INTRODUCTION TO VARIOUS TRANSPORTATION METHODS FOR OPTIMIZATION PROBLEMS

Mukesh Kumar[1], Kanu Monga[2]
[1]*Lecturer, S.B.S.S.T.C, Ferozepur, Punjab, India*
[2] *Lecturer, S.B.S.S.T.C, Ferozepur, Punjab, India*

ABSTRACT

Problem statement: Managing the increasing traffic at optimum price is a big problem all over the world. The optimization problems are solved effectively by choosing the best element from set of available options. The most important and successful applications in the optimization refers to transportation problem (TP), that is a special class of the linear programming (LP) in the operation research (OR). The main objective of transportation problem solution methods is to minimize the cost or the time of transportation. Most of the currently used methods for solving transportation problems are trying to reach the optimal solution. The intent of the paper is to have a review on various methods for solving transportation problems by illustrating the fundamental algorithm with a suitable example and then suggesting the best method among them.

Keyword: - *Operation research, transportation problem, linear programming, optimization problems, transportation model, algorithm, and objective function*

1. INTRODUCTION

Transportation problem is concerned with the optimal pattern of the product units' distribution from various origins to various destinations. Suppose there are m points of origin $A_1, \dots, A_2, \dots, A_m$ and n destinations $B_1, \dots, B_j, \dots, B_n$. The point A_i (i = 1, . . .,m) can supply a_i units, and the destination B_j(j = 1, . . ., n) requires by j units.

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

Whereby, the cost of shipping a unit from A_i to Bj , is computed as c_{ij}. As well as, the problem in determining the optimal distribution pattern consists of the pattern for which shipping costs are at a minimum. Moreover, the requirements of the destinations B_j , j = 1, . . ., n, must be satisfied by the supply of available units at the points of origin A_j , i = 1, . . .,m.

If x_{ij} is the number of units that are shipped from A_i to B_j , then the problem in determining the values of the variables x_{ij}, i = 1, . . ., m and j = 1, . . ., n, should minimize the total of the shipping costs.

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

Mathematically, the transportation problem can be represented as a linear programming model. Since the objective function in this problem is to minimize the total transportation cost as given by the following equation:

$$Z = c_{11}x_{11} + c_{12}x_{12} + \dots\dots c_{mn}\, x_{mn}$$

The above equation is a mathematical formulation of a transportation problem known as objective function. This technique can be used in different areas such as improving the distribution policy of a food industrial group [1]. However, The LP technique can be generally used to intelligent transportation system (ITS)[2]. The transportation solution problem can be found with a good success in the improving the service quality of the public transport systems [3] along with modeling of taxi services [4]. It can be used in defining relationships between logistics and transportation [5] and for Urban Transportation Network Design Problem (UTNDP)[6].These methods are also found effective in scientific fields like oxygen requirement[7]and others. These Typically, the standard scenario for solving transportation problems is working by sending units of a product across a network of highways that connect a given set of cities.

1.1 Transportation model

In a transportation problem the points may represent factories to produce items, and to supply a required quantity of the products to a certain number of destinations. This process must be done successfully in such a way as to maximize the profit or minimize the cost transportation. Therefore, the places of production and supply are collected as the original points and the destinations respectively. Sometimes the original and destinations points are also termed as sources and sinks. However, to illustrate a typical transportation model, suppose that m factories supply certain items to n warehouses. As well as, let factory i (i = 1, 2, …, m) produces a_i units, and the warehouse j (j = 1, 2, …, n) requires b_j units. Furthermore, suppose the cost of transportation from factory i to warehouse j is c_{ij}. The decision variables x_{ij} is being the transported amount from the factory i to the warehouse j.

1.2 FUTURE PROSPECTS

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2. REFERENCE EXAMPLE

A dairy farm has three plants located in a state. Daily milk production of each plant is as follows [9]:
Plant 1…. 6 million litres,
Plant2…. 1 million litres, and
Plant3….10 million litres.

Each day the firm must fulfill the needs of its four distribution centres. Milk requirement at each centre is as follows
Distribution centre 1…. 7 million litres,
Distribution centre 2…. 5 million litres,
Distribution centre 3…. 3 million litres, and
Distribution centre 4…. 2 million litres.

