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An Effective Methodology for Solving Transportation Problem

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ABSTRACT

The transportation model is a special type of linear programming problem. It deals with the situation in which a commodity is shipped from source to destinations. The objective is to be determined the amounts shipped from each source to each destination that minimize the total shipping cost while satisfying both the supply limit and the demand requirements. The model assumes that the shipping cost on a given route is directly proportional to the number of units shipping on that route. In general, the transportation model can be extended to areas other than the direct transportation of a commodity, including among others, inventory control, employment scheduling and personnel assignment. So it is very competitive and difficult situation to make a vital decision. In this paper, I have tried to reveal a new approach method namely **"**ADDITIVE AND SUBTRACTIVE MINIMUM ODD COST METHOD**"**is proposed to find an initial basic feasible solution for the transportation problems. The method is also illustrated with numerical examples and comparison of the results obtained by various methods.

Keywords: Transportation Problem, Initial Basic Feasible Solution, Additive and Subtractive Minimum Odd Cost Method, Optimal Solution.

1. Introduction

The transportation problem is a special kind of linear programming problem, which deals with shipping commodities from source to destinations. The objective of the transportation problem is to determine the shipping schedule that minimize that total shipping cost while satisfying supply and demand limits. The transportation problem has an application in industry, communication network, planning, scheduling transportation and allotment etc.

The basic transportation problem is one of the special class of linear programming problem, which was first formulated by Hitchcook [5], Charnes et al. [1], Appa [6] and Klingman and Russel [4] developed further the basic transportation problem. Basically, the papers of Charnes and Klingman [2] and Szwarc [8] are treated as the sources of transportation paradox for the researches. In the paper of A.Charnes and Klingman [2], they name it "more for less" paradox and wrote "the paradox was first observed in the early days of linear programming history and has been a part of the folklore known to some, but unknown to the great majority of workers in the field of linear programming". Subsequently, in the paper of Appa [6], he mentioned that this paradox is known as "Doig Paradox" at the London School of Economics, named after Alison Doig. Gupta et al. [3] established a sufficient condition for a paradox in a linear fractional transportation problem with mixed constraints. Adlakha and Kowalski [7] derived a sufficient condition to identify the cases where the paradoxical situation exists.

The transportation criterion is however hardly mentioned at all where the transportation problem is treated. Apparently several researchers have discovered the criteria independently from each other. But most papers on the subject refer to the papers by Charnes and Klingman [2] and Szwarc [8] as the initial papers. In Charnes and Klingman [2] name it the more-for- less, and they write: The criteria was first observed in the early days of linear programming history and has been a part of the folklore known to some, but unknown to the great majority of workers in the field of linear programming. The transportation criteria is known as Doigs criteria at the Landon school of Economics, named after Alison Dong who used it in exams etc. around 1959.

The transportation problem deals with the distribution of goods from several points, such as factories often known as sources, to a number of points of demand, such as warehouses, often known as destinations. Each source is able to supply a fixed demand, usually known as requirement. Because of its major application in solving problems which involving several products sources and several destinations of products, this type of problem is frequently called "The Transportation problem".

2. Proposed approach to find an initial basic feasible solution

In the proposed approach, by adding with the odd to odd value and subtract from even to even value to bring some balance between odd and even cost cells. Then a new transportation table is formed to find the optimum solution for the original transportation problem. That's why this method is named as Additive and Subtractive Minimum Odd Cost Method and the method is illustrated below:

