NEW APPROACH TO SOLVE UNBALANCED TRANSPORTATION PROBLEMS USING LEAST COST METHOD

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Abstract:

Transportation problem is considered a vitally important aspect that has been studied in a wide range of operations including research domains. As such, it has been used in simulation of several real life problems. Thus, optimizing transportation problem of variables has remarkably been significant to various disciplines. In this paper suggests a new approach in order to balance the unbalanced transportation problem and improve the Least Cost Method (LCM). in order to get improved (sometimes) initial solution of unbalanced transportation problem in comparison to usual LCM.

Key words: Transportation problem, Least Cost Method, unbalanced transportation problem, Discounts and Schemes, Overtime

1.1 INTRODUCTION

Transportation problem is a type of linear programming problem that may be solved by using simplex technique called transportation method. It includes major application in solving problems involving several product sources and several destinations of products, this type of problem is frequently called the transportation problem. The two common objectives of such problems are either

(1) Minimize the cost of shipping m units to n destinations or

(2) Maximize the profit of shipping m units to n destinations.

The aim of this study is to determine the minimum transportation cost in an easy and efficient manner. TP can also be formulated as linear programming problem that can be solved using either dual simplex or Big M method. Sometimes this can also be solved using interior approach method. However it is difficult to get the solution using all this method. There are many methods for solving TP. Vogel's method gives approximate solution while MODI and Stepping Stone (SS) method are considered as a standard technique for obtaining to optimal solution. Since decade these two methods are being used for solving TP. Goyal (1984) improving VAM for the Unbalanced Transportation Problem, Ramakrishnan (1988) discussed some improvement to Goyal's Modified Vogel's Approximation method for Unbalanced Transportation Problem.

Moreover Shafaat and Goyal (1988) studied initial basic feasible solution and resolution of degeneracy in Transportation Problem.

There are various types of transportation models and the simplest of them was first presented by Hitchcock (1941). It was further developed by Koopmans (1949) and Dantzig (1951). Several extensions of transportation model and methods have been subsequently developed. Transportation Problem (TP) is based on supply and demand of commodities transported from several sources to the different destinations. The sources from which we need to transport refer the supply while the destination where commodities arrive referred the demand. It has been seen that on many occasion, the decision problem can also be formatting as TP. In general we try to minimize total transportation cost for the commodities transporting from source to destination.

Adlakha and Kowalski (2009) suggested a systematic analysis for allocating loads to obtain an alternate optimal solution. However, the study on alternate optimal solutions is clearly limited in the literature of transportation with the exception of Sudhakar VJ, Arunnsankar N, Karpagam T (2012) who suggested a new approach for finding an optimal solution for transportation problems. Nigus Girmay and Tripti Sharma (2013) suggested a heuristic approach in order to balance the unbalanced transportation problem and improve the Vogel's approximation method. Few researchers have tried to give their alternate method for overcoming major obstacles over MODI and SS method.

2. MATHEMATICAL STATEMENT OF THE PROBLEM

The classical transportation problem can be stated mathematically as follows:

Let a_i denotes quantity of product available at origin i, b_j denotes quantity of product required at destination j, C_{ij} denotes the cost of transporting one unit of product from source/origin i to destination j and x_{ij} denotes the quantity transported from origin i to destination j.

Assumptions: $\sum_{i=1}^{m} a_i = \sum_{j=1}^{n} b_j$

This means that the total quantity available at the origins is precisely equal to the total amount required at the destinations. This type of problem is known as balanced transportation problem.

A transportation problem is unbalanced if the sum of all available quantities is not equal to the sum of requirements or vice-versa. In regular approach, to balance the unbalanced transportation problem either a dummy row or dummy column is introduced to the cost matrix such that if total availability is more than the total requirement, a dummy column (destination) is introduced with the requirement to overcome the difference between total availability and total requirement. Cost for dummy row or column is set equal to zero. Such problem is usually solved by Vogel's Approximation Method to find an initial solution.

This paper suggests an algorithm which gives improved initial solution than Vogel's Approximation Method.

2.1 ANALYSIS

Goyal (1984) suggested that to assume the largest unit cost of transportation to and from a dummy row or column, present in the given cost matrix rather than assuming to be zero as usual in Vogel's Approximation method. He claimed that by this modification, the allocation of units to dummy row or column is automatically given least priority and in addition to this the row or column penalty costs are considered for each interaction. He justified his suggestion by comparing the solution of a numerical problem with VAM and Shimshak et.al (1981). While Shimshak et.al (1981) suggested to ignore the penalty cost involved with the dummy row or column. So that to give least priority to the allocation of units in dummy row or column. With this suggestion Shimshak et.al (1981) obtained initial solution by Vogels Approximation Method.

2.2 SUGGESTION

For the more than last of the decades no intensive and fruitful approach came into being in this area. This paper suggests a method to balance an unbalanced transportation problem. In this present method no dummy row or column is needed to use in order to balance the unbalanced transportation problem. In order to find basic initial solution, it is suggested that instead of using dummy row or column, increase the demand or supply to balance the unbalanced transportation problem. That is, if the sum of supply is x (say), the sum of demand is y (say),

(i) Suppose total supply is greater than total demand then increase the demand x -y = c to the column which has the minimum cost cell.

(ii) Suppose total demand is greater than total supply then increase the demand y-x = d to the row which has the minimum cost cell, then the unbalanced T.P. will become balanced.

