

Optimization of Real Time Model using Linear Programming and MATLAB

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Abstract—The Reliance Corporation is a large, fully integrated petroleum company based in India. The company produces most of its oil in its own oil field. A large distribution network is used to transport the oil to the company’s refineries and then to transport the petroleum products from the refineries to Reliance’s distribution centres. This work represents transportation problem and addresses the transportation flow of refined & processed oil from the refineries to the company’s distribution centres. The aim is to achieve the minimum cost of transportation flow, since the cost minimization directly relates to the company’s profitability of which is representing operation efficiency. The transportation model is converted into linear programming problem and is solved using MATLAB software. The models were studied based on a real time data model and as example of transportation flow of oil from various refineries to various distribution centres.

Keywords—Transportation, Linear Programming, MATLAB, OIL Refinery.

I. INTRODUCTION

Linear programming is used for optimization of a function (maximization or minimization) of variables known as *objective function*, subject to set of linear equalities or inequalities known as *constraints*. The objective function may be used to define profit, cost, production capacity or any other measure of effectiveness, which is to be obtained in the best possible or optimal manner. The constraints may be imposed by different sources such as market demand, production processes and equipment, storage capacity; raw material availability etc. Linearity is a mathematical expression in which variables do not have powers.

All organizations have men at their disposal, also machines, material and money, the supply of which may be fairly limited. If the supply of these resources were infinite, there would be no need for management tool like linear programming at all. As the quantity of resources supplied is limited, the management needs to find the best allocation of its resources in order to maximize their profit or minimize the loss or utilize the production capacity to maximum extent.

II. METHODOLOGY

The procedure used for solving this problem by Linear programming approach is explained with the help of an example.

Consider the table below:

Table 1: Table for Linear Programming Problem

Supply from	Cost per unit			Supply
	P	Q	R	
M1	a	b	c	S1
M2	d	e	f	S2
M3	g	h	i	S3
Demand	D1	D2	D3	D1+D2+D3=S1+S2+S3

It is required to determine how much the commodity must be transported from each supply center to each distribution center so that the total transportation cost is minimized.

Step 1:

From the study of the situation find the key decision to be made. In this given situation key decision is to decide the amount of commodity that must be transported from supply centres to distribution centres such that the transportation cost is minimized.

Step 2:

Assume symbols for variable quantities noticed in step 1. Let the amounts of commodities be $X_{11}, X_{12}, X_{13}, X_{21}, \dots, X_{33}$.

Step 3:

Express the feasible alternatives mathematically in terms of variables. Feasible alternatives are those which are physically and economically possible. In this given situation, $X_{11}, X_{12}, \dots, X_{33} \geq 0$ since negative commodity to be transported has no meaning and is not feasible.

Step 4:

Mention the *objective* quantitatively and express it as a linear function of variables. In the present situation, objective is to maximize profit. i.e. minimize

$$Z = aX_{11} + bX_{12} + cX_{13} + dX_{21} + eX_{22} + fX_{23} + gX_{31} + hX_{32} + iX_{33}$$

Step 5:

Put into words the *constraints*. These occur generally because of limit on availability or demands. Express these constraints in terms of variables, which in this case are on supply and demand for each centre.

$$X_{11} + X_{12} + X_{13} \leq S1$$

$$\text{Similarly } X_{11} + X_{21} + X_{31} \leq D1$$

And so on....

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a. Real Data for the project

We have taken the data of Reliance corporation which is a fully integrated petroleum company based in India. The company produces oil in its own occupied oil fields. A large distribution network is used to transport the oil to the company's refineries and then to transport the petroleum products from the refineries to Reliance's distribution centres. For this project, we have taken the data for all the company's refineries and its distribution centres which is given below:

Supply data for each Refinery:-

- 1.) Mumbai (HPCL) = 100 million barrels
- 2.) Mumbai (BPCL) = 60 million barrels
- 3.) Jamnagar = 80 million barrels
- 4.) Deogarh = 80 million barrels
- 5.) Koyali = 60 million barrels
- 6.) Vadinar = 70 million barrels

Demand data for each distribution centre:-

- 1.) Panvel = 100 million barrels
- 2.) Thane = 80 million barrels
- 3.) Surat = 80 million barrels
- 4.) Raigarh = 100 million barrels
- 5.) Pune = 40 million barrels
- 6.) Vadodara = 50 million barrels

