TEST Engineering & Management

January-February 2020
ISSN: 0193-4120 Page No. 16267 - 16271

Optimal Solution of a Transportation Problem using Harmonic Mean Approach Rule

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Article Info
Volume 82
Page Number: 16267 - 16271
Publication Issue:
January-February 2020

Article History
***Article Received**: 18 May 2019*
***Revised**: 14 July 2019*
***Accepted**: 22 December 2019*
***Publication**: 28 February 2020*

Abstract:
Operational research includes a wide range in problem solving techniques and decision making in various real life situation. Finding Initial Basic Feasible Solution (IBFS) the transportation problem is one of the best Rules in Linear Programming Problem (LPP). Not only in Linear Programming Problem but also in finding optimal solution. The Transportation Problem is considered as an important aspect that has been studied in a large scale of operations including in research domains and it mainly used to reduce the cost. As such the Transportation Problem used in simulation of several real life problems. Here, the optimizing transportation problem of variables has unique been significant to numerous disciplines. The main approach of the work to transport the products from one destination to another destination where the total cost to shift the product is to minimize and the transportation time is reduced. To achieve the minimum cost a new Rule Harmonic Mean Approach (HMA) is introduced. Some real-world examples are illustrated.

Keywords: *Transportation, Linear Programming Problem, Harmonic Mean Approach, IBFS, Transportation Problem(TP).*

I. Introduction

Operational Research is considered as an interdisciplinary that deals in problem solving and advanced analytical Rules to give better decisions. Most probably the operational research, problems are divided into basic components and it is also solved in defined steps by mathematical analysis. Mathematical logic, simulation, network analysis, queuing theory, and game theory are most commonly used analytical Rules in operational research. Here the process can be broadly classified into three steps.

1. A set of potential solutions to a problem is progress. (The set may be large.)
2. The option are derived in the first step are analyzed and diminished to a small set of solutions most probably to prove it is workable.
3. The option are derived in the second step are subjected to simulated implementation and, if possible, tested out in real-world situations. In this final step, psychology and management science often play essential roles.

In Operational Research the transportation problem mainly used to reduce cost of single commodity from the given number of sources and to the given number of destinations

II. TRANSPORTATION PROBLEM

F.L.Hithcock who first examined the transportation problem. The transportation problem is a special type of linear programming problem it is used to minimize the cost of distributing products from one sources to another destination.In general transportation problem mainly deals with the transportation of the commodity from p sources to q destinations. It is also given that

- A supply level at each source and the analysis the demand at every destination.
- A unit transportation cost of commodity from each source and to each destination is

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recognized and it also given that the cost of transportation is linear.

III. MATHEMATICAL FORMULATION FOR TRANSPORTATION PROBLEM

Let us consider that there are m sources and n destinations. Let a_i be the supply at the source i, b_j be the demand at the destination j, c_{ij} be the unit transportation cost from source i to destination j and x_{ij} be the no of units shifted from source i to destination j. The transportation problem can be expressed mathematically as

$$\min z = \sum_{i=1}^{m}\sum_{j=1}^{n} c_{ij}x_{ij}$$

$$\sum_{j=1}^{n} x_{ij} = a_i; i = 1,2,3, \ldots \ldots . m$$

$$\sum_{i=1}^{m} x_{ij} = b_j; j = 1,2,3 \ldots \ldots . n \text{ and } x_{ij} \geq 0$$

The main objective of transportation problem is to determine the amount to be shifted from each source to each destination such that the total transportation cost is minimum. The initial basic feasible solution can be obtained by three ways, they are

1. Upper Left-Hand Corner Rule
2. Matrix Minima Rule (or) LCM Rule
3. Unit Cost Penalty Rule (or) VAM Rule

Balanced Transportation and Unbalanced transportation are two vital types in transportation problem. Consider the problem is balanced transportation problem if it is entire supply's and entire demands are equal. Suppose the entire supply's and entire demands are not equal it is consider to be unbalanced transportation problem. To balance the unbalanced problem add dummy column if source of product is greater than the demand. Again add dummy row if the demand larger than the source, to change the given unbalanced problem to balanced problem.Here becomes challenging to introduce the new rule whether it can be proper to the real-life problems. The optimum solution with low transportation cost can be find using new statistical rule HMA.

The Upper Left-hand corner rule, LCM rule, VAM rules are compared with New Rule with some examples. Initial basic feasible solution is derived and we also verified the optimality solution of the problem. Some numerical examples are given below.

The statistical formula to calculate the harmonic mean

$$HM = \frac{N}{\sum \frac{1}{x}}$$

IV. ALGORITHM

Step 1: Create the transportation table (TT) for the given transportation problem (TP).

Step 2: Check whether the given transportation problem is balanced or unbalanced.

