JOURNAL OF ALGEBRAIC STATISTICS
Volume 13, No. 2, 2022, p. 1274 - 1280
https://publishoa.com
ISSN: 1309-345

New Approach for Solving Fuzzy Transportation Problem

Nathiya K[1,a)], Balasubramanian Kr[2], Sakthivel K[3]

[1]Research Scholar in Mathematics, H.H .The Rajah's college, Pudukkottai - 622001(Affiliated to Bharathidasan University-Trichy).
[2]Assistant Professor in Mathematics, H.H .The Rajah's college, Pudukkottai- 622001 (Affiliated to Bharathidasan University-Trichy).
[3]Assistant Professor in Mathematics, Government Arts and Science College, Veppanthattai, Perambalur-621116. (Affiliated to Bharathidasan University-Trichy).
[a)]nathiyagk30@gmail.com

Abstract: In this article, we are developing a new approach for solving a transportation problem in fuzzy environment to find out the lease fuzzy transportation cost. Here, we are solving trapezoidal fuzzy transportation problem with the help of ranking technique, whose parameters are trapezoidal fuzzy numbers. This new approach is well defined procedure and it can be utilized for all types of fuzzy transportation problem whether maximize or minimize objective function. At the end, this method is illustrated with a numerical example.

Keywords: Median, Median of Trapezoidal Fuzzy Numbers, Median of Triangular Fuzzy Numbers, Trapezoidal Fuzzy Numbers, Transportation Problem, and Fuzzy Transportation Problem.

1. Introduction

The transportation problem is one of the earliest applications of linear programming problems. Transportation models have wide applications in logistics and supply chain for reducing the cost efficient algorithms have been developed for solving the transportation problem when the cost coefficients and the supply and demand quantities are known exactly. The occurrence of randomness and imprecision in the real world is inevitable owing to some unexpected situations. There are cases that the cost coefficients and the supply and demand quantities of a transportation problem may be uncertain due to some uncontrollable factors. Consider $\tilde{a}_i$ thenumberof items thatavailableat the source $\tilde{i}$ and $\tilde{b}_j$ the number of items thatnecessary at the destination $\tilde{j}$ .Consider $\tilde{\alpha}_{ij}$ asthe priceoftransferringoneitemfromsource $\tilde{i}$ toend terminal $\tilde{j}$ and $\tilde{X}_{ij}$ astheamountof itemcarried fromsource $\tilde{i}$ to terminal end $\tilde{j}$. Afuzzytransportation problem isaprogressive method in that we can get the expenditure of the transportation,Demand and supply factsarefuzzyquantities. The firstintroduced fuzzy set concept by Zadeh[1]. Zimmerman [2] devised fuzzy linear programming. R. Srinivasan [3], [4], [5] recommended a novel algorithm to crack fuzzy transportation problems. Ghosh, S [6]introduced a genetic algorithm to solve fully Intuitionistic fuzzy fixed-charge solid transportation problems. Bharati, S.K[7]proposed a new algorithm namely, the impact of a new ranking. Progress in Artificial Intelligencefor finding a ranking of a fuzzy number. Muhammad Saman; Farikhin[8]described a new fuzzy transportation algorithm for finding the fuzzy optimal solutions.R. Srinivasan and Karthikeyan,[9] have explored a two-stage cost-minimizing fuzzy

JOURNAL OF ALGEBRAIC STATISTICS
Volume 13, No. 2, 2022, p. 1274 - 1280
https://publishoa.com
ISSN: 1309-345

transportation problem where supply and demand are trapezoidal fuzzy numbers using a stricture approach to reach a fuzzy solution. N. Karthikeyan[10] proposed a novel algorithm to crack the fuzzy transportation problem for Trapezoidal fuzzy numbers. The proposed algorithm is to unravel a strong solution by using fuzzy transportation problems taking an account of supply, demand, and item transportation price as trapezoidal fuzzy numbers.

2. Preliminaries

Here, in this division, we describe some crucial descriptions the same will be applied in this manuscript by R. Srinivasan[19].

2.1 Definition: Fuzzy Set

$\tilde{A}$ is a fuzzy set on R is defined as a set of ordered pairs

$$\tilde{A}=\left\{x_0,\mu_{\tilde{A}}\left(x_0\right)/\,x_0\in\tilde{A},\mu_{\tilde{A}}\left(x_0\right)\rightarrow[0,1]\right\}$$

where $\mu_{\tilde{A}}\left(x_0\right)$ is said to be the membership function.

