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Comparative Study of LINGO based Fuzzy Hungarian Approach for Set-Based Transportation Model

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ABSTRACT

The research paper define transportation problem on Wireless gadget model was solve by a mathematical software LINGO and it had to discover the fuzzy optimum solution of fuzzy transportation model represented by totally factors as trapezoidal fuzzy numbers. The proposed method of fuzzy transportation problem solved by using the Hungarian method and find the result. Comparative study is also done and the result obtained by proposed method is very close to previous one. The process is very easy, and nearby put arranged for definition in actual lifecycle situations the fuzzy best result of fuzzy transportation. But in the other side, if the problem is very large, which form big network, the LINGO model will help to evaluate the approximate result. Both the methods for finding out the optimal solution for minimizing the sum of transportation cost have their own limitation depending upon the problem size.

Keywords : *Hungarian method; Fuzzy transportation; fuzzy numbers; optimal solution, Lingo Model*

I. INTRODUCTION

In Operations Research, the most important part of integer programming problems in network in the transportation problem. which covenants through allotting several product since any collection of 'sources' to any collection of term in uses or 'sinks' the maximum price in effect mode by assumed 'supply' and 'demand' limits. Proceeding the source of nature of the price function, we can consider the transportation problem with linear and nonlinear transportation problem. Conveyance problem is a part of linear LPP stanched since a network construction involving of no. of vertices is finite and the arcs is complicated . In general, manufacture is near by conveyed from m bases to n terminuses besides capabilities are p_1, p_2,...p_m and r_1 ,r_2 ...r_n, respectively. The cost of price C_{ij} & Variable X_{ij} related with conveying unit of manufacture & new expanse near by transported from source i to terminus j. For example, the element transport price may differ in a period structure. The materials and demands could be undefined owed near several strong part. Bellman et.al.[1] studied the conception of resolution making in fuzzy situation. S.Chanas [3] studied the method created proceeding break and detail of fuzzy elements is must. In the present research work, we have compared the solutions obtained by fuzzy transportation problems and used the trapezoidal fuzzy integer and LINGO based software model. In 1979, Isermann also developed new process for solved by problematic it was provide actual solutions. Lai Hwang[8] measured the condition where all parameters are fuzzy. This is iterative processes for solved by linear, multi criteria and conveyance. We consider in the paper the fuzzy transportation problem of fuzzy by debated with limitations in this paper we consider the greatest conciliation description between the usual of practicable solutions for Fuzzy transportation problem and the solution by LINGO Model. Finally, we have concluded that, the LINGO model based result is more optimal.

Problem formulation of fuzzy transportation model

A Firm has 3 stores supplying 3 retailers for the gadgets. The supply of gadgets of each stores that cannot be increased, and every retailer has a demand for gadgets that must be satisfied. The firms want to define in what way the gadgets to transport from every storeroom to every retailer then we have to reduce the total distribution cost. Optimization problem combined is important near by the transportation problem. Then every storeroom can transport to every retailer, the total no. of possible ship path or arcs is 9. We compulsory a variable for any arc to denote the cost of transported arranged the arc. This work exertions on developed by the method of FLP for optimizing and the fuzzy environment have transport plan .

Sets:

I= Source Index, where i=1to m
J=destination, where $j = 1$ *to n*
G= objective index , where g=1,2…….m
T_{ij} =elements conveyed Objective functions
Z_1 transportation costs (Rs.)
Parameters
k_{ij} : transportation cost
S_i : total supply
D_j : total demand
Objective functions:
cost price of total minimize transportation

$$Min\ Z_1 = \sum_{i=1}^{m}\sum_{j=1}^{n} C_{ij} Q_{ij}$$

the sum of supply of every foundation I on constraints

$$\sum_{j=1}^{n} T_{ij} \sum S_i$$

the sum of every demand for every destination j

$$\sum_{j=1}^{n} T_{ij} \sum D_j$$

the fuzzy parameters are T*ij*, S*i*, or D*j* , the sum of the transportation cost Z is developed by fuzzy as well. The well defined problem with conformist conveyance then tries into the fuzzy transportation problem.

General Fuzzy Transportation Model:

The Transportation problem having m rows and n columns of fuzzy matrix. Suppose that $k_{ij} = k_{ij}^{1)}, k_{ij}^{(2)}, k_{ij}^{(3)}, k_{ij}^{(4)}]$ and the cost of transporation is the part of the produce from i^th rows to j^th column for fuzzy matrix. $t_i = [t_i^{(1)}, t_i^{(2)}, t_i^{(3)}, t_i^{(4)}]$ is the total no.of commodity at fuzzy column *i* , $D_j = [d_j^{(1)}, d_j^{(2)}, d_j^{(3)}, d_j^{(4)}]$ we needed the quantity ofof the no. commodity at fuzzy destination *j*. $Y_{ij} = [y_{ij}^{(1)}, y_{ij}^{(2)}, y_{ij}^{(3)}, y_{ij}^{(4)}]$ be the transportation quantity from i^th rows to j^th column of fuzzy matrix.
tabular form.

