsilon_3})$	(18.4,20,21;1)	(9.6,12,13;1)	(7.8,10,10.8;1)	(14,15,16;1)	(10.2,12,13.8;1)
Demands $(\widetilde{\nu_j})$	(6.2,7,7.8;1)	(8.6,10,11.4;1)	(6.5,8,9.5;1)	(7.8,9,10.2:1)	

Clearly that $\sum_{\iota=1}^{m} \widetilde{\upsilon_\iota} = (29.4,34,38.6) \neq \sum_{j=1}^{n} \widetilde{\nu_j}$ = (29.1,34,38.9). Example 1 is said unbalanced FTP. Insert a fuzzy fiction of column and row i.e $\widetilde{\omega_{\iota j}}$ = (0,0,0), supply fiction i.e $\widetilde{\upsilon_4}$ = (0,0.3,0.6) and dummy fiction i.e $\widetilde{\nu_5}$ = (0.3,0.3,0.3) such that $\sum_{\iota=1}^{m} \widetilde{\upsilon_\iota} = \sum_{j=1}^{n} \widetilde{\nu_j}$ = (29.4,34.3,39.2). Next, the ordering of $\widetilde{\omega_{\iota j}}$ use Algorithm with pairwise matrix column for supplies i.e $\begin{pmatrix} & \tilde{v}_1 & \tilde{v}_2 & \tilde{v}_3 \\ \tilde{\upsilon}_1 & 1 & 5 & 4 \\ \tilde{\upsilon}_2 & 0.2 & 1 & 0.33 \\ \tilde{\upsilon}_3 & 0.25 & 3 & 1 \end{pmatrix}$ and demands i.e $\begin{pmatrix} & \tilde{v}_1 & \tilde{v}_2 & \tilde{v}_3 & \tilde{v}_4 \\ \tilde{v}_1 & 1 & 5 & 2 & 4 \\ \tilde{v}_2 & 0.2 & 1 & 0.5 & 0.5 \\ \tilde{v}_3 & 0.5 & 2 & 1 & 2 \\ \tilde{v}_4 & 0.25 & 2 & 0.5 & 1 \end{pmatrix}$ such that the result of ordering fuzzy number $\widetilde{\omega_{\iota J}}$ demands can be seen Table 3.

Table 3. The ordering fuzzy numbers of Example 1

	$\tilde{v}_1$	order	$\tilde{v}_2$	order	$\tilde{v}_3$	order	$\tilde{v}_4$	order
$\tilde{\upsilon}_1$	(8,10,10.8;1)	**1**	(20.4,22,24;1)	**4**	(8,10,10.6;1)	**2**	(18.8,20,22;1)	**3**
$\tilde{\upsilon}_2$	(14,15,16;1)	**9**	(18.2,20,22;1)	**12**	(10,12,13;1)	**10**	(6,8,8,8;1)	**11**
$\tilde{\upsilon}_3$	(18.4,20,21;1)	**5**	(9.6,12,13;1)	**8**	(7.8,10,10.8;1)	**7**	(14,15,16;1)	**6**

From this table, it can be seen that solving fuzzy transportation problems can be solved without having to rank fuzzy numbers so that fails in interpreting fuzzy numbers because subjectivity in the ranking process can be avoided. In addition, the using of algorithm 1 as a ordering fuzzy numbers will not produce fuzzy numbers or $\widetilde{\omega_{\iota J}}$ having the equal order.

Next step to obtain IFBS by using Algorithm 3. Then, to find fuzzy optimal solution by using Algorithm 4 that be seen on Table 4.

Table 4. The data of the fuzzy transportation problem Example 1

	Optimal solution of FTP
IFBS	$\begin{pmatrix} & \tilde{v}_1 & \tilde{v}_2 & \tilde{v}_3 & \tilde{v}_4 & \tilde{v}_5 \\ \tilde{\upsilon}_1 & (6.2,7.0,7.8) & (0.0,0.0,0.0) & (1.0,1.0,1.0) & (0.0,0.0,0.0) & (0.0,0.0,0.0) \\ \tilde{\upsilon}_2 & (0.0,0.0,0.0) & (8.6,9.7,10.8) & (0.0,0.0,0.0) & (3.1,4.0,4.9) & (0.3,0.3,0.3) \\ \tilde{\upsilon}_3 & (0.0,0.0,0.0) & (0.0,0.0,0.0) & (5.5,7.0,8.5) & (4.7,5.0,5.3) & (0.0,0.0,0.0) \\ \tilde{\upsilon}_4 & (0.0,0.0,0.0) & (0.0,0.3,0.6) & (0.0,0.0,0.0) & (0.0,0.0,0.0) & (0.0,0.0,0.0) \end{pmatrix}$
Fuzzy Optimal Solution	$\begin{pmatrix} & \tilde{v}_1 & \tilde{v}_2 & \tilde{v}_3 & \tilde{v}_4 & \tilde{v}_5 \\ \tilde{\upsilon}_1 & (6.2,7.0,7.8) & (0.0,0.0,0.0) & (1.0,1.0,1.0) & (0.0,0.0,0.0) & (0.0,0.0,0.0) \\ \tilde{\upsilon}_2 & (0.0,0.0,0.0) & (0.0,0.0,0.0) & (3.9,4.7,5.5) & (7.8,9.0,10.2) & (0.3,0.3,0.3) \\ \tilde{\upsilon}_3 & (0.0,0.0,0.0) & (8.6,9.7,10.8) & (1.6,2.3,3.0) & (0.0,0.0,0.0) & (0.0,0.0,0.0) \\ \tilde{\upsilon}_4 & (0.0,0.0,0.0) & (0.0,0.3,0.6) & (0.0,0.0,0.0) & (0.0,0.0,0.0) & (0.0,0.0,0.0) \end{pmatrix}$

While, the value of fuzzy solution from Eq. (1) can be resulted and are compared finding by existing methods like Amarpreet and Amit [1], Liang, et al.[17] that can be seen Table 5.

Table 5. The comparison of fuzzy optimal value Example 1

Method finding of finding solution	Fuzzy optimal value ($\tilde{Y}$)	Rank
Amarpreet and Amit [1]	(279600,352000,382000; 1)	341400
Liang, et al.[17]	(279600,352000,382000; 1)	341400
New proposed method	(238440,347800,428900; 1)	-

2. CONCLUSION

This paper, a new fuzzy least cost method like as the one proposed to determine IFBS and the value of an fuzzy optimal solution FTP whose fuzzy distribution logistic costs are represented as triangular fuzzy numbers and products supplies and demands. The advantages of the new proposed method is presented using a numerical examples of fuzzy transportation problems whose results can improve from the shortcomings of existing methods. The new proposed method makes sense and can be used by decision makers to solve transportation problems in real life.

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