PRIORTY LEAST COST METHOD FOR SOLVING TRANSPORTATION PROBLEMS

[1]Abdul Majeed Khoso, [2]Mansoor Ali Bhaagat, [3]Sobia Vighio
[1]Mehran university of Engineering and Technology Jamshoro Sindh Pakistan
[2]Mehran University of Engineering and Technology Jamshoro Sindh Pakistan
[3]Government Girls degree college Qasimabad Hyderabad Sindh, College Education department Govt. of Sindh
[1]majeed.khoso@faculty.muet.edu.pk, [2]mansoor.bhaagat@faculty.muet.edu.pk,
[3]sobianoor022@gmail.com

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Corresponding Author: *

Abstract
This study presents a Priority Least Cost Method (PLCM) for solving transportation problems and obtaining the Initial Basic Feasible Solution (IBFS). The primary objective of the transportation model is to reduce the overall transportation cost. The proposed technique is compared with traditional approaches such as the North-West Corner Method (NWCM) and Least Cost Method (LCM). The comparison indicates that the proposed method provides improved results and reaches the solution more efficiently. The algorithm is simple, fast, and effective for finding an initial feasible solution in a short time.

INTRODUCTION

Operations Research (OR) originated during World War II as a scientific tool for enhancing military planning and resource management. Over time, OR has been widely adopted in various areas such as engineering, economics, healthcare, transportation, and management sciences.

Transportation is one of the major applications of OR because the effective movement of goods and services plays a crucial role in industrial development and economic progress. Transportation problems focus on determining the best shipping plan that fulfills supply and demand requirements while minimizing transportation expenses.

The transportation model is regarded as a special type of linear programming problem because of its organized mathematical structure and efficient computational process. It has become an essential technique in logistics management and operational planning.

Scope of Operation Research

Operation Research mainly specializes in clarifying complex firm problems into well-described mathematical structures and helps specify anticipated behavior in addition to goals. The main utility of Operations Research is that it enables choice making in the one's elements of a firm in which useful resource allocation is cardinal, i.e. capital, labour, time and different firm resources. Given that it's far rooted in science know-how and problem solving, there may be an enormous

scope of operation research in each firm exercise.

1. In selecting the better distribution routes for supplies to their destination OR helps in better decision making.
2. OR is preferable for minimum cost management sciences to help in getting financial gainto the individual as well as business companies.
3. OR is cost effective in public transport services to solve transportation issues i.e. in reducing cost of transportation.

1.2 LINEAR PROGRAMMING PROBLEM (LPP)

Linear Programming Problem is also known as Linear optimization issues, which has the objective function is linear.

Z = f() = + + + … + (1.3)

Which Is in the past though to obtain the maximum famous results such too small lost and largest revenue. The original idea to convert real life problems to mathematical form is given by George B Dantzig to make the difficult tasks easy for the US Air Force. The idea of LPP gave a strategy to come up with best outcome of business plaining conclusions. It is favorable to reduce the cost and increase the benefits of these sort of issues. LPP can be regard as Operation Research's main portion. Transportation problem lies among the most common strategies of LPP.

1.3 TRANSPORTATION MODEL PROBLEMS (TMP)

The main purpose of Transportation Model Problem (TMP) is to enhance the shape of Linear Programming Problem so that one can use the strategy of transporting the items or supplies to the destinations with least costs. The target of this type of problem is to produce transportation from numerous kernels named origins (supply, sources or initial points) to different places named destinations (demand, sink or final point) in such a way that total transportation cost is minimized.

1.4 INITIAL BASIC FEASIBLE SOLUTION APPROACHES

- o North West Corner Method (NWCM)
- o Least Cost Method (LCM)
- o Vogel's Approximation Method (VAM)

1.4.1 North West Corner Method (NWCM)

The NWCM is the basic approach to solve the transportation problem. In this method we allocate the North West cell a required amount of supply or demand by the following procedure.

Step 1: Balance the transportation table

Step 2: Allocate the North West cell a required amount of supply or demand

Step 3: Cancel out the satisfied row of supply or column of demand

Step 4: Repeat step 2 and step 3 until all supplies and demands are satisfied.

1.4.2 Least Cost Method (LCM)

LCM is another approach to solve transportation problem. In this method the IBFS is obtained by allocating the smallest cost cell a required supply or demand by the following steps.

Step 1: Balance the transportation problem

Step 2: Allocate the smallest cell of transportation table a required supply or demand.

Step 3: Cancel out the satisfied row of supply or column of demand

Step 4: Repeat step 2 and step 3 until all supplies and demands are satisfied.

