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# SOLVING TRANSPORTATION PROBLEM BY MONALISHA APPROXIMATION METHOD USING DODECAGONAL FUZZY NUMBER

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**ABSTRACT**

In this paper, we provide a Dodecagonal fuzzy number-based on the fuzzy transportation problem. In a fuzzy environment, we discover the best optimal solution to a transportation problem. To find the best answer, we developed a Hosoya Triangle for converting the fuzzy number into crisp value. We also find the minimum transportation cost by combining the fuzzy transportation problem with existing approaches. These steps are demonstrated using a numerical example based on the fuzzy algorithm.

**KEYWORDS AND PHRASES**: Transportation Problem, Fuzzy Transportation Problem,Hosoya Triangle, Dodecagonal Fuzzy Number

## 1.INTRODUCTION

Transportation problems are well known in industrial research because of their wide range of practical applications. This is a special type of network optimization problem, in which goods are transported from a set of sources to a set of destinations, where the transportation problem will minimize costs. The basic Transportation problem developed by Hitchcock.

A fuzzy set was first introduced by Lofti Zadeh (1965),Lai and Hwang [13] developed a transportation model to solve the fuzzy quantity and price problem. Chanas and Kuchta [12] presented the concept of the optimal solution of a transportation problem using the fuzzy coefficient expressed as a fuzzy number and developed an algorithm to obtain the optimal solution.

A Fuzzy transportation problem in which all transportation problem in a fuzzy environment are expressed by normal fuzzy number. Chanas and Kuchta presented an algorithm to solve the transportation problem using the fuzzy supply and demand value of and the integral conditions applied to the solution.

## 2. PRELIMINARIES

**Definition 2.1. Fuzzy Set**

Let X be a non-empty set. The Fuzzy set A of X is defined as

$A = \{(x, \mu_A(x))/x \in X\}$

Where $\mu_A(x)$ is called the Membership Function which maps each elements of X toa value between 0 and 1.

**Definition 2.2. Fuzzy Number**

A Fuzzy number A is a convex normalized fuzzy set on the real line R such that

1) There exist at least one x belongs to R with $\mu_A(x)$ =1

2) $\mu_A$(x) is piecewise continuous

**Definition 2.3. Triangular Fuzzy Number**

A Fuzzy number A is a Triangular Fuzzy Number denoted by A = $(a_1, a_2, a_3)$ where $a_1, a_2$ and $a_3$ are real numbers and its membership function is given below,

$$\mu_A(x) = \begin{cases} \frac{x-a_1}{a_2-a_1} & for\ a_1 \le x \le a_2 \\ \frac{a_3-x}{a_3-a_2} & for\ a_2 \le x \le a_3 \\ 0 & otherwise \end{cases}$$

**Definition 2.3. Fuzzy Transportation Problem**

Consider a Fuzzy Transportation problem with m sources and n destination with the HFN's. The Mathematical formulation of Fuzzy Transportation problem whose parameters are Dodecagonal fuzzy numbers in which total supply is equivalent to total demand is given by,

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

Subject to the constraints,

$$\sum_{i=1}^{n} \tilde{x}_{ij} \approx \tilde{a}_i \qquad i=1,2,\ldots,m$$

$$\sum_{j=1}^{n} \tilde{x}_{ij} \approx \tilde{b}_j \qquad j=1,2,\ldots,n$$

in which transportation costs $\tilde{c}_{ij}$ supply $\tilde{a}_i$ and demand $\tilde{b}_j$ are Dodecagonal fuzzy quantities. [2]

**Definition 2.3. Dodecagonal Fuzzy Number**

A Fuzzy number A is a Dodecagonal Fuzzy Number denoted by A = $(a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8, a_9, a_{10}, a_{11}, a_{12})$ where $a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8, a_9, a_{10}, a_{11}$ and $a_{12}$ are real numbers and its membership function is given below, [7]