Step-1: Construct a transportation Table (TT) from the given transportation problem.
Step-2: Ensure whether the transportation problem is balanced or not.
Step-3: Select minimum odd cost (MOC) from all the cost cells of TT. If there is no odd cost in the cost cells of the TT, keep on diving all the cost cells by 2 (two) till obtaining at least an odd value in the cost cells. If there is no even cost keep on adding all the cost cells by 1 till obtaining at least an even value in the cost cells.
Step-4: Next adding the selected MOC only with each of the odd valued cost cells of the TT. Again select the minimum even cost from the TT. Then subtract the minimum even cost from all the even cost valued cells of the TT. Then we get a new transportation table.
Step-5: At first start the allocation from minimum of supply/demand. Allocate this minimum of supply/demand in the place of selected MOC from the TT. If demand is satisfied, delete the column. If it is supply, delete the row.
Step-6: Now identify the next minimum cost and allocate minimum of supply/demand at the place of selected minimum cost in the new TT. In case of more than one minimum cost, then see that where row and column both are vanished, if it is not then select the minimum cost cell where minimum allocation can be made. Again in case of same allocation in the minimum cost cells, choose the minimum cost cell which is corresponding to the cost Cells of TT formed in Step-1 (i.e. this minimum cost cell is to be found out from the TT which is constructed in Step-1). Again if the cost cells and the allocations are equal, in such case choose the nearer cell to the minimum of

demand/supply which is to be allocated. Now if demand is satisfied delete the column and if it is supply delete the row.

Step-7: Repeat Step-6 until all the demand and supply are exhausted.

Step-8: Now transfer this allocation to the original TT.

Step-9: Finally calculate the total transportation cost of the TT

3. Numerical examples with illustrations

3.1. Example-1

Consider the following cost minimizing transportation problem with three origins and four destinations.

Find the initial basic feasible solution according to additive and subtractive minimum odd cost method.

	Destinations				
Origins	A	B	C	D	Supply
1	5	3	6	2	19
2	4	7	9	1	37
3	3	4	7	5	34
Demand	16	18	31	25	90

Table 1: Finding basic feasible solution of by additive and subtractive minimum odd cost method

In this Table 1, we see that minimum even cost is 2 and minimum odd cost is 1. Now subtract the selected minimum even cost from others even cost in the table. And adding the selected minimum odd cost with others odd cost in the table. Then we get a new TT.

	Destinations				
Origins	A	B	C	D	Supply
1	5	3	6	2	19
2	4	7	9	1	37
3	3	4	7	5	34
Demand	16	18	31	25	90

Table 2: New transportation table of the proposed method

	Destinations				
Origins	A	B	C	D	Supply
1	6	4	4	2	19
2	2	8	10	1	37
3	4	2	8	6	34
Demand	16	18	31	25	90

Table 3: Allocation of various cells in the new TT by this Proposed Method

Destinations					
Origins	A	B	C	D	Supply
1	6	4	4	2	19
2	2	8	10	1	37
3	4	2	8	6	34
Demand	16	18	31	25	90

- According to step-2: It is found that the given problem is balanced. Because of the sum of supplies=sum of the demands=90.
- As per step-3, minimum odd cost is 1 in cost cell (2, 4) and the minimum even cost is 2 in cost cell (1, 4) among all the cost cells of the transportation Table 1.
- Now adding this minimum odd cost with all other odd valued cost cells of the transportation table 1. Like in cost cell (1, 1) is 5 and (1, 2) is 3 in transportation table 1, but in new table this cell value is 6= (5+1) and 4= (3+1).Similarly doing this with other odd cost cells. Next subtract the selected minimum even cost from all other even valued cost cells of the transportation table 1. Like in cost cell (1, 3) is 6 and (2, 1) is 4 but in new table this cell value is 4= (6-2) and 2= (4-2). Similarly doing this with all other even cost cells.
- According to step-5, minimum supply/demand is 25 that is allocated in the selected MOC 1 in the cell (2, 4). After allocating this value it is found that the demand is satisfied. For which column D is to be exhausted.
- After step-5, we see that there is same minimum cost 2 in cost cells (2, 1) and (4, 2). But we select the cost cell (2, 1) because minimum allocation can be made there. Then the supply is satisfied and row 3 is to be exhausted.
- Again it is found that 2 is the next minimum cost in the remaining cells which appears in the cells (1, 1), (1, 2), (1, 3) and (4, 1), (4, 2), (4, 3). Among these six cells, minimum allocation 18 is made in cell (4, 2). Then the demand is satisfied and column B is to be exhausted.
- Again we see that there is same minimum cost 4 in cost cells (1, 3) and (4, 1). But we select the cost cell (4, 1) because minimum allocation can be made there. Minimum allocation 4 is made in cell (4, 1). Then the demand is satisfied and column A is to be exhausted.
- Next minimum cost is 4 in cost cell (1, 3) and minimum allocation 19 is made in cell (1, 3).then the supply is satisfied and row 1 is to be exhausted.
- Finally complete the allocation by allocating 12 in the cell (4, 3). Then the column c and row 3 is to be exhausted. All the allocations are made according to step-6 and step-7 of the proposed algorithm.
- Now according to step-8, all these allocations are transferred to the transportation table 1, which is shown in the final TT 3.9. In this table it is found that the number of basic cells are 6= (4+3-1) which represents the initial basic feasible solution according to the proposed algorithm.