3. EXISTING METHODS FOR FINDING AN IBFS

A set of non-negative allocations, which satisfies the row and column restrictions, is known as IBFS. This is an initial solution of the problem, and is also known as a starting solution of TP. The IBFS may or may not be optimal. By improving upon the IBFS we obtain an optimal solution. Solution procedure of the existing methods mentioned in this article for finding an IBFS is discussed below:

3.1 LEAST COST METHOD (LCM)

In Least Cost Method, basic variables are selected according to the every next least cost cell and the process of allocation is continued until all the demand and supply are allocated. Allocation procedure of this method is summarized below.

Step 1: Balance the transportation problem.

Step 2: Find the smallest cost cell cij in the transportation table. Allocate xij= min(si, dj) at the cell (i, j).

Step 3: If the allocation $xij=si$, and $xij \neq di$, cross out i-th row, reduce dj to ($dj-si$), and then go to Step-4. If $xij=dj$, and $xij \neq si$, cross out j-th column, reduce sj to ($sj-di$), and then go to Step-4. If $xij=si=dj$, cross out both i-th row or j-th column and then reduce both sj and dj to zero.

Step 4: Continue this process until all units are allocated. Whenever the smallest costs are not unique, make an arbitrary choice among the smallest costs.

Step-5: Finally calculate the total transportation cost which is the sum of the product of cost and corresponding allocated value.

3.2 PROPOSED METHOD

It is already mentioned that LCM is an uncomplicated calculation procedure. But result varies when there is a tie which needs to be arbitrarily broken in Least Cost Method.

Step 1: Balance the transportation problem. In order to find basic initial solution, it is suggested that instead of using dummy row or column increase the supply or demand correspondingly a cell which has minimum Cij value.

Step 2 : Find the smallest cost cell *cij* in the transportation table. Allocate *xij*= min (*si* , *dj*) at the cell (i, j). In case of ties, select the cell where maximum allocation can be allocated.

Step 3 : If the allocation *xij*=*si*, and *xij*≠di, cross out i-th row, reduce *dj* to (*dj*-*si*), and then go to Step-4. If *xij*=d*j*, and *xij* ≠*si*, cross out j-th column, reduce *sj* to (*sj*-*di*), and then go to Step-4. If *xij*=*si*=d*j*, cross out both i-th row or j-th column and then reduce both *sj* and *dj* to zero.

Step 4 : Continue this process until all units are allocated. Whenever the smallest costs are not unique, make an arbitrary choice among the smallest costs.

Step 5 :Finally calculate the total transportation cost which is the sum of the product of cost and corresponding allocated value.

4. NUMERICAL EXAMPLES

4.1 INITIAL SOLUTION BY LCM

	D1	D2	D3	Capacity
O1	4	8	8	76
O2	16	24	16	82
03	8	16	21	77
Requirement	72	102	41	

Here total supply =235, total demand =215

To find initial solution for the given problem using usual LCM introduce the dummy column with zero cost.

Initial solution by LCM: 2872

4.2 INITIAL SOLUTION BY PRESENT ALGORITHM

Increase the availability of first column by 20

	D1	D2	D3	Capacity
O1	4	8	8	76
O2	16	24	16	82
03	8	16	21	77
Requirement	92	102	41	

	D1	D2	D3	Capacity
O1	4**(76)**	8	8	76
O2	16	24**(41)**	16**(41)**	82
03	8**(16)**	16**(61)**	21	77
Requirement	92	102	41	

Initial transportation cost =3048

4.3 CONSIDER THE FOLLOWING TRANSPORTATION PROBLEM

	D1	D2	D3	D4	D5	Capacity
O1	5	8	6	6	3	800
O2	4	7	7	6	5	500
03	8	4	6	6	4	900
Requirement	400	400	500	400	800	

Using LCM initial solution is: 10400

4.4 PROPOSED MODEL

Increase the capacity of first row by 300

	D1	D2	D3	D4	D5	Capacity
O1	5	8	6	6	3	1100
O2	4	7	7	6	5	500
03	8	4	6	6	4	900
Requirement	400	400	500	400	800	

	D1	D2	D3	D4	D5	Capacity
O1	5	8	6	6**(300)**	3**(800)**	1100
O2	4**(400)**	7	7	6**(100)**	5	500
03	8	4**(400)**	6**(500)**	6	4	900
Requirement	400	400	500	400	800	

Initial solution: 11000

5. DISCOUNTS AND SCHEMES

Festival season is a good time for the retailers to appeal to customers with discounts and schemes. The consumers too look forward to avail the discounts on offer. The festival season is considered auspicious for shopping too which adds to its attraction.

Festival season discounts comes in two ways

(i) The cash discount where the retailer cuts the price by a significant amount and sells cheaper

(ii) The retailer provides a loan to buy goods at an easy EMI. Typically the interest rate is zero.

Cash discount is easy to understand and is offered by all retailers, big or small. Buy one, get one free is one such discount. 50% off on your purchase is another type of cash discount. Buy one get 50% off on second item is another type. These types are easy to understand. The discount is also immediate. Hence this is most attractive to consumers.

Loan discount, EMI facilities, and zero interest rates are generally offered by big retailers because offering such discounts need an infrastructure with banks and credit card companies. Discount with zero interest rate, easy EMI, pay by credit card and pay back to credit card in instalments are types of discount where cash flow is not immediate.

5.1 OVERTIME

Overtime refers to the time worked in excess of one's regular working hours. They are doing/working overtime to get the job done on time. Everyone is on overtime means being paid extra for working after the usual time in that weekend.

6. CONCLUSION

When supply exceeds the actual demand sale may be increased by special offers. If the demand exceeds the supply, then the required demand is balanced by working over time

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