$$\mu_A(x) = \begin{cases} \frac{1}{5}\left(\frac{x-a_1}{a_2-a_1}\right) & for\ a_1 \le x \le a_2 \\ \frac{1}{5}+\frac{1}{5}\left(\frac{x-a_2}{a_3-a_2}\right) & for\ a_2 \le x \le a_3 \\ \frac{2}{5}+\frac{1}{5}\left(\frac{x-a_3}{a_4-a_3}\right) & for\ a_3 \le x \le a_4 \\ \frac{3}{5}+\frac{1}{5}\left(\frac{x-a_4}{a_5-a_4}\right) & for\ a_4 \le x \le a_5 \\ \frac{4}{5}+\frac{1}{5}\left(\frac{x-a_5}{a_6-a_5}\right) & for\ a_5 \le x \le a_6 \\ 1 & for\ a_6 \le x \le a_7 \\ 1-\frac{1}{5}\left(\frac{x-a_7}{a_8-a_7}\right) & for\ a_7 \le x \le a_8 \\ \frac{4}{5}-\frac{1}{5}\left(\frac{x-a_8}{a_9-a_8}\right) & for\ a_8 \le x \le a_9 \\ \frac{3}{5}-\frac{1}{5}\left(\frac{x-a_9}{a_{10}-a_9}\right) & for\ a_9 \le x \le a_{10} \\ \frac{2}{5}-\frac{1}{5}\left(\frac{x-a_{10}}{a_{11}-a_{10}}\right) & for\ a_{10} \le x \le a_{11} \\ \frac{1}{5}\left(\frac{a_{12}-x}{a_{12}-a_{11}}\right) & for\ a_{11} \le x \le a_{12} \\ 0 & for\ a_{11} \le x \le a_{12} \end{cases}$$

## 3. HOSOYA TRIANGLE

**1**

**1 1**

**2 1 2**

**3 2 2 3**

**5 3 4 3 5**

**8 5 6 6 5 8**

**13 8 10 9 10 8 13**

**21 13 16 15 15 16 13 21**

**34 21 26 24 25 24 26 21 34**

**55 34 42 39 40 40 39 42 34 55**

**89 55 68 63 65 64 65 63 68 55 89**

**144 89 110 102 105 104 104 105 102 110 89 144**

**APPROACH**

The Dodecagonal solution of Hosoya Triangle is given by,

Let A= $(x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}, x_{11}, x_{12})$ be Dodecagonal fuzzy numbers then we can take the coefficient of fuzzy numbers from the triangle of Hosoya and apply the approach.

$$\mathbf{D\ (A)} = \frac{144[x_1+x_{12}]+89[x_2+x_{11}]+110[x_3+x_{10}]+102[x_4+x_9]+105[x_5+x_8]+104[x_6+x_7]}{1308}$$

The coefficient of $(x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}, x_{11}, x_{12})$ are 144,89,110,102,105, 104,104,105,102,110,89,144. This method can also be applied to the Dodecagonal fuzzy order of n-dimensional Hosoya Triangle. [8]

## 4. ALGORITHM

### Monalisha's Approximation Method

**Step 1**: Verify whether the given problem is balanced or unbalance .If unbalanced change into a balanced one by introducing a source or destination utilizing Zero Fuzzy item transportation expenses.

**Step 2**: Find the smallest cost in each row of the given cost matrix and then sub-tract the same from each cost of the row

**Step 3**: In the reduced matrix, locate the smallest cost in each column of the given cost matrix and then subtract the same from each cost of that column

**Step 4**: For each row of the Transportation Problem Identify the smallest and the next-to- smallest costs. Determine the difference between them for each row. Displaythe transportation table by enclosing them against the respective rows. Similarly compute the differences for each column.

**Step 5**: Identify the row or column with the largest difference among all the rows and columns. If a tie occurs, use any arbitrary tie-breaking choice. Let the greatest difference corresponds to $i^{th}$ row and let 0 be in the $i^{th}$ row. Allocate the maximum feasible amount $x_{ij}$=min($a_i, b_j$) in the $(i.j)^{th}$ cell and cross off either the $i^{th}$row or the $j^{th}$column in the usual manner.