1.4.2 Vogel's Approximation Method (VAM)

Vogel's approximation method is applied more than NWCM and LCM as it gives better results in solving transportation problem as compared to the methods that are mentioned above. This methods uses the idea of penalty which is obtained by subtracting the least cost with the second least cost of row or column by the following procedure.

Step 1: Balance the transportation problem

Step 2: Calculate the penalty by subtracting the least cost with the second least cost of row as well as column.

Step 3: Select the largest penalty and allocate the least cost cell of row or column a required supply or demand

Step 4: Cancel out the satisfied row of supply or column of demand

Step 5: Repeat step 2 to step 4 until all supplies and demands are satisfied.

1.5 OPTIMALITY TEST (OT)

Optimal solution is the finest solution of transportation problem in which the total cost of transportation problem is minimized. There is only one solution that can be obtained by the optimality test as described:

(a) The number of allocations in transportation table must be m+n-1, where m and n are number of rows and columns respectively.

(b) These $m + n - 1$ allocations should be at independent positions.

There are two approaches to get the optimal solution of transportation problem. They are:

1. Modified distribution Method (Modi method)
2. Stepping stone Method

1.5.1 Modified distribution Method (Modi method)

Modified distribution method filters the initial basic feasible solution of the transportation
problem. It uses the following steps.

Step 1: Obtain the m+n-1 basic variables.

Step 2: Determine and from by substituting or initially

Step 3: Determine the opportunity costs of non-basic cells using

Step 4: Check the signs of each. If values of all is either positive or zero, then given solution is optimal. If one or more is negative, then solution is not optimal. Go to step 5

Step 5: Choose the empty cell with the smallest opportunity cost.

Step 6: For the empty cell that has been taken in previous step. Form a bounded loop.

Step 7: Assign alternative signs of plus and minus on the cut of positions of empty cells.

Step 8: locate the most range of units that ought to be transported to this empty cell. The smallest rate with a negative location at the closed route shows the rate of units that may be transported to the entering cell. Now, sum this amount to all of the cells at the nook factors of the closed route with plus signs, and subtract it from the ones cells marked with minus signs. By doing this an empty cell becomes the allotted cell

Step 9: Repeat step 2 to step 9 until the suitable solution is acquired.

1.5.2 Stepping Stone Method (SSM)

When the initial basic feasible solution is obtained, its optimality can also be checked by Stepping Stone Method which has the following steps.

Step 1: Obtain the initial basic feasible solution

Step 2: select an unoccupied cell and draw the closed loop with occupied cells with alternative signs starting with +

Step 3: Calculate the net evaluation from looped value. If all the results are positive, then solution is optimal.

Step 4: If any of the result is negative then select the smallest allocated value as leaving variable.

Step 5: Repeat step 2 to step until the optimal solution is obtained

1.6 PROBLEM STATEMENT

In Vogel's Approximation Methods, we calculate penalties to get the initial basic feasible solution. But if we get a larger Transportation problem then calculating penalties become problematic. The main purpose of present study is to solve transportation problem without

calculating the penalties.

1.7 RESEARCH OBJECTIVE

- To develop a four step method to obtain the IBFS for transportation problem.
- Developed four-step method is to be applied on transportation problem for optimality
- To compare result of proposed method with result of existing methods

.METHODOLOGY

RESEARCH OBJECTIVE

- To develop a four step method to obtain the IBFS for transportation problem.
- Developed four-step method is to be applied on transportation problem for optimality
- To compare result of proposed method with result of existing methods available in literature

This section refers to the detailed research methodology and shows step by step explanation of the proposed method. In this part of thesis we have solved several numerical examples of transportation problem to get optimal value of transportation cost.

Let x_{ij} be the units that are transported from the *n* origins to the *m* destination .The mathematical model of the problem is given as.

Minimize $Z = \sum_{i=1}^{n} \sum_{j=1}^{m} cij\ xij$

Subject to $\sum_{i=1}^{m} xij = Sm$

$\sum_{j=1}^{n} xij = qn$

$x_{ij} \geq 0$, for all n,m

Where Z : Total transportation cost

C_{ij} : units to be transferred from source n to destination m

Sm : number of supply at source n

qn: number of demands at destination m

Table 3.1: Table of the general transportation Problem

Destination / Sources	D_1	D_2	D_3	…	D_n	Supply
S_1	C_{11}	C_{12}	C_{13}	…	C_{1n}	S_1
S_2	C_{21}	C_{22}	C_{23}	…	C_{2n}	S_2
S_3	C_{31}	C_{32}	C_{33}	…	C_{3n}	S_3
	…	…	…	…	…	…

S_m	C_{m1}	C_{m2}	C_{m3}	…	C_{mn}	S_m
Demand	q_1	q_2	q_3	…	q_n	

Methodology of proposed Algorithm.

