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Solving Multi-Objective Transportation Problem to reduce Transportation Cost and Time

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ABSTRACT

In this paper we study the multi-objective transportation problem for Procter & Gamble to reduce transportation cost and time of goods which is supply from one source to another source. To solve this problem we are using a new proposed algorithm which is different form to another existing method. This proposed method providing the support to decision makers for handling time oriented problems.

Keywords

Multi-objective Transportation problem; Transportation cost; Transportation Time; Optimum Solution.

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INTRODUCTION

Transportation problem is special type of subset of Linear programming problem that involve moving goods from one location to another location is called the transportation problem. In other words "Distribution of Product from depot to customer while satisfying both the supply capacity and the demand requirement is called the transportation problem. Transportation problem firstly introduced by F L Hitchcock [6] in 1941 in his historic study "The distribution of a product from several source to numerous localities" This is first important contribution for solution of transportation problem. In 1947 T C Koopmans [9] also presented another important study, "Optimum utilization of the transportation problem study".

After above contribution many authors working in this field like Haly [3] in 1962 introduced the solid transportation problem which also knows as multi commodity transportation problem; Hammer [4,5] in 1969, 1971 introduced the time transportation problem for reduced time of distribution of goods from one source to another source; Kaufmann & Gupta [8] in 1991 put forward first the fuzzy transportation problem with fuzzy coefficients; Speranza and Ukovich [13] in 1994 focuses on a multiproduct production system on a single link to reduce transportation cost ; Srdjevic & Tihomir [14] in 1997 introduced the standard and network linear programming method for transportation problem; Sharma and swarup [12] in 1997 is also present the research paper on transportation problem; Ammar & Youness [1] in 2005 studied the multi-objective transportation problem, in which the cost factors, the sizes of supply and demand are all fuzzy numbers; chakrobarty & chakrobarty [2] in 2010 presenting method for minimizing the cost and time for transportation problem for this they using linear membership function; Mahapatra and et al [10] in 2010 presented multi-objective stochastic unbalanced transportation problem, they used fuzzy programming technique and stochastic method for randomness of sources and destination parameters in inequality type constraints; Huseen and et al [7] in 2011 introduced the possibilistic multi-objective transportation problem is considered possibilitic parameters with know distribution into multi-objective programming frame work; Venkatasubbaiah and et al [15] in 2011 they introduced multi-objective transportation problem as a special class of vector minimum linear programming problem, in which constraints are of inequality type and all the objective are non-commensurable and conflict with each other; Pandian and Natrajan [11] in 2011 introduced new method namely blocking method and blocking zero point method to solve bottleneck cost transportation problem.

In this we are study P&G in Madhya Pradesh, Procter & Gamble is marketing company, its working with many companies which is made many useful products in daily life. It is stored the in warehouse and distribute in whole over distribution centers. In Madhya Pradesh Company distributed goods in whole over state with three ware houses, which is placed in Mandideep, Indore and Gwalior.

1. MULTI-OBJECTIVE TRANSPORATION PROBLE

In real life situations, all the transportation problems are not single objective. The transportation problems which are characterized by multiple objective functions are considered here. A special type of linear programming problem in which constraints are in equality types and the entire objective are conflicting with each other, are called MOTP. Similar to a typical transportation problem, in a MOTP problem a product is to be transported from m sources to n destinations and their capacities are a_1 $a_2,\ldots\ldots,a_m$ and b_1, $b_2,\ldots.,b_n$ respectively. In addition, there is a penalty c_{ij} associated with transporting cost a unit of product from i^{th} and j^{th} destination and t_{ij} associated with transporting time a unit of product from i^{th} and j^{th} destination. This penalty may be cost or delivery time or safety of delivery or etc. A variable x_{ij} represents the unknown quantity to be shipped from i^{th} source to j^{th} destination. A mathematical model of MOTP with r objectives, *m* sources and *n* destinations can be written as: Mathematically, the problem can be stated as

Minimize $Z_1 = \sum_{i=1}^{m}\sum_{j=1}^{n} c_{ij}.x_{ij}$

$$Z_2 = \sum_{i=1}^{m}\sum_{j=1}^{n} t_{ij}.x_{ij}$$

Subject to $\sum_{j=1}^{n} x_{ij} = a_i, \quad i = 1, 2, \ldots., m$

$$\sum_{i=1}^{m} x_{ij} = b_j, \quad j = 1, 2, \ldots., n$$

$$x_{ij} \geq 0 \quad \forall\, i, j$$

A transportation problem is said to be balanced if total supply from all sources equals to the total demand in all destinations $\sum_{i=1}^{m} a_i = \sum_{j=1}^{n} b_j$. Otherwise it is called unbalanced.

2.1 Level of satisfaction: To find satisfaction level for Time M, we are using following formula [11]

$$\alpha = \frac{T_m - M}{T_m - T_c}$$

2.2 Idle condition: when number of assignment is equal to number of row and number of column this called idle condition for allocation.