Distribution centers →

Table 2: Cost data for shipping oil to a distribution center

Refinery	Panvel	Thane	Surat	Raigarh	Pune	Vadodara	Supply
Mumbai (HP)	6.5	5.5	6	8	5	6	100
Mumbai (BP)	7	5	4	7	6	7	60
Jamnagar	7	8	4	3	5	4	80
Deogarh	8	6	3	2	4	3	80
Koyali	5	4	3	6	4	5	60
Vadinar	4	3	1	5	6	2	70
Demand	100	80	80	100	40	50	450

Now let us assume some variables:

- X_{11} = oil from Mumbai (HP) to Panvel
- X_{12} = oil from Mumbai (HP) to Thane
- X_{13} = oil from Mumbai (HP) to Surat
- X_{14} = oil from Mumbai (HP) to Raigarh
- X_{15} = oil from Mumbai (HP) to Pune
- X_{16} = oil from Mumbai (HP) to Vadodara

- X_{21} = oil from Mumbai (BP) to Panvel
- X_{22} = oil from Mumbai (BP) to Thane
- X_{23} = oil from Mumbai (BP) to Surat
- X_{24} = oil from Mumbai (BP) to Raigarh
- X_{25} = oil from Mumbai (BP) to Pune
- X_{26} = oil from Mumbai (BP) to Vadodara

- X_{31} = oil from Jamnagar to Panvel
- X_{32} = oil from Jamnagar to Thane
- X_{33} = oil from Jamnagar to Surat
- X_{34} = oil from Jamnagar to Raigarh
- X_{35} = oil from Jamnagar to Pune
- X_{36} = oil from Jamnagar to Vadodara

- X_{41} = oil from Deogarh to Panvel
- X_{42} = oil from Deogarh to Thane
- X_{43} = oil from Deogarh to Surat
- X_{44} = oil from Deogarh to Raigarh
- X_{45} = oil from Deogarh to Pune
- X_{46} = oil from Deogarh to Vadodara
- X_{51} = oil from Koyali to Panvel
- X_{52} = oil from Koyali to Thane
- X_{53} = oil from Koyali to Surat
- X_{54} = oil from Koyali to Raigarh
- X_{55} = oil from Koyali to Pune
- X_{56} = oil from Koyali to Vadodara

- X_{61} = oil from Vadinar to Panvel
- X_{62} = oil from Vadinar to Thane
- X_{63} = oil from Vadinar to Surat
- X_{64} = oil from Vadinar to Raigarh
- X_{65} = oil from Vadinar to Pune
- X_{66} = oil from Vadinar to Vadodara

So the objective function based on the cost matrix is as follows:

$$Z = 6.5X_{11} + 5.5X_{12} + 6X_{13} + 8X_{14} + 5X_{15} + 6X_{16} + 7X_{21} + 5X_{22} + 4X_{23} + 7X_{24} + 6X_{25} + 7X_{26} + 7X_{31} + 8X_{32} + 4X_{33} + 3X_{34} + 5X_{35} + 4X_{36} + 8X_{41} + 6X_{42} + 3X_{43} + 2X_{44} + 4X_{45} + 3X_{46} + 5X_{51} + 4X_{52} + 3X_{53} + 6X_{54} + 4X_{55} + 5X_{56} + 4X_{61} + 3X_{62} + 1X_{63} + 5X_{64} + 6X_{65} + 2X_{66}$$

The constraints, to which the objective function is subjected to, are formulated based on supply data and demand data.

They are as follows:

- 1.) $j=(1-n); \sum X_{ij}=S_i \quad (i = 1,2,3,\dots)$
 - i.e. a.) $X_{11} + X_{12} + X_{13} + X_{14} + X_{15} + X_{16} = 100$
 - b.) $X_{21} + X_{22} + X_{23} + X_{24} + X_{25} + X_{26} = 60$
 - c.) $X_{31} + X_{32} + X_{33} + X_{34} + X_{35} + X_{36} = 80$
 - d.) $X_{41} + X_{42} + X_{43} + X_{44} + X_{45} + X_{46} = 80$
 - e.) $X_{51} + X_{52} + X_{53} + X_{54} + X_{55} + X_{56} = 60$
 - f.) $X_{61} + X_{62} + X_{63} + X_{64} + X_{65} + X_{66} = 70$
- 2.) $i=(1-n); \sum X_{ij}=D_j \quad (j = 1,2,3,\dots)$
 - i.e. a.) $X_{11} + X_{21} + X_{31} + X_{41} + X_{51} + X_{61} = 100$
 - b.) $X_{12} + X_{22} + X_{32} + X_{42} + X_{52} + X_{62} = 80$
 - c.) $X_{13} + X_{23} + X_{33} + X_{43} + X_{53} + X_{63} = 80$
 - d.) $X_{14} + X_{24} + X_{34} + X_{44} + X_{54} + X_{64} = 100$
 - e.) $X_{15} + X_{25} + X_{35} + X_{45} + X_{55} + X_{65} = 40$
 - f.) $X_{16} + X_{26} + X_{36} + X_{46} + X_{56} + X_{66} = 50$
- 3.) $X_{1,j} \geq 0$

