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Research Paper Mathematics

Application of Revised Distribution Method for Finding Optimal Solution of Unbalanced Transportation Problems

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ABSTRACT

Unbalanced transportation problem is a special type of linear programming problem. The objective of this paper is to find an optimal solution for the unbalanced transportation problem using Revised Distribution method (RDI). This method is based on allocating units to the cells in the transportation matrix starting with minimum demand or supply to the cell with minimum cost in the transportation matrix and then try to find an optimum solution to the given transportation problem. The proposed method is a easy to apply and can be utilized for unbalanced transportation problem with minimize objective functions. At the end, this method is illustrated with some numerical example.

KEYWORDS Unbalanced transportation problem, Linear programming Problem, REDI Method, MODI method

INTRODUCTION

A transportation problem is said to be [1], the type of linear programming problem. This is particularly important in the theory of decision making. Different methods have been presented for Transportation problem and various articles have been published on the subject.

In this problem we determine optimal shipping patterns between origins or sources and destinations [5]. Many problems which have nothing to do with transportation have this structure. Suppose that *m* origins are to supply *n* destinations with a certain product. Let be the amount of the product available at origin i, and be the amount of the product required at destination j. Further, we assume that the cost of shipping a unit amount of the product from origin i to destination j is we then let represent the quantity of the product transported from origin i to destination j.

If shipping cost, are assumed to be proportional to the amount shipped from each origin to each destination so as to minimize total shipping cost turns out to be a linear programming problem.

Transportation models have wide applications in logistics and supply chain for reducing the cost. When the cost coefficients and the supply and demand quantities are known exactly, many algorithms have been developed for solving the transportation problem.

[9] A transportation problem is said to be balanced if the total supply from all the sources equals the total demand in all the destinations and is called unbalanced otherwise.

A considerable number of methods have been so far presented for finding an initial solution of a Transportation problem. It must be feasible i.e., it must satisfy all the supply and demand constraints. A solution is said to be feasible if (cells [3] of the transportation matrix are allocated some units/items.

The cells having an allocation are known as 'Occupied cells' while, other cells are termed as 'Unoccupied cells'. The main concept of transportation is to establish the 'least cost route' problem is to find the optimum allocation of a number of resources to an equal number of demand points. An allocation plan is optimal if optimizes the total cost or effectiveness of transferring all the goods. This paper attempts to propose a method for finding optimal solution of transportation problem which is different from the preceding methods.

RELATED WORKS

This is work is alternative for existing MODI (Modified Distribution Method) method [3] in which the number of iteration is minimized. The optimal solution is coincide with the MODI method. It is also applicable for balanced [4] transportation problems.

MATHEMATICAL FORMULATION OF UNBALANCED TRANSPORTATION PROBLEM

Mathematically a transportation problem can be stated as follows:

$$\text{Minimize } Z = \sum_{i=1}^{m}\sum_{j=1}^{m} c_{ij}x_{ij}$$

For an unbalanced transportation problem

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

A NEW APPROACH FOR SOLVING UNBALANCED TRANSPORTATION PROBLEM

This section presents REDI method to solve the unbalanced transportation problem which is different from the preceding method.

Step (i) Start with the addition of dummy row or dummy column based on the demand and supply of the unbalanced transportation problem. Insert the dummy column if the supply is not sufficient to meet out the demand similarly adds row if the demand is less and vice versa.

Step (ii) Start with the minimum value in the supply column and demand row. If tie occurs, then select the demand or supply value with least cost [7].

Step (iii)Compare the figure of available supply (capacity) in the row and demand in the column and allocate the units equal to capacity or demand whichever is less.

Step (iv)If the demand in the column is satisfied, move to the next minimum value in the Demand row and supply column.

Step (v) The cells either in the dummy row or dummy column should be filled only after the steps i to iv.

Step (vi) Repeat Steps (ii) and (iv) until capacity condition of all the plants demand conditions of all ware houses have been satisfied.

MATHEMATICAL CONCEPT OF THE SUBJECT

One of the operations associated with matrices is calculation of scalar value known as the determinant of a square matrix [6]. Here we do not want calculate the determinant of a matrix, only we want to use the properties of the determinant operator, when we use customary and common notation, for the determinant of the matrix. [table1]

plants(i)	Warehouse(j)				Supply(i)
	1	2	.....	n	
1	C_{11} X_{11}	C_{12} X_{12}	– –	C_{1n} X_{1n}	S_1
2	C_{21} X_{21}	C_{22} X_{22}	– –	C_{2n} X_{2n}	S_2
..	– –	– –	– –	– –	–
m	C_{m1} X_{m1}	C_{m2} X_{m2}		C_{mn} X_{mn}	S_m
Demand	D_1	D_2	–	D_n	

Table 1.a Transportation Matrix

Numerical example

The following examples may be helpful to clarify the proposed method:

Consider the following transportation problem. Find most economical shipment to minimize the transportation cost.