2.2 Definition: Fuzzy Number

$\tilde{A}$ is a fuzzy set on R, likely bound to the stated conditions given beneath

i. $\mu_{\tilde{A}}\left(x_0\right)$ is part by part continuous

ii. There exist at least one $x_0\in\Re$ with $\mu_{\tilde{A}}\left(x_0\right)=1$

iii. $\tilde{A}$ is regular and convex

2.3 Definition: Trapezoidal Fuzzy Number

A fuzzy number $\tilde{A}$ is a trapezoidal fuzzy number which is termed as $\left(\tilde{a}_1,\tilde{a}_2,\tilde{a}_3,\tilde{a}_4\right)$ where $\tilde{a}_1\le\tilde{a}_2\le\tilde{a}_3\le\tilde{a}_4$ is in R whose function of a membership $\mu_{\tilde{A}}\left(\tilde{x}\right)$ is assumed by

$$\mu_{\tilde{A}}(x)=\begin{cases}\dfrac{x-\tilde{a}_1}{\tilde{a}_2-\tilde{a}_1} & ,\tilde{a}_1\le x\le\tilde{a}_2\\ 1 & ,\tilde{a}_2\le x\le\tilde{a}_3\\ \dfrac{\tilde{a}_4-x}{\tilde{a}_4-\tilde{a}_3} & ,\tilde{a}_3\le x\le\tilde{a}_4\\ 0 & ,x>\tilde{a}_4\end{cases}$$

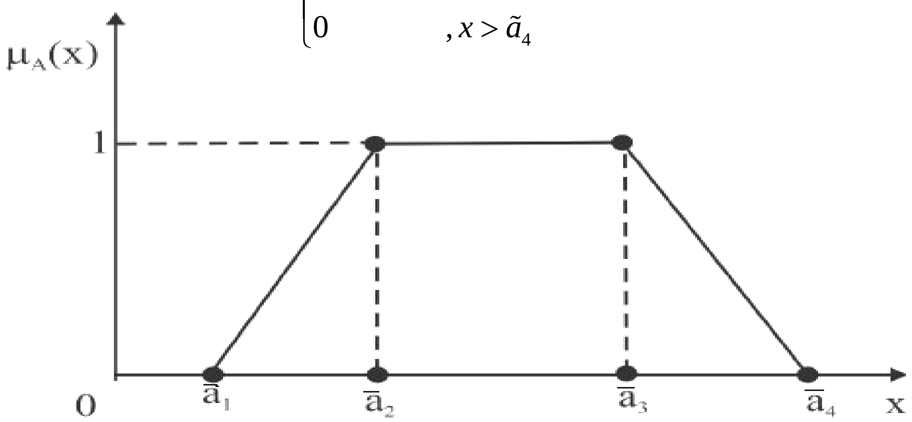

Figure 2.1 Membership function of Trapezoidal fuzzy number $\tilde{A}$

2.4 Median of Fuzzy number

Let $\tilde{\alpha}_A = \left(\tilde{a}_1, \tilde{a}_2, \tilde{a}_3, \tilde{a}_4, \tilde{a}_5, \tilde{a}_6, ...\tilde{a}_n\right)$ be fuzzy numbers than Median of Fuzzy numbers as follows

$$M\left(\tilde{\alpha}_A\right) = \begin{cases} \tilde{a}_{\left(\frac{n+1}{2}\right)} & , if\ n\, is\, odd \\ \dfrac{\tilde{a}_{\left(\frac{n}{2}+1\right)} + \tilde{a}_{\left(\frac{n}{2}\right)}}{2} & , if\ n\, is\, even \end{cases}$$

2.5Fuzzy transportation problem utilizing Mathematical formulation

A transportation problem can be declared in mathematical form as follows:

Minimum $Z = \sum_{i=1}^{s}\sum_{j=1}^{t} \tilde{\alpha}_{ij}\tilde{x}_{ij}$

Subject to the constraints

$$\sum_{j=1}^{t} \tilde{x}_{ij} = \tilde{a}_i \quad j = 1, 2, ...t$$

$$\sum_{i=1}^{s} \tilde{x}_{ij} = \tilde{b}_j \quad i = 1, 2, ...s$$

$$\sum_{i=1}^{s} \tilde{a}_i = \sum_{j=1}^{t} \tilde{b}_j\,;\ i = 1, 2, ...s;\ j = 1, 2, ...t \text{ and } \tilde{x}_{ij} \ge 0,\ i = 1, 2, ...s, \quad j = 1, 2, ...t$$

The fuzzy transportation problem is explicitly represented by the fuzzy transportation table:

