OPTIMAL SOLUTION OF NORTH WEST CORNER AND LEAST COST METHOD FUZZY TRANSPORTATION PROBLEM BY USING DECAGON FUZZY NUMBERS

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***Abstract*: In this paper, we take decagon numbers and convert to the fuzzy values by using robust ranking method and the Fuzzy Transportation problem has been taken to known that the values are Fuzzy i.e. Supply, demand and so on. Decagon Fuzzy Numbers are used and showed membership function. By using least cost method and North West corner method, we have solved numerical examples with the help of such method for optimal solutions and finding the minimum solution by using VAM.**

***Keywords*: Robust ranking method, Fuzzy transportation problem, Decagon fuzzy number, least cost method, North West corner method, VAM**

1. Introduction:

Many methods are available to solve the mathematical problems in operation Research, so these methods are useful to clear the complexity. Linear programming problem is the most prominent technique in operation research. Taha introduced transportation model and different methods to understand transport route. The transportation model is one of the techniques of linear programs that deal with shipping schedule which can satisfy supply and demand of goods. Transportation problem is more convenient in supply chain management to reduce time and better effect. Klir constructed fuzzy models to clear the complexity, credibility and uncertainty. Fuzzy transportation problem of transportation problem is more accurate to solve such problems which can't come by the used methods. It means that FTP is leading method in transportation problem. It gives ranking techniques for numbers. Dhanalakshmi and feblin are used ranking method with fuzzy numbers. Fuzzy transportation problem is a transportation problem that all parameters must be fuzzy numbers i.e. supply and demand quantities are fuzzy quantities. Fegade and Jaddhav used zero suffix method to find FTP with triangular fuzzy numbers. Annie and Malini proposed centroid ranking method to solve FTP by using BCM method. They used hexagonal fuzzy numbers. Mohideen and Devi deal with alpha cut and fuzzy octagonal numbers with the help of ranking method. There are many methods to calculate the fuzzy transportation problem. Pathinathan and ponnivalam used pentagonal fuzzy numbers. Also Anandhi and Ramesh solved pentagonal transportation problem using fuzzy numbers and gave optimum solution. Thamarasailvi and Santhi used fuzzy numbers and calculate the fuzzy transportation problem.Solving transportation problem supply and demand must be balanced but some time problem occurring with unbalanced numbers. Finally, with the help of dummy variables we solved fuzzy transportation problem. Ghadle and Pathade compare balanced and unbalanced fuzzy transportation problem by using hexagonal fuzzy numbers and robust ranking technique. Cheng used a fuzzy approach to solve fuzzy transportation problem. Rajarajeshwari and Sangeeta used hexagonal fuzzy transportation problem. For nearest optimal solution BCM is best option. Ahmed and Ahmed and Mohammad solved FTP by using Best Candidate method.[2]

2. Preliminary

In this section, we collect some basic definitions that will be important to us in the sequel.

Definition 2.1.

A fuzzy set is characterized by a membership function mapping element of a domain, space, or the universe of discourse X to the unit interval [0,1] i.e A = {(µA(x);x ∈ X)}. Here µA(x) : X −→ [0,1] is a mapping called the degree of membership value of x inX in the fuzzy set A.[2]

Definition 2.2.

For any fuzzy set A=(U,M) and $\alpha \in [0,1]$ the following crisp sets are defined

- $A^{\geq\alpha} = A_\alpha = \{x \in \mathrm{U} | (\mathrm{m(x)} \geq \alpha)\}$ is called its α − cut.
- $A^{>\alpha} = A'_\alpha = \{x \in \mathrm{U} | (\mathrm{m(x)} > \alpha)\}$ is called its strong α − cut.[2]

Definition 2.3.

The support of a fuzzy set $\tilde{A}$ is the set of all points x in X such that $\mu_{\tilde{A}}(x)$> 0. That is support ($\tilde{A}$)={x/$\mu_{\tilde{A}}(x) > 0$}[2]

Definition 2.4

A fuzzy set $\tilde{A}$ is convex if, $\mu_{\tilde{A}}(\lambda/x_1 + (1-\lambda x_2) \geq \min\left(\mu_{\tilde{A}}(x_1), \mu_{\tilde{A}}(x_2)\right)$, $x_1 x_2 \in$ X and $\lambda \in [0,1]$. Alternatively, a fuzzy set is convex, if all α −level sets are convex.[2]

Definition 2.5

The Least Cost Method is another method used to obtain the initial feasible solution for the transportation problem. Here, the allocation begins with the cell which has the minimum cost. The lower cost cells are chosen over the higher-cost cell with the objective to have the least cost of transportation.

Definition 2.6.

The North-West Corner Rule is a method adopted to compute the initial feasible solution of the transportation problem. The name North-west corner is given to this method because the basic variables are selected from the extreme left corner.

Definition 2.7.

The Vogel's Approximation Method or VAM is an iterative procedure calculated to find out the initial feasible solution of the transportation problem. Like Least cost Method, here also the shipping cost is taken into consideration, but in a relative sense.

Definition 2.8.

North-West Corner Method (NWCM) Steps (Rule)[3][4]

Step:1 Select the upper left corner cell of the transportation matrix and allocate min(s_i,d_j).

