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AN INNOVATIVE METHOD TO SOLVE TRANSPORTATION PROBLEM BASED ON A STATISTICAL TOOL

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ABSTRACT. Transportation Problem is one of the models in the linear programming problems. In this paper, we have developed a new method for finding of the initial basic feasible solution of the transportation problem. The objective of this paper is to find how to transport the product from the origin to the destination such that the transportation cost will be minimized. To achieve this new approach, the transportation problem under uncertainty, is considered by using of the arithmetic mean.

1. INTRODUCTION

In the linear programming problems, Transportation Problem (TP) plays an important role. Nowadays, the business environment competition is raising a day by day and it is most important for every goods to deliver products to customers in the cost effective way by satisfying their demandsfor dealing with human uncertainty, [3]. Uncertainty theory was founded by Liu (2007) and refined by Liu (2010) based on normality, duality, sub additivity and product axioms. TP was developed by Hitchcock, [4] concerning its special structure for finding initial basic feasible solution such as, North west corner method (NWCM), Least cost method, vogel's approximation method given by Reinfeld et al. in [9]. There are two types of TPs, first type is balanced TP and the second

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type is unbalanced TP. In the first type, the number of supply is equal to the number of demand, and if it is not equal means unbalanced. To find optimal solutions to TP different methods are discussed in many papers [2, 10] and so far. Abdul Kalam Azadet et al. in [1] gave an algorithmic approach to solve TP with the average total opportunity cost method. Joshua et al. in [6] developed a NWCM to give an initial basic feasible solution for TP. Juman and Nowarathne in [5] give an efficient alternative approach to solve a TP. Palanivel and Suganya in [7] developed a new method to solve transportation problem for harmonic mean approach and Patal et al. in [8] to find a optimal solution of TP.

In this paper we discuss about to study a transportation model with uncertain values (unit cost, demand and supplies). Then, it will be converted into single values and solved it.

2. Uncertain Transportation Model

Assume that there are m sources and n destinations in the transportation problem. Let C_{ij} denote the cost of transporting a unit from source i to destination j, and x_{ij} denote the amount transported from source i to destination j, $i = 1, 2, ..., n$. Then the total cost as well as the objective function is

$$\sum_{i=1}^{m}\sum_{j=1}^{n} C_{ij}x_{ij}.$$

Subject to

$$\begin{aligned} \sum_{j=1}^{n} x_{ij} &= a_i, \quad i = 1, 2, ..., m \\ \sum_{i=1}^{m} x_{ij} &= b_j, \quad j = 1, 2, ..., n. \end{aligned}$$

Let a_i denote the availability of source i, and b_j denote the requirement of destination j. Then the amount x_{ij} should satisfy the following constraints,

$$\begin{aligned} \sum_{j=1}^{n} x_{ij} &\leq a_i, \quad i = 1, 2, ..., m \\ \sum_{i=1}^{m} x_{ij} &\geq b_j, \quad j = 1, 2, ..., n. \end{aligned}$$

Thus the charge transportation problem is formulated as follows,

$$\min \quad \sum_{i=1}^{m}\sum_{j=1}^{n} C_{ij}x_{ij}.$$

Subject to

$$\sum_{j=1}^{n} x_{ij} \;\leq\; a_i, \quad i = 1, 2, ..., m$$
$$\sum_{i=1}^{m} x_{ij} \;\geq\; b_j, \quad j = 1, 2, ..., n.$$

$x_{ij} \geq 0,\ i = 1, 2, ...m,\ j = 1, 2, ..., n.$

In the above model, the quantities cij, ai, bj are all assumed to be crisp values.