Cost of shipping one million litres of milk from each plant to each distribution centre is given in the following table in rupees.

PLANTS	D1	D2	D3	D4	SUPPLY	
1	2	3	11	7	6	
2	1	0	6	1	1	
3	5	8	15	9	10	
DEMAND	7	5	3	2	17	17

Algorithms for solving transportation problems which are based on different linear programming methods are:

2.2 Northwest Corner Method

PLANTS	D1	D2	D3	D4	SUPPLY	
1	2_6	3	11	7	6/0	
2	1_1	0	6	1	1/0	
3	5	8_5	15_3	9_2	10/5/2/0	
DEMAND	7/1/0	5/0	3/0	2/0	17	17

Z=[2*6+1*1+8*5+15*3+9*2] = 116

2.3 Row Minimum Method

PLANTS	D1	D2	D3	D4	SUPPLY	
1	2_6	3	11	7	6/0	
2	1	0_1	6	1	1/0	
3	5_1	8_4	15_3	9_2	10/9/5/2/0	
DEMAND	7/1/0	5/4/0	3/0	2/0	17	17

Z=[2*6+0*1+5*1+8*4+15*3+9*2]=112

2.4 Column Minimum Method

PLANTS	D1	D2	D3	D4	SUPPLY	
1	2_6	3	11	7	6/0	
2	1_1	0	6	1	1/0	
3	5	8_5	15_3	9_2	10/9/2/0	
DEMAND	7/6/0	5/4/0	3/0	2/0	17	17

Z=[2*6+1*1+5*0+8*5+15*3+9*2]=116

2.5 Minimum Cost Method

PLANTS	D1	D2	D3	D4	SUPPLY	
1	2_6	3	11	7	6/0	
2	1	0_1	6	1	1/0	
3	5_1	8_4	15_3	9_2	10/9/5/3/0	
DEMAND	7/1/0	5/4/0	3/0	2/0	17	17

Z=[2*6+0*1+5*1+8*4+15*3+9*2]=112

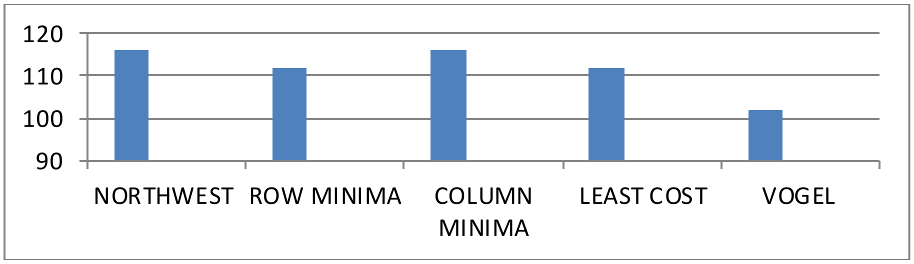
2.6 Vogel's Approximation Method

PLANTS	D1	D2	D3	D4	SUPPLY	
1	2_1	3_5	11	7	6/1/0[1] [1] [5]←	
2	1	0	6	1_1	1/0[1]	
3	5_6	8	15_3	9_1	10/4/3/0[3][3][4]	
DEMAND	7/6/0 [1] [3] [3]	5/0 [3] [5] ↑	3/0 [5] [4] [4]	2/1/0 [6] ↑ [2] [2]	17	17

Z=[2*1+3*5+1*1+5*6+15*3+9*1]=102

3. RESULTS AND DISCUSSION

The difference among these methods is the quality of the initial basic feasible solution they produce, in the sense that a better starting solution will be the objective function. The transportation cost associated with Vogel's Approximation Method is least and comparatively lesser in Row minima and Least cost method in comparison Northwest Corner Method. We analyze that Vogel's Approximation Method yields the best starting solution and Northwest Corner Method yields the worst result though it is easier to apply.



4. CONCLUSIONS

Since Vogel approximation method results in the most economical initial feasible solution, we shall use this method for all transportation problems.

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