Table 1.

i or j	*1*	*2…….*	*N*	*Fuzzy Supply*
1	k_{11} X_{11}	k_{12} X_{12}	k_{1n} X_{1n}	S_1
2 . .	k_{21} . . Y_{21}	k_{22} . . Y_{22}	k_{2n} . . Y_{2n}	S_2 . .
M	k_{m1} Y_{m1}	k_{m2} Y_{m2}	k_{mn} Y_{mn}	S_m
Fuzzy Dem.	d_1	d_2……	d_n	$\sum_{j=1}^{n} d_j \sum_{i=1}^{m} Si$

Where: $k_{ij} = [k_{ij}^{(1)}, k_{ij}^{(2)}, k_{ij}^{(3)}, k_{ij}^{(4)}]$,

$Y_{ij} = [y_{ij}^{(1)}, y_{ij}^{(2)}, y_{ij}^{(3)}, y_{ij}^{(4)}]$

$r_i = [r_i^{(1)}, r_i^{(2)}, r_i^{(3)}, r_i^{(4)}]$,

$p_j = [p_j^{(1)}, p_j^{(2)}, p_j^{(3)}, p_j^{(4)}]$

1.3 Methodology:

The method used to solve the fuzzy transportation problem has following steps

i. Find the lowermost price in each column and row of the shipping matrix and subtract the lowest cost well-known for each row or column from the respective row and column.

ii. Check in each column, the demand is a smaller amount the total supply and concentrated price in that column are fuzzy zero. if every row supply is fewer to total no. of the column demands and the costs is reduced in that row are fuzzy zero. go to step 4 of go to step 3.

iii. To cover all fuzzy zeros we draw the minimum number of horizontal & vertical lines and determine the minimum fuzzy cost which is not covered by any line & subtract it from all uncovered fuzzy costs and adding the similar to all fuzzy costs two-faced at the connection of any two lines. Apply this step till fuzzy supply fulfills fuzzy demand for all rows & columns.

iv. Allocate the maximum quantity to be transported where the costs have been zero depending on the fuzzy demand and fuzzy supply.

v. Repeat the process till all supply and demand quantities are exhausted.

vi. Use the MODI method for optimal solution.

Solution based on Fuzzy Hungarian Approach:

Wireless_gadgets Firm has 3 stores supplying 3 retailers with their gadgets. The supply of gadgets of each stores that could not be increased, and every retailer has a requirement for gadgets that surely satisfied. The firms wants to define in what way the gadgets to transport from every storeroom to every retailer then the total transport cost have minimized. This kind of optimization problem is combined is important near by the transportation problem. Then every storeroom can transport to every retailer, the total no. of possible ship path or arcs is 9. We compulsory a variable for any arc to denote the cost of transported arranged the arc. This work exertions on developed by the method of FLP optimizing and the fuzzy environment have transport plan

In this problem the following data is available.

Firm	Gadgets on Hand
1	[12 14 14]
2	[15 16 17]
3	[9 10 12]

Gadget Capacity Data

Retailer	Gadget Demand
1	[9 10 11]
2	[13 14 15]
3	[14 16 17]

Retail	Gadget		Demand
	r_1	r_2	r_3
AB1	[6 8 9]	[9 10 14]	[11 12 1
AB2	[14 16 17]	[8 10 11]	[10 14 15]
AB3	[8 9 10]	[16 17 20]	[4 6 7]

Shipping Cost

We can obtain the initial basic solution the Hungarian method is applied to the resulting fuzzy transportation problem.

This is balanced fuzzy transportation problem.

Table 2

	D1	D2	D3	Supply
S1	[6 8 9]	[9 10 14]	[11 12 13]	[12 14 14]
S2	[14 16 17]	[8 10 11]	[10 14 15]	[15 16 17]
S3	[8 9 10]	[16 17 20]	[4 6 7]	[9 10 12]
Demand	[9 10 11]	[13 14 15]	[14 16 17]	[36 40 43]

Table 3

Total fuzzy transportation cost

	D1	D2	D3	Uj
S1	[6 8 9] **[9 10 11]**	[9 10 14]	[11 12 13] **[3 4 3]**	**[12 14 14]**
S2	[14 16 17]	[8 10 11] **[13 14 15]**	[10 14 15] **[2 2 2]**	**[15 16 17]**
S3	[8 9 10]	[16 17 20]	[4 6 7] **[9 10 12]**	**[9 10 12]**
Vj	**[9 10 11]**	**[1314 15]**	**[1416 17]**	**[3640 43]**