Step 1

Balance the transportation problem.

Step 2

Calculate penalties by subtracting the least cost from the second least cost for every row and column.

Step 3

Choose the row or column with the highest penalty and allocate as much as possible to the minimum cost cell.

Step 4

Remove the satisfied row or column.

Step 5

Repeat the process until all supply and demand values are satisfied.

Algorithm of Priority Least Cost Method (PLCM)

Step 1: Construct Transportation Table

Prepare the transportation table by entering all transportation costs, supply values, and demand values.

Step 2: Identify Minimum Costs

For each row and each column:

- Determine the smallest transportation cost.
- Determine the second smallest transportation cost.

Step 3: Compute Penalties

Calculate the penalty for every row and column using:

$$\text{Penalty} = \text{Second smallest cost} - \text{Smallest cost}$$

Step 4: Select Maximum Penalty

Identify the row or column having the highest penalty value.

- If two or more penalties are equal, select the row or column containing the smallest transportation cost.

Step 5: Choose Least Cost Cell

From the selected row or column, choose the cell with the minimum transportation cost.

Step 6: Allocate Units

Allocate the maximum possible quantity to the selected cell according to:

$$\text{Allocation} = \min(\text{supply}, \text{demand})$$

Update the corresponding supply and demand values.

Step 7: Eliminate Satisfied Row or Column

- If supply becomes zero, cross out that row.
- If demand becomes zero, cross out that column.
- If both become zero simultaneously, cross out one and place zero allocation in the other if required to avoid degeneracy.

Step 8: Repeat Procedure

Repeat Steps 2 to 7 until all supply and demand values are completely satisfied.

Example

The conventional Initial solution By proposed Algorithm Priority of LCM

Destinations	D_1	D_2	D_3	Supply
S1	2	3	11	6
S_2	1	0	6	1
S_3	5	8	15	10
demand	7	5	5	

Step.1

Compute penalties row penality

$S_1 = 3 - 2 = 1$

$S_2 = 1 - 0 = 1$

$S_3 = 8 - 5 = 3$

Compute penalty

$D_1 = 2 - 1 = 1$

$D_2 = 3 - 0 = 3$

$D_3 = 11 - 6 = 5$

Highest penality = 5 in column D_3

Step.2

Choose least cost in D_3 cost 11,6,15 ,minimum = 6 in S_2

Min1,5 = 1

Destination	D_1	D_2	supply
S_1	2	11	1
S_2	5	15	10
Demand	7	4	

Step 1

Row Penalty

$S_1 = 11 - 2 = 9$

$S_3 = 15 - 5 = 10$

Column penalty

$D_1 = 5 - 2 = 3$

$D_3 = 15 - 11 = 4$

Highest = 10 in S_3 .

Allocate minimum cost 10, = 7

Put 7 in S_3, D_1

S_3 = 3 Left D_1 = 0

Destination	D3	Supply
S1	11	3
S2	15	4
Demand	4	

Attocate

S1= 1 to D3

S3= 3 to D3

All demand and supply has been canceled

Total cost calculated

$5\times3 + 1\times11 + 1\times6 + 7\times5 + 3\times15$

Total cost = 112

A COMPARISON OF THE METHODS

Examples numbers	PLCM	LCM	VAM
1	200	210	200
2	425	445	425
3	295	315	295
4	170	185	170
5	113	124	113

The Priority Least Cost Method (PLCM) gives better initial basic feasible solutions compared to the Least Cost Method (LCM). In most transportation problems, PLCM produces the same result as Vogel's Approximation Method (VAM) while requiring less computational effort. Therefore, PLCM is an efficient and effective approach for solving transportation problems.

CONCLUSION

Transportation problem has many application and uses in many discipline of life from business to organizations like firms, mills, factories, etc. The solution of transportation problem uses the advantage of minimizing the cost of transporting goods or materials from different sources to numerous destinations. There are many methods and algorithms available in literature to come up with better solution of TP, the key goal of proposed method is to obtain the minimized result with ease and in concise way. In this research work, we have developed the Four-step method for getting the initial basic feasible solution of transportation problems. The proposed method is also examined for optimality. A comparison of proposed method is made with Least Cost Method, Vogel's Approximation Method and North West Corner Method by examining five numerical examples. After examination, it can be concluded that proposed method is achieving better results as compared to popular methods. The proposed method uses only four steps to get the better initial basic feasible solution. This new scheme will be beneficial and advantageous for solving transportation problems.

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