JOURNAL OF ALGEBRAIC STATISTICS
Volume 13, No. 3, 2022, p. 205 - 214
https://publishoa.com
ISSN: 1309-3452

Solving Fuzzy Transportation Problem Using Zero Suffix And Heuristic Method With Two Distinct Fuzzy Numbers

A. Theresal Jeyaseeli,
Department of Mathematics , Holy Cross College (Autonomous),Tiruchirappalli – 620002 , Tamilnadu, India
Email:supertheresa16@gmail.com

ABSTRACT
In many practical applications, transportation issues are crucial to Maintaining the supply from the source to the destination is the goal of this issue. The Transportation Problem is frequently utilized to take on a real-world problem. Due to some unanticipated circumstances, unpredictability and imprecision will always exist in the actual world. In this study I have, use robust ranking technique for Defuzzification process , to which resource have the lowest shipping cost. The study to investigate the least transportation cost of zero suffix method is less than the heuristic method.

KEYWORDS : Robust ranking technique, zero suffix method and heuristic method,

I. INTRODUCTION

The Transportation Problem is a form of linear programming problem in which the goal is to reduce the cost of transporting a commodity from several sources or origins to multiple destinations. In real-world applications however, fluctuating weather, social and economic situations make it difficult to exactly specify supply and demand quantities in the Transportation Problem. Fuzzy set theory is most beneficial for real world problems that involve the computation of hidden knowledge. One of the special type of fuzzy linear programming problem is the fuzzy Transportation Problem.
A fuzzy Transportation Problem is one in which the cost, supply anddemand for transportation are all uncertain situation. It has been transformed using the Robust Ranking Technique . The goal is to use the Zero Suffix Method and Heuristic Method to solve a problem with fuzzy parameters in the form of a linear programming issue. By L.A Zadeh was the first to create the fuzzy set in order to mathematically express imprecision or vagueness in daily life.
In this paper using a Robust ranking technique to examine the transportation lowest cost, here offer a new strategy to solving TP with hexagonal and octagonal fuzzy numbers. which can be solved using the zero suffix and heuristic method.

Robust Ranking technique:

A new innovative technique proposed in this study the term as "robustranking" it refers to the process of ranking as follows.

$R(\tilde{F}) = \int_0^1 (0.5)\left(a_{F_\alpha}{}^{L}, a_{F_\alpha}{}^{U}\right)$ Where $\tilde{F} = k_1, l_1, m_1, n_1, o_1, p_1$ and

$$\left(a_{F_\alpha}{}^{L}, a_{F_\alpha}{}^{U}\right) = [(l_1 - k_1)\alpha + k_1, n_1 - (n_1 - m_1)\alpha] - [(n_1 - m_1)\alpha + m_1, p_1 - (p_1 - o_1)\alpha]$$

Transportation Problem:

i. The Fuzzy transportation challenges means moving a single item frommultiple suppliers to various consumers.

ii. Generally 'C' sources $C_1, C_2 \ldots\ldots C_n$ with a_i (i = 1,2….C) at each source i, there is many available supply among D possible destinations $D_1, D_2 \ldots.. D_n$ with b_j (j = 1,2…D) at each destination j, there is specific criteria.

iii. Let, C_{ij} be the delivery cost from i to j for each path then x_{ij} be the components delivered per path from source i to destination j.

iv. The goal to discover a transportation schedule that minimizing the total transportation cost while satisfying supply and demand criteria.

JOURNAL OF ALGEBRAIC STATISTICS
Volume 13, No. 3, 2022, p. 205 - 214
https://publishoa.com
ISSN: 1309-3452

$$Minimize\ \tilde{z} = \sum_{i=1}^{m}\sum_{j=1}^{n}\tilde{c}_{ij}\,\tilde{x}_{ij}$$

$\tilde{x}_{i1} + \tilde{x}_{i2} + \cdots + \tilde{x}_{in} = \tilde{a}_i\ \ , i = 1,2,\dots,m$

$\tilde{x}_{1j} + \tilde{x}_{2j} + \cdots + \tilde{x}_{mj} = \tilde{b}_j\ \ , j = 1,2,\dots,n$ and $\tilde{x}_{ij} \geq 0\ \forall\ i\ and\ j$

In order for a feasible solution to arise supply needs equal total demand.

$$\sum_{i=1}^{m}\tilde{a}_i = \sum_{j=1}^{n}\tilde{b}_j$$

II .METHODOLOGY FOR FINDING A SOLUTION:

Algorithm of Fuzzy extension of zero suffix method:

The stages for using this methodology to resolve transportation concerns are asfollows:
STEP 1: create a transportation concern.

STEP 2: subtract the cheapest value of each row from a matrix, same as subtractthe cheapest value of each column from the focused matrix.