From/To Plants	Warehouse (j)			Capacity
	P	Q	R	
A	35	25	15	875
B	10	20	30	575
Demand	350	350	450	1450 1150

Table 1.b Transportation Matrix of the problem

From/To Plants	Warehouse (j)				Capacity
	P	Q	R	W	
A	35	25	15	0	875
B	10	20	30	0	575
Demand	350	350	450	300	1450 1150

Table 2. Matrix of the given unbalanced transportation problem.

From/To Plants	Warehouse (j)				Capacity
	P	Q	R	W	
A	35	25	15	0	875
B	10 350	20	30	0	225
Demand	0	350	450	300	1100 1100

Table 3. Allocation of shipment to the cell BP

In the table 3 the minimum value in the demand row and capacity column are 350 (ignoring the dummy column which is having the value 300). The cell which is having least transportation cost in the Pth column is BP. Hence allocate the entire 350 units to this cell. It is (cell AR) ignored for the next iteration. The revised values of the table 3 are indicated in the table-4. The occupied cell value is **(350×10 = 3500).**

From/To Plants	Warehouse (j)			Capacity
	Q	R	W	
A	25	15	0	875
B	20 225	30	0	0
Demand	125	450	300	875 875

[table 4] allocation of shipment to the cell BQ

In the table 4 the minimum value in the demand row and capacity column are 450 (ignoring the dummy column which is having the value 300). The cell which is having least transportation cost in the Qth column is QB. Hence allocate 225 units to this cell. It is (cell QB) ignored for the next iteration. The revised values of the table 4 are indicated in the table-5. The occupied cell value is **(225×20 = 4500).**

From/To Plants	Warehouse (j)			Capacity
	Q	R	W	
A	25 125	15	0	750
B	20 225	30	0	0
Demand	0	450	300	750 750

[table 5] allocation of shipment to the cell AQ

In the table 5 the minimum value in the demand row and capacity column are 450 (ignoring the dummy column which is having the value 300). The cell which is having least transportation cost in the Qth column is QA. Hence allocate 125 units to this cell. It is (cell QA) ignored for the next iteration. The revised values of the table 5 are indicated in the table-6. The occupied cell value is **(125×25 = 3125).**

From/To Plants	Warehouse (j)		Capacity
	R	W	
A	15 450	0	300
B	30	0	0
Demand	0	300	300 300

[table 6] allocation of shipment to the cell AR

The occupied cell value is **(450×15 = 6750).**

From/To Plants	Warehouse (j) W	Capacity
A	0 300	0
B	0	0
Demand	0	0 0

[table 7] allocation of shipment to the cell AR

The occupied cell value is **(300×0 = 0).**

REDI Method
The numbers of occupied cell are hence the basic feasible solution is ready for optimality. So there is no degeneracy in the transportation problem.

Optimal Solution
(125 × 25) + (450 × 15) + (350 × 10) + (225 ×20) + (300 ×0) = Rs.17,875

Existing One MODI Method
II-Test for Optimality by MODI Method

Stone squares	Equation	Value of r_i and k_j if $r_1 = 0$
AQ	$r_1 + k_2 = 25$	$r_1 = 0$, $k_2 = 25$
AR	$r_1 + k_3 = 15$	$k_3 = 15$
AW	$r_2 + k_3 = 0$	$k_4 = 0$
BP	$r_2 + k_1 = 10$	$k_1 = 15$, r_2
BQ	$r_2 + k_2 = 20$	r_2, $k_2 = 25$

Water squares	Net Cost Change
AP	$C_{11} - (r_1 + k_{1)} = 35 - (0+ 15) = 20$
BR	$C_{23} - (r_2 + k_{3)} = 30 - (-5+15) = 20$
BW	$C_{21} - (r_2 + k_{1)} = 70 - (50+19) = 1$

Since net cost change for all water square is positive, the solution by REDI method is optimal.

Conclusion
In this paper, a new and simple method was introduced for solving unbalanced transportation problem. This method can be applied for an unbalanced transportation problems, which is having objective function of minimize. The number of iteration is minimized when compared to other methods like MODI and stepping stone. This new method is based on the allocation of demand and supply items in the transportation matrix, and finds an optimal solution interms of the ones.

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