Transportation Problem:

Origin (i)	Destinations(j)				Supply(a_i)
	1	2	$\cdots$	n	
1	X_{11} C_{11}	X_{12} C_{12}	$\cdots$	X_{1n} C_{1n}	a_1
2	X_{21} C_{21}	X_{22} C_{22}	$\cdots$	X_{2n} C_{2n}	a_2
3	X_{31} C_{31}	X_{32} C_{32}	$\cdots$	X_{3n} C_{3n}	a_3
$\cdots$	$\cdots$	$\cdots$	$\cdots$	$\cdots$	$\cdots$
m	X_{m1} C_{m1}	X_{m2} C_{m2}	$\cdots$	X_{mn} C_{mn}	a_m
Demand (b_j)	b_1	b_2	$\cdots$	b_n	$\sum a_i = \sum b_j$

3. Algorithm

Step:1 Uncertainty values it converted into single values by using arithmetic mean.

Step:2 Check whether the TP is balanced or not. If it is unbalanced, then add dummy demand or dummy supply to make the problem is balanced and then go to the next step. Find initial basic feasible solution by using arithmetic mean approach.

Step:3 Find the arithmetic mean for each row and each column. Then find the maximum value among the demand or supply value.

Step:4 At first, Start the allocation from minimum supply or demand. Allocate this minimum value of supply or demand in the place of related row or column.

Step:5 Repeat step 3 and 4 until the demand and supply are exhausted.

Step:6 Finally calculate the total transportation cost of the transportation table. This calculation is the sum of the product of cost and corresponding allocated value of the transportation table.

(ie) Total minimum cost=Sum of the product of the cost and its corresponding allocated values of supply or demand.

4. Numerical illustration

In this section, we use the uncertain transportation model to transportation problems and produce an feasible solution. According to the statistical data (uncertain values) gathered, we consider the supply capacities a_i from source i, where $i = 1, 2, 3, 4$ as random variables and the demanding capacities $b_j,\ j = 1, 2, 3$, the unit cost c_{ij} of transportation from source i to destination j.

We have constructed the following table, by using the arithmetic mean for finding crispy transportation values.

The transportation problem is

	D_1	D_2	D_3	D_4	Supply
S_1	21	25	38	49	12
S_2	50	51	49	45	25
S_3	39	49	46	50	55
Demand	16	9	47	20	92

Next Applying the Arithmetic Mean Method, for initial basic feasible solution, the allocations are as follows

	D_1	D_2	D_3	D_4	Supply
S_1	21	9 25	3 38	49	12
S_2	50	51	5 49	20 45	25
S_3	16 39	49	39 46	50	55
Demand	16	9	47	20	92

The minimum cost using Arithmetic Mean Method is obtained as follows:
Total minimum cost=(25*9)+(38*3)+(49*5)+(45*20)+(39*16)+(46*39)=
=3902.

Next Applying the Least Cost Method, for initial basic feasible solution, the allocations are as follows

	D_1	D_2	D_3	D_4	Supply
S_1	12 21	25	38	49	12
S_2	50	5 51	49	20 45	25
S_3	4 39	4 49	47 46	50	55
Demand	16	9	47	20	92

The minimum cost using Least Cost Method is obtained as follows:

Total minimum cost=(21*12)+(51*5)+(45*20)+(39*4)+(49*4)+(46*47)= =3921.

Next Applying the North West Corner Method, for initial basic feasible solution, the allocations are as follows

	D_1	D_2	D_3	D_4	Supply
S_1	21 [12]	25	38	49	12
S_2	50 [4]	51 [9]	49 [12]	45	25
S_3	39	49	46 [35]	50 [20]	55
Demand	16	9	47	20	92

The minimum cost using North West Corner Method is obtained as follows,

Total minimum cost=(21*12)+(50*4)+(51*9)+(49*12)+(46*35)+(50*20) =4109.

5. Conclusion

This paper is focused on finding the minimum cost with uncertain unit cost, demand and supplies. We conclude that the minimum cost is obtained by the new method is less than the minimum cost calculated with the other methods. The new method is very easy for finding of the solution for minimum cost, because there are less computations. So we can conclude that with arithmetic mean approach we can solve transportation problem.

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