STEP 3: from the focused matrix, there should be at least one zero value in e veryrow and column.

STEP 4: then you will need to figure out the suffix values, then it is signified as S_z.

$$S_z = \frac{\text{Add up the cost of two closest neighbor sides that are zero}}{\text{Added cost}}$$

STEP 5 : To determine the values of zeros in appropriate row and column, expect from the chosen row, and make a note of the total numbers of zeros in the suffix.

STEP 6 : Mark the suffix just like the way of STEP 5, for each zero.

STEP 7 :Cchoose the lowest suffix and assign the conforming cell to it eachallotment is arranged in ascending order of sufficiency.

STEP 8 : If we confirm that there are less than m+n-1 cells ,then restart the process from STEP 2 to STEP 7.

STEP 9 : The procedure goes till all the cells are met.

Algorithm of Fuzzy extension of Heuristic method:

STEP 1: From the Transportation Problem, create a fuzzy transportation table.

STEP 2: check to see if the Transportation Problem is balanced and if isn’t mate itso.

STEP 3: determine the liabilities for each row and column by subtracting the two least expensive cost cell for each row and column. These are regarded as respectively, liabilities L.

STEP 4: compute the total cost of each row and column T □ stands for these values. STEP 5: Multiply the liabilities L by the total cost T □ to have the product L T □

STEP 6: Find the row/column with least amount of LT □

STEP 7: choose the cell in row/column identifies in STEP 6, has lowest cost and assign the most possible resource to the selected cells.

STEP 8: Determine which row/column has the lowest LT and choose the cell with lowest cost in selected row and column , and assign the possible resource to selected cells.

STEP 9: Remove the satisfied row / column by crossing out and continue the process till you've met all of the conditions, then transfer the amount to original FTT.

STEP 10: Finally, calculate the FTTs entire profit their calculations is the result ofmultiplying the cost by FTTs assigned value

III. NUMERICAL EXAMPLES

Example : 1

Using Hexagonal Fuzzy Number:

A Branded company manufacture a three products from the production plant Chennai, Trichy and Madurai these products are sold through wholesale distributors of three locations, location 1 , location 2 and location 3 using the method of zero suffix and heuristic method , determine the least cost way of shipping from plantto distributors.

Distributor / Plant	Location 1	Location 2	Location 3	Supply
Chennai	(2,4,6,8,10,12)	(2,6,8,12,14,16)	(8,10,12,14,16,18)	(16,20,24,24,12,8)
Trichy	(6,12,10,8,6,4)	(4,6,10,12,14,10)	(8,14,12,10,4,2)	(4,6,10,12,4,2)
Madurai	(2,10,12,14,12,4)	(2,16,14,12,10,12)	(10,18,8,12,14,12)	(10,20,24,34,22,20)
Demand	(10,16,16,14,10,8)	(10,2,12,14,10,4)	(4,6,2,6,10,14)	

Using Robust ranking technique:

1

$R(\tilde{F}) = \int_0^1 (0.5)\left(a_{F_\alpha}{}^{L}, a_{F_\alpha}{}^{U}\right)$ Where $\tilde{F} = k_1, l_1, m_1, n_1, o_1, p_1$ and

$\left(a_{F_\alpha}{}^{L}, a_{F_\alpha}{}^{U}\right) = [(l_1 - k_1)\alpha + k_1, n_1 - (n_1 - m_1)\alpha] - [(n_1 - m_1)\alpha + m_1, p_1 - (p_1 - o_1)\alpha]$

$R_1{}' = (2,4,6,8,10,12)$
$= [(4-2)\alpha + 2, 8 - (8-6)\alpha] - [(8-6)\alpha + 6, 12 - (12-10)\alpha]$
$= [2\alpha + 2 + 8 - 2\alpha - 2\alpha + 6 + 12 - 2\alpha] = 28$

$$R_1{}' = \frac{1}{2}\int_0^1 28 \; d\alpha = 14$$

Similarly to get

$R_2{}' = 19 \quad R_3{}' = 26 \quad R_4{}' = 16 \quad R_5{}' = 19.5 \quad R_6{}' = 18 \quad R_7{}' = 20 \quad R_8{}' = 23 \; R_9{}' = 23.5$

For Demand Values
$D_1{}' = 26 \quad D_2{}' = 19.5 \quad D_3{}' = 12.5$
For Supply Values
$S_1{}' = 38 \quad S_2{}' = 15 \quad S_3{}' = 47$

Crisp Model :

Distributor / Plant	Location 1	Location 2	Location 3	supply
Chennai	14	19	26	38
Trichy	16	19.5	18	15
Madurai	20	23	23.5	47
Demand	26	19.5	12.5	