Step 3: If the problem is balanced continue with step 4 otherwise if the problem is unbalanced add dummy row or column to the transportation table then go to step 4.

Step 4: By using formula calculate the HM for each row and column and check the largest value in each column and row.

Step 5: At the place of minimum value of the related row or column allocate the minimum supply or demand to the respective column or row.

Step 6: Repeat the step 4 and step 5 until all the demands and supply got satisfied

Step 7: Finally to find the transportation cost

Total transportation cost = total the boxes with the product of the cost to be shipped and product the transportation supply and demand in the transportation table.

V. PROBLEMS

1. A company manufactures Cars and it has three factories KG factory, HK factory and HB factory whose Monthly production capacities are 200, 300 and 400 pieces of cars respectively. The company supplies Cars to its four showrooms located at Tamil Nadu, Kerala, Karnataka and Andhra Pradesh whose Monthly demands are 150, 250, 350 and 150 pieces of cars respectively. The transportation costs per piece of Cars are given in the transportation. Find out the schedule of shifting of Cars from factories to showrooms with minimum cost:

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Table 1: Transportation costs per piece of Cars are given in the transportation table

Factories	Showrooms (in Lakhs)				Production Capacity (in Thousands)
	Tamil Nadu	Kerala	Karnataka	Andhra Pradesh	
KG factory	3	1	4	2	200
HK factory	2	5	7	8	300
HB factory	3	4	9	6	400
Demand (in Thousands)	150	250	350	150	

VI. SOLUTION

Here the tp is balanced i.e. Supply = 900 and Demand = 900. Hence Supply=Demand.

Consider the above transportation problem in transportation table. The IBFS is found using Harmonic Mean Approach Rule

Table 2: Solution for HMA

FACTORIES	TN	KE	KA	AP	Supply				
KG factory	3	1	4 [200]	2	200	1.92	-	-	-
HK factory	2 [150]	5	7 [150]	8	300,150	4.15	4.15	3.64	2.86
HB factory	3	4 [250]	9	6 [150]	400,250	4.65	4.65	4	3.45
Demand	150	250	350,150	150					
	2.59	2.07	6	3.77					
	2.41	4.44	12	6.78					
	2.41	4.44	-	6.78					
	2.41	4.44	-	-					

The Initial Basic Feasible Solution is
IBFS = (4*200) + (2*150) + (7*150) + (4*150) + (6*150) = 4050
Hence the total transportation cost is Rs.4050/- (in Lakhs)

1. The company manufactures Mobile phones and it has three factories NK factory, GK factory and SN factory whose weekly production capacities are 30, 40 and 50 pieces of mobile phones respectively. The company supplies Mobile phones to its four Main Branches located at Coimbatore (D1), Madurai (D2), Chennai (D3) and Tiruchirappalli (D4) whose weekly demands are 50, 20, 30 and 20 pieces of mobile phones respectively. The transportation costs per piece of Mobile phones are given in the transportation. Find out the schedule of shifting of Mobile phones from factories to Branches with minimum cost:

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Table 3: Transportation costs per piece of mobile phones are given in the transportation table

Factories	Branches (in Thousands)				Production (in Thousands)
	D1	D2	D3	D4	
NK factory	80	20	10	15	50
GK factory	40	60	30	70	30
SN factory	30	15	35	25	40
Demand (in Thousands)	20	20	30	50	

FACTORIES	D1	D2	D3	D4	Supply			
NK factory	80	20	10	15 [50]	50	17.45	23.23	17.14
GK factory	40	60	30 [30]	70	30	44.80	-	-
SN factory	30 [20]	15 [20]	35	25	40,20	23.73	21.43	18.75
Demand	20	20	30	50				
	42.35	22.50	18.53	24.80				
	43.64	17.14	-	18.75				
	-	17.14	-	18.75				

VII. CONCLUSION

In today's highly competitive world, the range of market in various organizations wants to deliver the products in a cost effective way. In such a way that the market becomes more competitive to face the challenge the transportation problem model provides a powerful framework to judge the best ways to deliver the goods to the customer. In this article, a new proposed Rule named Harmonic Mean Approach (HMA) for finding an Initial Basic Feasible Solution of transportation problem is derived. The efficiency of Harmonic Mean Approach has been tested by solving several numbers of costs minimizing transportation problem and it is found that the harmonic mean approach yields a global optimum solution in a lesser step.From the comparison table, the optimum solution we obtained by the proposed Rule is less than that the existing Rule. Finally it can be claimed that the Harmonic Mean Approach may provide a remarkable Initial Basic Feasible Solution by ensuring that the minimum transportation cost. This will help the aim to those who want to minimize the transportation cost and maximize their profit.

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