	1	…	**t**	Supply
1	$\tilde{\alpha}_{11}$	…	$\tilde{\alpha}_{1t}$	$\tilde{a}_1$
⋮	⋮	…	⋮	⋮
S	$\tilde{\alpha}_{s1}$	…	$\tilde{\alpha}_{st}$	$\tilde{a}_s$
Demand	$\tilde{b}_1$	…	$\tilde{b}_t$	

Mathematical formulation of a fuzzy transportation problem

3. Solution Procedure

Now, we introduce a new approach for solving a fuzzy transportation problem where the transportation cost, supply and demands are fuzzy numbers. The fuzzy numbers in each problem may be triangular or trapezoidal or any fuzzy numbers or mixture of them. The optimal solution for the fuzzy transportation problem can be obtain as a crisp or fuzzy form.

JOURNAL OF ALGEBRAIC STATISTICS
Volume 13, No. 2, 2022, p. 1274 - 1280
https://publishoa.com
ISSN: 1309-345

Step – 1: Check the problem whether is balanced or not. If not, make a balanced fuzzy transportation problem with the help of dummy row and dummy column.

$$\text{(i.e)} \ \sum_{i=1}^{s} \tilde{a}_i = \sum_{j=1}^{t} \tilde{b}_j .$$

If unstable, change into a stabled one by introducing a model source or model destination utilizingzero fuzzy item transportation expenses.

Step – 2: Convert the fuzzy cost to crisp cost using median function.

Step – 3: Find the penalty values
Rules for penalty

i. Find the minimum cost of each row / column.
ii. Find the difference between the least cost and every other cost in same column and row / column.
iii. Add the values of sum of the difference and number of rows/column. This is called penalty.

Step – 4: Select the greatest penalty in row / column, and choose the least cost in same row / column. Remove the columns or rows corresponding to where the supply or demand is satisfied.

Step – 5: Repeat steps 3 and 4 until the supply-and-demand is totally met.

Step – 6: Replace the original transportation value with the satisfied cell value.

Step – 7: Workout the minimum cost. (i.e.), Total Cost =

4. Result and Discussion

4.1 Numerical example

A resolution that we affirm to fuzzy transportation problem which involves transportation cost, customer needs and demands and existence of products using trapezoidal Fuzzy figures. Observe the following transportation problem,

	R_a	R_b	R_c	R_d	Supply
I_a	(–2,0,2,8)	(–2,0,2,8)	(–2,0,2,8)	(–1,0,1,4)	(0,2,4,6)
I_b	(4,8,12,16)	(4,7,9,12)	(2,4,6,8)	(1,3,5,7)	(2,4,9,13)
I_c	(2,4,9,13)	(0,6,8,10)	(0,6,8,10)	(4,7,9,12)	(2,4,6,8)
Demand	(1,3,5,7)	(0,2,4,6)	(1,3,5,7)	(1,3,5,7)	(4,10,19,27)

4.2 Solution

Table 1

By using Median Technique, we have to convert fuzzy Trapezoidal numbers into a crisp value

	R_a	R_b	R_c	R_d	Supply
I_a	1	1	1	0.5	3.0
I_b	10	8	5	4	6.5

JOURNAL OF ALGEBRAIC STATISTICS
Volume 13, No. 2, 2022, p. 1274 - 1280
https://publishoa.com
ISSN: 1309-345

I_c	6.5	7	7	8	5.0
Demand	4.0	3.0	4.0	4.0	

Table 2

The given problem is unbalanced, and we are adding 0 rows to balance the given problem.

	R_a	R_b	R_c	R_d	Supply
I_a	1	1	1	0.5	3.0
I_b	10	8	5	4	6.5
I_c	6.5	7	7	8	5.0
I_d	0	0	0	0	0.5
Demand	4.0	3.0	4.0	4.0	

Find the penalty values from all the row and column and allocate the particular cost cell of the given problem. If we have more than one resultant value, we can choose anyone.

Table 3

	R_a	R_b	R_c	R_d	Supply	Penalty
I_a	1	1	1	0.5	3.0	5.5
I_b	10	8	5	4	6.5	15
I_c	6.5	7	7	8	5.0	6.5
I_d	**0.5** 0	0	0	0	0	4
Demand	3.5	3.0	4.0	4.0	15	
Penalty	**21.5**	20	17	16.5		

The same procedure will be followed again and again until we reach the final allocation. Finally, using the new proposed algorithm obtained gives the best possible resolutions are as follows.