Total supply = 100 and Total Demand = 58

Here $\sum_{i=1}^{m} \tilde{a}_i > \sum_{j=1}^{n} \tilde{b}_j$ then the transportation problem was not balanced

Now we have a balanced fuzzy transportation problem instead of an imbalanced fuzzy transportation problem using the dummy columns in various Methods

1.Least Cost Method:

Distributor / Plant	Location 1	Location 2	Location 3	Location 4	supply
Chennai	14	19	26	[38] 0	38
Trichy	[11] 16	19.5	18	[4] 0	15
Madurai	[15] 20	[19.5] 23	[12.5] 23.5	0	47
Demand	26	19.5	12.5	42	

Total cost= (39×0) +(11×16) +(4×0) +(15×20)+(19.5×23)+(12.5×23.5)
= Rs. 1218.25

JOURNAL OF ALGEBRAIC STATISTICS
Volume 13, No. 3, 2022, p. 205 - 214
https://publishoa.com
ISSN: 1309-3452

2. North – west corner method:

Distributor / Plant	Location 1	Location 2	Location 3	Location 4	Supply
Chennai	24 14	12 19	26	0	38
Trichy	16	7.5 19.5	7.5 18	0	15
Madurai	20	23	5 23.5	42 0	47
Demand	26	19.5	12.5	42	100

Total cost = (26×14)+(12×19)+(7.5×19.5)+(7.5×18)+(5×22.5)+(42×0)

= Rs. 990.75

3.Vogel's Approximation Method:

Distributor / Plant	Location 1	Location 2	Location 3	Location 4	supply
Chennai	26 14	12 19	26	0	38
Trichy	16	2.5 19.5	12.5 18	0	15
Madurai	20	5 23	23.5	42 0	47
Demand	26	19.5	12.5	42	

Total cost = (26×14)+(12×19)+(2.5×19.5)+(12.5×18)+(5×23)+(12×0)

= Rs. 981.75

4. ZERO SUFFIX METHOD

Total cost = (26×14)+ (12×19)+(2.5×19.5)+(12.5×18)+(5×23)+(42×0)

= Rs . 980.75

JOURNAL OF ALGEBRAIC STATISTICS
Volume 13, No. 3, 2022, p. 205 - 214
https://publishoa.com
ISSN: 1309-3452

Distributor / Plant	Location 1	Location 2	Location 3	Location 4	Supply
Chennai	26 | 14	12 | 19	26	0	38
Trichy	16	2.5 | 19.5	12.5 | 18	0	15
Madurai	20	5 | 23	23.5	42 | 0	47
Demand	26	19.5	12.5	42	

5. HEURISTIC METHOD

Distributor / Plant	Location 1	Location 2	Location 3	Location 4	Supply
Chennai	14	19	26	38 | 0	38
Trichy	15 | 16	19.5	18	0	15
Madurai	11 | 20	19.5 | 23	12.5 | 23.5	4 | 0	47
Demand	26	19.5	12.5	42	

Total cost = (38×0)+(15×16)+(11×20)+(19.5×23)+(12.5×23.5)+(4×0)

= Rs. 1202.25

Example: 2

Using Octagonal Fuzzy Number:

A Branded company manufacture a three products from the production plant Delhi, Karnataka and Kerala these products are sold through wholesale distributors of three locations, location 1 , location 2 and location 3 using the method of zero suffix and heuristic method , determine the least cost way of shipping from plant to distributor.

Distributor / plants	location 1	location 2	location 3	Supply
Delhi	(2,4,6,8,10, 12,14,18)	(2,6,8,12,14, 16,18,20)	(8,10,12,14,16, 18,20,22)	(16,20, 21,24 12,8,10,6)
Karnataka	(6,12,10,8, 6,4,2,14)	(4,6,10,12, 14,10,18,20)	(8,14,12,10, 4,2,18,16)	(4,6,10,12, 4,2,18,22)
Kerala	(2,10,12,14, 12,4,2,6)	(10,18,8,12, 14,12,6,4)	(2,16,14,12, 10,12,6,20)	(10,20,24,34, 22,20,18,16)
Demand	(10,16,16,14, 10,8,12,18)	(10,2,12,14, 10,4,2,6)	(4,6,2,6,10, 14,16,20)	

Using Robust ranking technique:

$R_1{}' = 18.5$ $R_2{}' = 24$ $R_3{}' = 30$ $R_4{}' = 14.5$ $R_5{}' = 23.5$ $R_6{}' = 21$
$R_7{}' = 15.5$ $R_8{}' = 22$ $R_9{}' = 23$

For Demand Values
$D_1{}' = 26$ $D_2{}' = 15$ $D_3{}' = 19.5$
For Supply Values
$S_1{}' = 30$ $S_2{}' = 20.5$ $S_3{}' = 41$