**Step 6**: Again compute the column and row differences for the reduced transportation table and go to step 5. Repeat the procedure until all the requirements aresatisfied. [1]

## 5. NUMERICAL ILLUSTRATION

Here we construct the Transportation Problem Based on Dodecagonal Fuzzy Number,

| | $D_1$ | $D_2$ | $D_3$ | $D_4$ | **Supply** |
|---|---|---|---|---|---|
| $S_1$ | (-3,-2,-1,0,1, 2,3,4,5,6,7,8) | (-2,-1,0,1,2,3, 4,5,6,7,8,9) | (6,7,8,9,10,11, 12,13,14,15,16,17) | (-5,-4,-3,-1,0,1, 2,4,5,6,7,9) | (-1,0,1,3,5,6, 7,8,10,12,13,14) |
| $S_2$ | (-4,-3,-2,-1,0,1, 2,3,4,5,6,7) | (-5,-4,-3,-2,-1,0, 1,2,3,4,5,6) | (8,9,11,12,14,15, 16,17,18,21,22,23) | (2,3,4,5,6,7, 8,9,10,11,12,13) | (-4,-3,-2,-1,0,1, 2,3,4,5,6,7) |
| $S_3$ | (0,1,2,3,4,5, 6,7,8,9,10,11) | (1,2,3,6,7,8, 9,10,12,13,15,16) | (0,1,2,4,5,6, 7,8,9,11,12,13) | (2,3,5,6,8,9, 10,11,12,15,16,17) | (2,4,5,6,8,10, 12,13,15,17,18,19) |
| **Demand** | (2,3,4,5,6,7, 8,9,10,11,12,13) | (-2,0,1,2,3,5, 6,7,8,10,11,12) | (-2,-1,0,1,2,3, 4,5,6,7,8,9) | (-3,-2,-1,0,1,2, 3,4,5,6,7,8) | |

**TABLE 1**

| | $D_1$ | $D_2$ | $D_3$ | $D_4$ | Supply |
|---|---|---|---|---|---|
| $S_1$ | (-3,-2,-1,0,1, 2,3,4,5,6,7,8) | (-2,-1,0,1,2,3, 4,5,6,7,8,9) | (6,7,8,9,10,11, 12,13,14,15,16,17) | (-5,-4,-3,-1,0,1, 2,4,5,6,7,9) | (-1,0,1,3,5,6, 7,8,10,12,13,14) |
| $S_2$ | (-4,-3,-2,-1,0,1, 2,3,4,5,6,7) | (-5,-4,-3,-2,-1,0, 1,2,3,4,5,6) | (8,9,11,12,14,15, 16,17,18,21,22,23) | (2,3,4,5,6,7, 8,9,10,11,12,13) | (-4,-3,-2,-1,0,1, 2,3,4,5,6,7) |
| $S_3$ | (0,1,2,3,4,5, 6,7,8,9,10,11) | (1,2,3,6,7,8, 9,10,12,13,15,16) | (0,1,2,4,5,6, 7,8,9,11,12,13) | (2,3,5,6,8,9, 10,11,12,15,16,17) | (2,4,5,6,8,10, 12,13,15,17,18,19) |
| **Demand** | (2,3,4,5,6,7, 8,9,10,11,12,13) | (-2,0,1,2,3,5, 6,7,8,10,11,12) | (-2,-1,0,1,2,3, 4,5,6,7,8,9) | (-3,-2,-1,0,1,2, 3,4,5,6,7,8) | |

By using Hosoya Triangle convert the Dodecagonal Fuzzy Number into Crisp value

$$\mathbf{D\ (A)} = \frac{144[x_1+x_{12}]+89[x_2+x_{11}]+110[x_3+x_{10}]+102[x_4+x_9]+105[x_5+x_8]+104[x_6+x_7]}{1308}$$

$$D\ (A) = \frac{144[-3+8]+89[-2+7]+110[-1+6]+102[0+5]+105[1+4]+104[2+3]}{1308}$$

$$D\ (A) = \frac{3270}{1308}$$

D (A) = 2.5

**TABLE 2**

| | $D_1$ | $D_2$ | $D_3$ | $D_4$ | Supply |
|---|---|---|---|---|---|
| $S_1$ | 2.5 | 3.5 | 11.5 | 1.7 | 6.5 |
| $S_2$ | 1.5 | 0.6 | 15.5 | 7.5 | 1.5 |
| $S_3$ | 5.5 | 8.4 | 6.5 | 9.5 | 10.7 |
| **Demand** | 7.5 | 5.2 | 3.5 | 2.5 | |