Step:2 a. Subtract this value from supply and demand of respective row and column.

b. If the supply is 0, then cross (strike) that row and move down to the next cell.

c. If the demand is 0, then cross (strike) that column and move right to the next cell.

d. If supply and demand both are 0, then cross (strike) both row & column and move diagonally to the next cell

Step:3 Repeat this steps until all supply and demand values are 0.[3][4]

Least Cost Method (LCM) and (Rule)

step:1 Select the cell having minimum unit cost c_{ij} and allocate as much as possible, i.e. min(s_i, d_j).

Step:2 a.Subtract this min value from supply s_i and demand d_j.

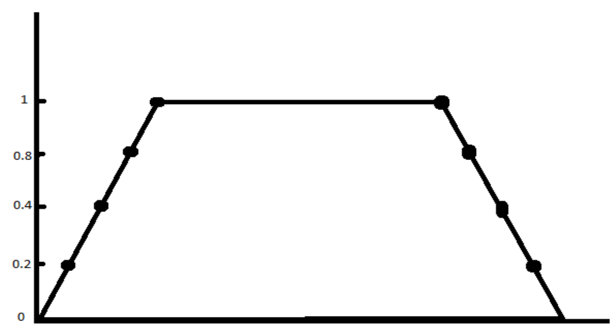
b. If the supply s_i is 0, then cross (strike) that row and If the demand d_j is 0 then cross (strike) that column.

c. If min unit cost cell is not unique, then select the cell where maximum allocation can be possible

Step:3 Repeat this steps for all uncrossed (unstriped) rows and columns until all supply and demand values are 0.

Definition 2.6

A Decagon fuzzy number $\widetilde{D}$ can be defined as $(a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8, a_9, a_{10})$, and the membership function is defined as



Membership function for decagon

$$\begin{cases} \frac{1}{4}\frac{(x-a_1)}{(a_2-a_1)}, & a_1 \le x \le a_2 \\ \frac{1}{4}+\frac{1}{4}\frac{(x-a_2)}{(a_3-a_2)}, & a_2 \le x \le a_3 \\ \frac{1}{2}+\frac{1}{4}\frac{(x-a_3)}{(a_4-a_3)}, & a_3 \le x \le a_4 \\ \frac{3}{4}+\frac{1}{4}\frac{(x-a_4)}{(a_5-a_4)}, & a_4 \le x \le a_5 \\ 1, & a_5 \le x \le a_6 \\ 1-\frac{1}{4}\frac{(x-a_6)}{(a_7-a_6)}, & a_6 \le x \le a_7 \\ \frac{3}{4}-\frac{1}{4}\frac{(x-a_7)}{(a_8-a_7)}, & a_7 \le x \le a_8 \\ \frac{1}{2}-\frac{1}{4}\frac{(x-a_8)}{(a_9-a_8)}, & a_8 \le x \le a_9 \\ \frac{1}{4}\frac{(a_{10}-x)}{(a_{10}-a_9)}, & a_9 \le x \le a_{10} \\ 0, & otherwise \end{cases}$$

3. Algorithm

Step:1 solve the decagon number by using the robust ranking formula.

Step:2 find the north west corner or lest cost method.

Step:3 find the VAM value for both the method.

Example:

Table: 1

	d_1	d_2	d_3	**Supply**
s_1	1,2,3,4,5,6,7,8,9,10	5,6,7,8,9,10,11,12,13,14	8,9,10,11,12,13,14,15,16,17,	30
s_2	9,10,11,12,13,14,15,16,17,18	7,8,9,10,11,12,13,14,15,16	4,5,6,7,8,9,10,11,12,13	40
s_3	2,3,4,5,6,7,8,9,10,11	3,4,5,6,7,8,9,10,11,12	6,7,8,9,10,11,12,13,14,15	20
Demand	60	10	20	

Robust ranking method

R(Ã)=$\int_0^1 (0.5)\,(\alpha_\alpha^L, \alpha_\alpha^U)$

a_{11}=$\int_0^1 (0.5)\,\{(2-1)\alpha+1,(4-3)\alpha+4\}+\{(4-3)\alpha+3,(6-5)\alpha+6\}+\{(6-5)\alpha+5,(8-7)\alpha+8\}+\{(8-7)\alpha+7,(10-9)\alpha+10\}$

=22

Similarly

$a_{12}=38, a_{13}=50, a_{21}=54, a_{22}=46, a_{23}=34, a_{31}=26, a_{32}=30, a_{33}=41$

Example:

Table-2 Least cost method

	d_1	d_2	d_3	Supply
s_1	22_{30}	38	50	30
s_2	54_{10}	46_{10}	34_{20}	40
s_3	26_{20}	30	41	20
demand	60	10	20	

The result is as per using **VAM**

=22(30)+54(10)+46(10)+34(20)+26(20)

=2860

Example:

Table-3 North West corner method

	d_1	d_2	d_3	Supply
s_1	22_{30}	38	50	30
s_2	54_{30}	46_{10}	34	40
s_3	26	30	41_{20}	20
Demand	60	10	20	

The result is as per using **VAM**

=22(30)+54(30)+46(10)+41(20)

=3560

Conclusion:

The Least Cost Method is considered to produce more optimal results than the North-west Corner because it considers the cost while making the allocation, whereas The Least Cost Method is another method used to obtain the initial feasible solution for the transportation problem. Here, the allocation begins with the cell which has the minimum cost. The lower cost cells are chosen over the higher-cost cell with the objective to have the least cost of transportation.

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