[9 (6+8+9) 10 (6+8+9) 11(6+8+9)] +[13 (8+10+11) 14(8+10+11) 15(8+10+11)] + [3(11+12+13) 4(11+12+13) 3(11+12+13)] + [2(10+14+15) 2(10+14+15) 2(10+14+15)] + [9(4+6+7) 10(4+6+7) 12(4+6+7)] = [207 230 253] + [377 406 435] + [108 120 130] + [60 84 90] + [153 170 204] = **336.33**

LINGO based Set-based Transportation Problem

A Firm where 3 stores supplying 3 retailers with their Gadgets. The supply of gadgets of each stores that cannot be increased and each retailer has a demand for Gadgets that must be satisfied. The following data is available for classical shipping problem and solved by LINGO software as Set-Based Transportation model.

Firm	Gadgets on Hand
1	13.33
2	16
3	10.33

Retailer	Gadget Demand
1	10

Gadget	Capability Data
2	14
3	15.67

Retailer Gadget Demand

	r_1	r_2	r_3
AB_1	7.67	11	12
AB_2	15.67	9.66	13
AB_3	9	17.67	5.67

Shipping Cost

LINGO Programme

```
MODEL:
! A 3 stores 3 Retailer Transportation Problem;
SETS:
STORES: CAPABILITY;
RETAILER: DEMAND;
LINKS( STORES, RETAILERS): COST, VOLUME;
FINISHSETS
! data sets are as;
DATA:
! members belongs to set;
STOREROOMS = AB1 AB2 AB3;
RETAILERS = a1 a2 a3;
!values of given attribute;
CAPACITY = 13 16 10;
DEMAND = 10 14 15;
COST = 7 11 12
15 9 13
9 17 5;
 END_DATA
```

```
! Program objective;
MIN = @SUM( LINKS( I', J'):
COST( I', J') * VOLUME( I', J'));
! The requirement constraints;
@FOR( RETAILER(J'):
@TOTALS( STORESS( I): VOLUME( I', J')) =
DEMAND(J'));
! The availability constraints;
@FOR(STORES(I'):
@SUM(RETAILERS(J'): VOLUME( I', J')) <=
CAPACITY( I'));
END
```

LINGO Result

Global optimum details found.	
Impartial value:	308.0000
Value of Illogicality:	0.000000
Total number of iterations:	5
Model Class form:	LP
Total variables:	9
Nonlinear variables:	0
Integer variables:	0
Sum of restraint:	7
No. of Nonlinear restraints:	0
Sum of non-zeros:	27
No. of Nonlinear non-zeros:	0

CAPACITY(AB1)	13.00000	0.000000
CAPACITY(AB2)	16.00000	0.000000
CAPACITY(AB3)	10.00000	0.000000
DEMAND(a1)	10.00000	0.000000
DEMAND(a2)	14.00000	0.000000
DEMAND(a3)	15.00000	0.000000
COST(AB1, a1)	7.000000	0.000000
COST(AB1, a2)	11.00000	0.000000
COST(AB1, a3)	12.00000	0.000000
COST(AB2, a1)	15.00000	0.000000
COST(AB2, a2)	9.000000	0.000000
COST(AB2, a3)	13.00000	0.000000
COST(AB3, a1)	9.000000	0.000000
COST(AB3, a2)	17.00000	0.000000
COST(AB3, a3)	5.000000	0.000000
VOLUME(AB1, a1)	10.00000	0.000000
VOLUME(AB1, a2)	0.000000	3.000000
VOLUME(AB1, a3)	3.000000	0.000000
VOLUME(AB2, a1)	0.000000	7.000000
VOLUME(AB2, a2)	14.00000	0.000000
VOLUME(AB2, a3)	2.000000	0.000000
VOLUME(AB3, a1)	0.000000	9.000000
VOLUME(AB3, a2)	0.000000	16.00000
VOLUME(AB3, a3)	10.00000	0.000000

Row	Slack or Surplus	Dual Price
1	308.0000	-1.000000
2	0.000000	-8.000000
3	0.000000	-9.000000
4	0.000000	-13.00000
5	0.000000	1.000000
6	0.000000	0.000000
7	0.000000	8.000000

II. CONCLUSION

By using Fuzzy Hungarian approach, the total optimal fuzzy transportation cost is Rs. 336.33 while using linear model in LINGO software, the value of objective function is Rs. 308 which less than the previous value. Therefore, Set based Lingo model of transportation problem is efficient as compare to Fuzzy Hungarian approach. The problem can further be extend to higher order of nodes and arcs.

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