Locating the smallest element in each row of the given cost matrix and thensubtracting the same from each element of that row, In the reduced matrix repeat this procedure for each column of the given cost matrix

**TABLE 3**

| | $D_1$ | $D_2$ | $D_3$ | $D_4$ | Supply |
|---|---|---|---|---|---|
| $S_1$ | 0.8 | 1.8 | 8.8 | 0 | 6.5 |
| $S_2$ | 0.9 | 0 | 13.9 | 6.9 | 1.5 |
| $S_3$ | 0 | 2.9 | 0 | 4 | 10.7 |
| **Demand** | 7.5 | 5.2 | 3.5 | 2.5 | |

For each row of the transportation table identify the smallest and the next to the smallest costs. Determine the difference between them for each row and allocate thetransportation cost. Similarly compute the difference for each column of the transportation table.

Identify the row or column with the largest difference among all the rows and columns. If a tie occurs, use any arbitrary tie-breaking choice.

**TABLE 4**

| | $D_1$ | $D_2$ | $D_3$ | $D_4$ | Supply | Penalty |
|---|---|---|---|---|---|---|
| $S_1$ | 0.8 | 1.8 | 8.8 | 0 | 6.5 | 0.8 |
| $S_2$ | 0.9 | 0 | 13.9 | 6.9 | 1.5 | 0.9 |
| $S_3$ | 0 | 2.9 | 3.5<br>0 | 4 | 10.7/7.2 | 0 |
| **Demand** | 7.5 | 5.2 | 3.5/0 | 2.5 | | |
| **Penalty** | 0.8 | 1.8 | 8.8 | 4 | | |

Let the greatest difference corresponds to $i^{th}$ row and let 0 be in the $i^{th}$ row. Allocate the maximum feasible amount $x_{ij}$=min($a_i, b_j$) in the $(i.j)^{th}$ cell and cross off either the $i^{th}$row or the $j^{th}$column in the usual manner.

Compute the column and row differences for the reduced transportation table and go to step 5.

Repeat the procedure until all the requirements aresatisfied

## 6.RESULT

Finally, using Monalisha’s Approximation Method algorithm gives the bestpossible resolutions,

<table>
<tr><th></th><th>$D_1$</th><th>$D_2$</th><th>$D_3$</th><th>$D_4$</th><th>Supply</th></tr>
<tr><td rowspan="2">$S_1$</td><td>0.3</td><td>3.7</td><td rowspan="2">11.5</td><td>2.5</td><td rowspan="2">6.5</td></tr>
<tr><td>2.5</td><td>3.5</td><td>1.7</td></tr>
<tr><td rowspan="2">$S_2$</td><td rowspan="2">1.5</td><td>1.5</td><td rowspan="2">15.5</td><td rowspan="2">7.5</td><td rowspan="2">1.5</td></tr>
<tr><td>0.6</td></tr>
<tr><td rowspan="2">$S_3$</td><td>7.2</td><td rowspan="2">8.4</td><td>3.5</td><td rowspan="2">9.5</td><td rowspan="2">10.7</td></tr>
<tr><td>5.5</td><td>6.5</td></tr>
<tr><td>Demand</td><td>7.5</td><td>5.2</td><td>3.5</td><td>2.5</td><td></td></tr>
</table>

Here (4+3-1) =6 cells are allocated. Now we get the optimal solution byMonalisha’s Approximation Method

Minimum Z =(2.5*0.3)+(3.5*3.7)+(1.7*2.5)+(0.6*1.5)+(5.5*7.2)+(6.5*3.5)

Z = 0.75 + 12.95 + 4.25 + 0.9 + 39.6 + 22.75

Minimum Z = 81.2

## 7.COMPARISON

The Comparison of Monalisha’s Approximation Method and Vogel’sApproximation Method are listed below,

| Methods | Monalisha’s Approximation | Vogel’s Approximation |
|---|---|---|
| **Optimal Solution** | 81.2 | 81.2 |

## 8.CONCLUSION

In this paper, we have discussed about how to solve the fuzzy transportationproblem through Monalisha’s Approximation Method (MAM) and Vogel’s Approximation Method (VAM) by using Hosoya Triangle for Dodecagonal Fuzzy Number. We obtained the result for Monalisha’s Approximation Method and Vogel’s Approximation Method is same.

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