2. NEW PROPOSED ALGORITHM

Step1: Check the given problem is balanced.

Step 2: We check the number of rows and columns are equal or not.

If number of rows are not equal to number of columns and vice versa. The dummy row or dummy column must be added with zero cost/time elements with zero demand/supply, so our matrix becomes a square matrix.

Step3: Find the smallest element of each row of the given matrix and subtract this smallest element from all element of that row. Therefore, there will be at least one zero in each row of this new matrix. In this new matrix Find the smallest element of each column of the given matrix and subtract this smallest element from all element of that column.

Thus each row and column have at least one zero in new reduced matrix.

Step4: In reduced matrix, find a row with exactly single zero. Make assignment to this single zero by square box and mark cross overall other zeros in the corresponding column, proceed in this way until all the row have been examined. Same process we have to use for column.

Step 5: If the number of assignment is equal to number of column or row, the our problem in idle condition.

If the number of assignment is not equal to number of column or row, the solution is not in idle condition, and then we go to next step

Step 6: We draw the minimum number of horizontal and vertical line crossing the all zeros.

Step7: Develop the new revised cost/time matrix as follows:

(i) Find the smallest element of reduced matrix not covered by the any minimum number of line.

(ii) Subtract this element from all uncovered elements and add this smallest element to all the elements lying at the intersection of horizontal and vertical lines.

Step 8: Go to step 5 and repeat the procedure until an idle condition is obtained.

Step 9: Firstly we have select those cell for allocation in row/column of idle transportation table which have only assignment, after that we have reaming cells for allocation in transportation table.

Step 10: Now we check the solution is optimal or not. If solution is not optimal then we are using stepping stone method to get optimal solution.

3. NUMERICAL EXAMPLE

Company ships truckloads of grain from three warehouses to four distributed centres. The supply (in Truckloads) and the demand (also in truckloads) together with the unit transportation costs is per Quintals per kilometre on the different routes and transportation time t_{ij} between source and destination are summarized in the transportation model in table.1.

Table - 1

		W_1	W_2	W_3	W_4	Availability
S_1	Time	6	8	7	3	23
	Cost	**188**	**340**	**272**	**76**	
S_2	Time	9	4	10	6	22
	Cost	**360**	**137**	**417**	**250**	
S_3	Time	7	13	11	8	25
	Cost	**318**	**581**	**577**	**394**	
Demand		19	16	17	18	

Now the time transportation problem is given below:

Table - 2

	D1	D2	D3	D4	Supply
S1	6	8	7	3	**23**
S2	9	4	10	6	**22**
S3	7	13	11	8	**25**
Demand	**19**	**16**	**17**	**18**	**70**

By using new proposed algorithm, we get the optimal solution of the time transportation problem is 10.

Now the cost transportation problem table given below:

Table - 3

	D1	D2	D3	D4	Supply
S1	188	340	272	76	**23**
S2	360	137	417	250	**22**
S3	318	581	577	394	**25**
Demand	**19**	**16**	**17**	**18**	**70**

By using new proposed algorithm, we get the optimal solution with allocations $x_{13} = 5$; $x_{14} = 18$; $x_{22} = 16$; $x_{23} = 6$; $x_{31} = 19$; and $x_{33} = 6$ and the minimum transportation cost is Rs 16926 and the minimum transportation time is 11.

Now, we have $T_0 = 10$; $T_m = 11$ and the time M = {10, 11}

Now the active cost transportation problem cost for M = 10 is given below:

Table - 4

	D1	D2	D3	D4	Supply
S1	6	8	7	3	**23**
S2	9	4	10	6	**22**
S3	7	-	-	8	**25**
Demand	**19**	**16**	**17**	**18**	**70**

Using new algorithm, the optimal solution with allocations $x_{13} = 11$; $x_{14} = 12$; $x_{22} = 16$; $x_{23} = 6$; $x_{31} = 19$ and $x_{34} = 6$ and total minimum transportation cost is Rs 17004

Now, the efficient solution of multi-objective transportation problem is given below in table 5:

Table - 5

S. No.	Efficient solution of multi-objective transportation problem	Objective value of MOTP	Satisfaction Level α
1	$x_{13} = 5$; $x_{14} = 18$; $x_{22} = 16$; $x_{23} = 6$; $x_{31} = 19$; and $x_{33} = 6$	(16926, 11)	0
2	$x_{13} = 11$; $x_{14} = 12$; $x_{22} = 16$; $x_{23} = 6$; $x_{31} = 19$ and $x_{34} = 6$	(17004, 10)	1

4. CONCLUSION

The new proposed algorithm is very simple from the computational point of view and also, simple to understand and apply. By proposed algorithm, we obtain a sequence of optimal solutions to a MOTP for a sequence of various time intervals. This method provides a set of transportation schedules to MOTP which helps the decision makers to select an appropriate transportation schedule, depending on his financial position and the decision maker to evaluate the economical activities and make the correct managerial decisions.

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