CRISP MODEL

Distributor / plants	location 1	location 2	location 3	Supply
Delhi	18.5	24	30	30
Karnataka	14.5	23.5	21	20.5
Kerala	15.5	22	23	41
Demand	26	15	19.5	

JOURNAL OF ALGEBRAIC STATISTICS
Volume 13, No. 3, 2022, p. 205 - 214
https://publishoa.com
ISSN: 1309-3452

Total Supply = 91.5 , Total Demand = 60.5

Here $\sum_{i=1}^{m} \tilde{a}_i > \sum_{j=1}^{n} \tilde{b}_j$ then the transportation problem was not balanced

Now we have a balanced fuzzy transportation problem instead of an imbalanced fuzzy transportation problem using the dummy columns in various Methods

ZERO SUFFIX METHOD

Distributor / plants	Location 1	Location 2	Location 3	Location 4	Supply
Delhi	18.5	24	30	[30] 0	30
Karnataka	[1] 14.5	23.5	[19.5] 21	0	20.5
Kerala	[25] 15.5	[15] 22	23	[1] 0	41
Demand	26	15	19.5	31	

Total cost = (30×0) +(1×14.5) +(19.5×21)+(25×15.5)+(15×22)+(1×0)

= Rs. 1141

HEURISTIC METHOD

Distributor / plants	Location 1	Location 2	Location 3	Location 4	Supply
Delhi	[5.5] 18.5	[5] 24	19.5 30	0	30
Karnataka	[20.5] 14.5	23.5	21	0	20.5
Kerala	15.5	[10] 22	23	[31] 0	41
Demand	26	15	19.5	31	

Total cost = (5.5×18.5) +(5×24) +(19.5×30)+(20.5×14.5)+(10×22)+(31×0)

= Rs. 1324

JOURNAL OF ALGEBRAIC STATISTICS
Volume 13, No. 3, 2022, p. 205 - 214
https://publishoa.com
ISSN: 1309-3452

IV . SENSITIVITY ANALYSIS OF HEXAGONAL AND OCTAGONAL FUZZY NUMBERS

No	Name of methods	Hexagonal fuzzy number (Total cost) Rs.	Octagonal fuzzy number (Total cost)
1	Least cost method	Rs. 1218.25	Rs. 1162
2	North west corner	Rs. 990.75	Rs. 1185
3	Vogel's approximation	Rs. 981.75	Rs. 1161
4	Zero suffix method	Rs. 980.75	Rs. 1141
5	Heuristic method	Rs. 1202.25	Rs. 1324

The Results Of The Zero Suffix And Heuristic Method

No	Name of methods	Hexagonal fuzzy number (Total cost) Rs.	Octagonal fuzzy number (Total cost) Rs.
1	Zero suffix method	Rs. 980.75	Rs. 1141
2	Heuristic method	Rs. 1202.25	Rs. 1324

V.CONCLUSION

In this study a new algorithm for solving fuzzy transportation problem using hexagonal and octagonal fuzzy number. In addition some parameters such as cost, demand and supply are treated as fuzzy numbers in this mathematical model of fuzzy transportation problem. The proposed algorithms are used to compute the least cost of fuzzy transportation problem. and a numerical problem illustrated using the zero suffix and heuristic method. And also the numerical problem compared to other way of methods such as (LCM, NWCR,VAM, Heuristic). the proposed model reached a better results in zero suffix method to get the least cost.

JOURNAL OF ALGEBRAIC STATISTICS
Volume 13, No. 3, 2022, p. 205 - 214
https://publishoa.com
ISSN: 1309-3452

VI. REFERENCES

1. Agastiti PTB, Bagu surarso and sutimin (2018) – zero point and zero suffix method with robust ranking for solving fully fuzzy transportation [3-5].

2. Fegade M.R., Jadhav V.A., Muley A.A. "Solution of multi-objective transportation problem using zero suffix and separation method", International eJournal of Mathematics and Engineering, 118 (2011)

3. George J. Klir /Bo yuan Fuzzy sets and fuzzy logic theory and applications

4. H.J zimmermann, Fuzzy set theory and its applications .

5. Stephen Dinagar D and Keerthivasan R (2018) –finidng optimal solution of the Transportation Problem with modern zero suffix method, volume 20, issue 4.

6. Uma Maheswari P and Ganesan K (2018) – solving fully fuzzy Transportation Problem using pentagonal fuzzy number.

7. Zadeh, L. A."Fuzzy sets, Information and Control", 8 (1965), pp 338–353.

8. Zimmermann H.J. " Fuzzy sets theory and its applications",(1996) Kluwer- Nijh off, Boston.