

A Study on Different Creative Methods to Solve Transportation Problems

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ABSTRACT

In 1781, the French mathematician Gaspard Monge formulated the optimal transportation problem that deals with the relocation of materials in the most economical way. The physical interpretation is to look for an optimal scheme of transporting a pile of soil or rubble to an excavation or fill, which requires the least work. Since then this optimization problem and its many applications have been extensively studied. In it, Tolstoi described a number of approaches to solve the transportation problem, illuminated by applications to the transportation of salt, cement, and other cargo between sources and destinations points along with the railway network of the soviet union. He seems to be the first to give a negative cycle criterion for optimality. Moreover, for that time a large-scale instance of the transportation problem was solved to optimality. First, Tolstoi considered the problem for the case where there are two sources. He observed that in that case, one can order the destination points by the difference between the distances to the two sources. In that case, one source can provide the destinations starting from the beginning of the list, until the supply of that source has been used up. The other sources supply the remaining demands. Next, Tolstoi studied the transportation problem for the case where all sources and destinations are along one circular railway line. In this case, considering the negative cycle criterion yields directly the optimum solution. He calls this phenomenon "Cycle Dependency". Finally, Tolstoi combined the two methods into a heuristic to solve a concrete transportation problem coming from cargo transportation along with soviet railway networks. The booklet and subsequently, L.V. Kantorovich singled out the transportation problem from other problems of linear programming. The Soviet mathematician and economist Leonid Kantorovich introduced a dual functional, by which the existence of optimal schemes can be established for a large class of cost functions. But for the original cost function proposed by Monge, the proof relies on a very different and more delicate analysis. In 1941, **F.L. Hitchcock** [1] presented a study entitled "**THE DISTRIBUTION OF PRODUCT FROM SEVERAL SOURCES TO NUMEROUS LOCALITIES**". These two contributions are the fundamentals for the progress of transportation problems. But the systematic procedure for finding solutions for transportation problems was developed by **Danzig** [2] in 1951. He developed a special form of the simplex method for the transportation problem which is widely used. The proposed method is based on a new combinatorial procedure recently developed by H. Kuhn for solving the optimal assignment problem. In this method, an essential feature of a proof given by Hungarian mathematician Eger vary for a theorem of Konig concerning linear graphs is combined with a very efficient algorithm for solving a specialized assignment problem. The transportation problem was further developed by **Charnes, Cooper, and Henderson**.

ALLOCATION TABLE METHOD**INTRODUCTION**

Finding an initial basic feasible is the prime requirement to obtain an optimal solution for transportation problems. In this chapter a new method called "ALLOCATION TABLE METHOD" (ATM) is introduced by Mollah Mesbahuddin Ahmed, Aminur Rahman Khan, Md.Sharif Uddin, Faruque Ahmed [1] in 2016. In this method an Allocation Table is formed to find the solution for the transportation problem.

ALGORITHM FOR "ALLOCATION TABLE METHOD" IS GIVEN BELOW

- **Step1:** Construct a Transportation Table (TT) from the specified transportation problem.
- **Step2:** Check whether the given transportation problem is balanced or not, if not make it balanced.
- **Step3:** Select Minimum Odd Cost (MOC) from the transportation table.
- If there is no odd cost in TT, keep on dividing all the cost cells by two till obtaining at least one odd value in the cost cells.
- **Step4:** Using step-3, form a new table which is called "ALLOCATION TABLE" (AT). Subtract selected minimum odd cost only from each of the odd cost values from the TT. Now all the cell values are called "ALLOCATION CELL VALUE" (ACV).
- **Step5:** Start the allocation from a minimum of supply/demand. Allocate this minimum of supply/demand in the place of minimum odd value in the Allocation Table formed in step-4. If demand is satisfied, delete the column. If it is supplied, delete the row.
- **Step 6:** Now identify the minimum ACV and allocate a minimum of supply/demand at the position of selected ACV in the AT. Again in case of same allocations in the ACVs, choose the minimum cost cell which is corresponding to the cost cells of TT formed in step-1. If the cost cells and the allocations are equal, in such cases choose the nearer cell to the minimum of supply/demand which is to be allocated. Now if demand is satisfied delete the column and if it is supplying delete the row.
- **Step7:** Repeat step-6 until the demand and supply are done in.
- **Step8:** Now transfer this allocation the original transportation table.
- **Step 9:** lastly calculate the total transportation cost of the TT. This calculation is the sum of the product of cost and corresponding allocated value of the transportation table.