Table 4

	R_a	R_b	R_c	R_d	Supply
I_a	**3.0** 1	1	1	0.5	3.0
I_b	10	8	**2.5** 5	**4.0** 4	6.5
I_c	**0.5** 6.5	**3.0** 7	**1.5** 7	8	5.0

I_d	**0.5** 0	0	0	0	0.5
Demand	4.0	3.0	4.0	4.0	15

4.3.1 Result

Here (4+4-1) = 7 cells are allocated. Next, we can get the optimal solution by means proposed algorithm.

$\text{Min } Z = 3(1) + 2.5(5) + 4(4) + 0.5(6.5) + 3(7) + 1.5(7) + 0.5(0)$

$\text{Min } Z = 66.25$

4.3.2Discussion

The Comparison of the new Proposed Technique with North – West Corner Method, the Least Cost Method, and Vogel's Approximation Method is listed below, it's clearly understood that the new proposed Technique affords the optimal results.

Methods	**Optimal solutions**
North – West Corner Method	88.00
Least Cost Method	70.75
VAM Method	66.50
New Proposed Method	**66.25**

5. Conclusion

A large number of transportation problems with different levels of sophistication have been studied in the literature. However, some of these problems have limited real-life applications because the conventional transportation problems generally assume crisp data for the transportation cost, the values of supplies and demands. Contrary to the conventional transportation problems, we investigated imprecise data in the real-life transportation problems and developed an alternative method that is simple and yet addresses these shortfalls in the existing models in the literature. In the FTP considered in this study, the values of transportation costs are represented by generalized trapezoidal fuzzy numbers and the values of supply and demand of products are represented by real numbers. Here we concluded that once the ranking function is chosen,the FTP is converted into a crisp one, which is easily solved by the standard transportation algorithms. Therefore, further research on extending the proposed method to overcome these shortcomings is an interesting stream future research.We shall report the significant results of these ongoing projects in the near future.

Reference:

1. L.A. Zadeh, Fuzzy sets, Inf. Control 8 (1965) 338–353.

2. H.J. Zimmermann, Fuzzy programming and linear programming with several objective functions, Fuzzy Sets Syst. 1 (1978) 45–55.DOI:https://doi.org/10.1016/0165-0114(78)90031-3
3. R. Srinivasan, S. Muruganandam, A new algorithm for solving fuzzy transportation problem with trapezoidal fuzzy numbers, International Journal of Recent Trends in Engineering and Research. 2 (3) (2016) 428–437. DOI:10.3923/ajit.2016.3501.3505
4. R. Srinivasan, the Modified method for solving fully fuzzy transportation problem', Global Journal for Research analysis 5 (4) (2016) 177–179.DOI:https://www.doi.org/10.36106/gjra
5. R. Srinivasan, S. Muruganandam, V. Vijayan, A new algorithm for solving fuzzy transportation problem with triangular fuzzy number, Asian Journal of Information Technology 15 (18) (2016) 3501–3505. DOI: 10.36478/ajit.2016.3501.3505
6. Ghosh, S., Roy, S.K., Ebrahimnejad, A. *et al.* Multi-objective fully intuitionistic fuzzy fixed-charge solid transportation problem. *Complex & Intelligent Systems.* **7,** 1009–1023 (2021). https://doi.org/10.1007/s40747-020-00251-3;
7. Bharati, S.K. Transportation problem with interval-valued intuitionistic fuzzy sets: impact of a new ranking. Progress in Artificial Intelligence (2021). https://doi.org/10.1007/s13748-020-00228-w;
8. A new fuzzy transportation algorithm for finding the fuzzy optimal solutions. Muhammad Sam'an; Farikhin. International Journal of Mathematical Modelling and Numerical Optimisation. 2021 Vol.11 No.1. **DOI**: 10.1504/IJMMNO.2021.111715
9. Srinivasan, R., Karthikeyan, N., Renganathan, K., &Vijayan, D. V. (2020). Method for solving fully fuzzy transportation problem to transform the materials. Materials Today: Proceedings. doi:10.1016/j.matpr.2020.05.423
10. Karthikeyan N, Yahya Mohamed, Solving Fuzzy Transportation problem using Distance ranking Method for Trapezoidal Fuzzy Numbers, Journal of Emerging Technologies and innovative research,5 (5) (2018) 25-29 DOI: 10.6084/m9.jetir.JETIR1805688
11. S. SathyaGeetha, K. Selvakumari, A New Method for Solving Fuzzy Transportation Problem Using Pentagonal Fuzzy Numbers, Journal of Critical Reviews, 7(9) (2020) 171 – 174 **DOI:** 10.31838/jcr.07.09.34
12. Dipankar De, A Method for solving fuzzy transportation problem of trapezoidal number, Conference Paper, (2016)