III. SOLUTION

Once the objective function is formed, and all the constraints, to which the objective function is subjected to, are formed, the problem set up is complete. This shows that the transportation problem has been transformed into Linear Programming problem and is ready for solution. Following the problem set up, the equations are solved in order to get the results which include the



amount of oil to be transported from refinery to distribution centre which will give us the minimum transportation cost. There are many ways to solve an LPP, such as graphical method, SIMPLEX method, etc. But due to the relative complexity of the problem, we will solve the equations in MATLAB software. A MATLAB code is prepared according to the formulated objective function and constraints. This will be run in MATLAB software which will give us the desired results through successive iterations and computations.

The MATLAB output for the Oil Company transportation problem:

OBJECTIVE FUNCTION VALUE
MINIMUM COST

fval = 1.7000e+003 = \$1700 million

Variable Barrel load annually (millions)

X ₁₁	47.9834
X ₁₂	12.0166
X ₁₃	0.0000
X ₁₄	0.0000
X ₁₅	40.0000
X ₁₆	0.0000
X ₂₁	0.0000
X ₂₂	60.0000
X ₂₃	0.0000
X ₂₄	0.0000
X ₂₅	0.0000
X ₂₆	0.0000
X ₃₁	0.0000
X ₃₂	0.0000
X ₃₃	5.9092
X ₃₄	51.6432
X ₃₅	0.0000
X ₃₆	22.4476
X ₄₁	0.0000
X ₄₂	0.0000
X ₄₃	4.0908
X ₄₄	48.3568
X ₄₅	0.0000
X ₄₆	27.5524
X ₅₁	52.0166
X ₅₂	7.9834
X ₅₃	0.0000
X ₅₄	0.0000
X ₅₅	0.0000
X ₅₆	0.0000
X ₆₁	0.0000
X ₆₂	0.0000
X ₆₃	70.0000
X ₆₄	0.0000
X ₆₅	0.0000
X ₆₆	0.0000

IV. RESULTS AND DISCUSSION

After successful iterations using MATLAB, the optimal solution of \$1700 million is computed. (To solve this LP by hand would have required computations for at least six

simplex tables).

The \$1700 million represents the minimum annual costs for the Oil Company Reliance from six refineries to six distribution centers. We can use the values in the Barrel load column to assign values to our variables and determine the barrel haul transportation. For variable X₁₁, which is Mumbai (HP) to Panvel, the value- Barrel load annually – is 48 million approx. For variable X₂₂, which is Mumbai (BP) to Thane, the value is 60 million; and from X₃₁, Jamnagar to Panvel, the value is zero, so no barrels will be hauled from Jamnagar to Panvel, and so on.

Distribution centers →

Table 3: Reliance Company barrel load haul (approximated)

Refinery	Panvel	Thane	Surat	Raigarh	Pune	Vadodara	Supply
Mumbai (HP)	48	12	0	0	40	0	100
Mumbai (BP)	0	60	0	0	0	0	60
Jamnagar	0	0	6	52	0	22	80
Deogarh	0	0	4	48	0	28	80
Koyali	52	8	0	0	0	0	60
Vadinar	0	0	70	0	0	0	70
Demand	100	80	80	100	40	50	450

Table 4: Annual shipping cost to a distribution center

Barrel load per day (Millions)	Cost per barrel (in \$)	Total cost (Millions of \$)
48	6.5	312
12	5.5	66
40	5	200
60	5	300
6	4	24
52	3	156
22	4	88
4	3	12
48	2	96
28	3	84
52	5	260
8	4	32
70	1	70

Total = 1700

V. CONCLUSION

In this project the real time data was taken from Reliance Corporation, which is a fully integrated petroleum company based in India. The transportation problem was constructed on the oil supply data from the company's refineries and the demand of its distribution centres. This transportation model is then converted into Linear Programming problem and subsequently also the objective function and all the constraints were formulated. The equations are solved so as to minimize the transportation cost for the transportation of oil from the refineries to distribution centres.