APPLICATIONS of ATM:

1. A company manufactures motor cars and it has three factories F_1 , F_2 , F_3 whose weekly production capacities are 300, 400 and 500 pieces of cars respectively. The company supplies motor cars to its four showrooms located at D_1 , D_2 , D_3 , and D_4 whose weekly demands are 250, 350, 400 and 200 pieces of cars respectively. The transportation costs per piece of motor cars are specified in the transportation table. Find out the list of shifting of motor cars from factories to showrooms with minimum cost

Factories

Showrooms

Production capacity

	D ₁	D ₂	D ₃	D ₄	
F ₁	3	1	7	4	300
F ₂	2	6	5	9	400
F ₃	8	3	3	2	500
Demand	250	350	400	200	

TABLE NO 1

SOLUTION

The given transportation problem is balanced. Because of the sum of supplies = the sum of demands = 1200.

	D ₁	D ₂	D ₃	D ₄	
F ₁	3	1	7	4	300
F ₂	2	6	5	9	400
F ₃	8	3	3	2	500
	250	350	400	200	

TABLE NO 2

In the transportation table "1" is the minimum odd cost value placed in the cell (1,2).

Step 1: Subtract "1" from all other odd valued cost cells of the transportation table.

	D ₁	D ₂	D ₃	D ₄	
F ₁	2	1	6	4	300
F ₂	2	6	4	8	400
F ₃	8	2	2	2	500
	250	350	400	200	

TABLE NO 3

Step 2: "1" is the minimum odd cost value and from the corresponding supply/demand 300 is minimum. Hence allocate 300 to the cell (1,2).

	D ₁	D ₂	D ₃	D ₄	
F ₁	2	300 1	6	4	300
F ₂	2	6	4	8	400
F ₃	8	2	2	2	500
	250	350	400	200	

(50)

TABLE NO 4

Here the supply F₁ is satisfied; hence the row F₁ is to be exhausted.

Step 3: The next minimum cost is "2" which is placed in the cells (2, 1), (3, 2), (3,3) and (3,4). Among these corresponding supply/demand 50 is minimum, which is allocated to the cell (3, 2).

	D ₁	D ₂	D ₃	D ₄	
F ₂ F ₃	2	6	4	8	400
	8	50 2	2	2	500(450)
	250	50	400	200	

TABLE NO 5

Here the demand D₂ is satisfied, hence delete column D₂.

Step 4: Again "2" is the minimum cost placed in the cells (2,1), (3,3) and (3,4). Among these the corresponding supply/demand "200" is minimum and it is allocate to the cell (3,4).

	D ₁		D ₃	D ₄
	2	4	8	400
F ₂ F ₃	8	2	200 2	450 (250)
	250		400	200

TABLE NO 6

The demand D₄ is satisfied and it is to be exhausted.

Step 5: Again "2" is the minimum in the cells (2,1) and (3,3). In both of these cells, the corresponding minimum supply/demand is 250. But in between these two cells it is found that the minimum cost appears in the cell (2,1) in the given transportation table, so allocate 250 to the cell (2,1).

	D ₁		D ₃	
	250 2	4	400 (150)	
F ₂ F ₃	8	2	250	
	250		400	

TABLE NO 7

Here the demand D₁ is satisfied and it is to be exhausted.

Step 6: Here "2" is the minimum cost placed in the cell (3,3) and the corresponding supply/demand 250 is minimum. Hence it is allocated to the cell (3,3)

		D ₃	
		4	150
F ₂ F ₃		250 2	250
		400 (150)	

TABLE NO 8

Here the supply F_3 is satisfied and it is to be exhausted.

Step 7: The last allocation is 150 and it is allocated to the cell (2,3).

	D_3	
F_2	150 4	150
	150	

TABLE NO 9

Step8: The allocations are transferred to the given transportation table which is shown below.

	D_1	D_2	D_3	D_4	
		300			
F_1	3	1	7	4	300
	250		150		
F_2	2	6	5	9	400
		50	250	200	
F_3	8	3	3	2	500

250 350 400 200

TABLE NO 10

The transportation cost is

$$300 \times 1 + 250 \times 2 + 150 \times 5 + 50 \times 3 + 250 \times 3 + 200 \times 2 = \text{Rs. } 2850.$$

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