Destinations					
Origins	A	B	C	D	Supply
1	5	3	6	2	19
2	4	7	9	1	37
3	3	4	7	5	34
Demand	16	18	31	25	90

Table 4: Initial basic feasible solution according to additive and subtractive minimum odd cost method

- total transportation cost is = (6 ×19 + 4×12+1×25+3×4+4×18+7×12) = 355 units

3.2. Example-2

Destinations					
Origins	A	B	C	D	Supply
1	4	6	5	2	6
2	6	4	1	4	10
3	5	2	3	1	12
4	4	6	7	8	14
Demand	9	16	10	7	42

Consider the following cost minimizing transportation problem with four origins and four destinations.

Find the initial basic feasible solution using the Additive and Subtractive Minimum Odd cost method.

Solution:

Destinations					
Origins	A	B	C	D	Supply
1	4	6	5	2	6
2	6	4	1	4	10
3	5	2	3	1	12
4	4	6	7	8	14
Demand	9	16	10	7	42

Table 5: Initial basic feasible solution according to additive and subtractive minimum odd cost method

- total transportation cost is = (2×6 +1×10 +2×11+3×0+1×1+4×9+6×5) **= 111 units**

4. Result analysis and comparison

After obtaining an IBFS by the proposed "Additive and Subtractive Minimum Odd Cost Method", the obtained result is compared with the results obtained by other existing methods is shown in the following table.

Methods	Results	
	Example-1	Example-2
North-west Corner Method	580	202
Row Minimum Method	442	111
Column Minimum Method	367	166
Least Cost Method	367	129
Vogel's Approximation Method	355	114
New Proposed Method	355	111
Optimum Results	355	111

Table 6: Comparison of the results obtained by various methods.

As observed from Table 4**,** the proposed Additive and Subtractive Minimum Odd Cost method provides comparatively a better initial basic feasible solution than the results obtained by the traditional algorithms which are either optimal or near to optimal. Again the performance of the solution varies for other methods which may happen also in case of the proposed method. It happens because it is quite difficult to assume a prior which of the methods will result in the best solution.

5. Conclusion

In this paper, we developed a new approach named 'Additive and Subtractive Minimum Odd Cost Method' for finding an initial basic feasible solution of transportation problem is proposed. Efficiency of this method has also been tested by solving several number of cost minimizing transportation problems and it is found that this method yields comparatively a better result.

The proposed method is an attractive method which is very simple, easy to understand and gives result exactly or even lesser or equal to VAM method. All necessary qualities of being time efficient, easy applicability etc. forms the core of being implemented successfully.

Finally it can be claimed that the 'Additive and Subtractive Minimum Odd Cost Method' may provide a remarkable initial basic feasible solution by ensuring minimum transportation cost. This will help to achieve the goal to those who want to maximize their profit by minimizing the transportation.

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