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Solving Transportation Problem Using Linear Programming

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Abstract:
Management should be effective and efficient in resource for various activate to regularly meet the eventual objectives. Delivering goods the lowest cost has become such an environment amidst fire completion that minimizing transpiration cost has become a challenge for companies. This study sheds light on linear programming and spreadsheet applications that promote transportation at the least cost. In this study, we have only analyzed how we can minimize the minimum transportation cost of the polymer, which given additional benefit to the companies.

Keyword: *Transportation cost, linear programming, balance sheet*

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I. Introduction:

In- charge and efficient business of supply and products and services is necessary and important for ever yen taking the finished products to the market at minimum cost creates hung potential for cost savings and as a result the profit of the company can also be maximized. Any company in India wants to optimize its distribution plan for its products in relation to transportation cost. It has always been observed that in this competitive business environment both the transfer and cost of products are almost the same. That is way the price of the delivered price also varies due to the distance between consumers and supplies being different. The choice of the quantity supplied here, like the place where the place of delivery and the place of delivery, are widely used to cause the problem of transportation and these are known as the transport problem. Its only aim is to reduce the cost of various goods from one place to another so that each arrival zone can be given full benefit and each supply can be operated within the right price. If we improve the transportation plan the bottom line of any company has a significant impact, one Research shows that if the transportation cost is reduced by 10 percent then sales increase 60 percent. it is generally observed that delivery cost range from 10 percent to 15 percent this can include all expenses if we talk about a bare house personnel and transportation expenses about 50 percent would be responsible for many transportation problem. Here linear programming and spreadsheets are being used to determine the minimum cost of polymer from four supply point to four parts levels

1. Solving the Transportation Problem in Operation Research

We define the transport problem here in such a way as to use a network in a given factory to deliver goods to the destination, that is, the warehouse, to reduce costs to some extent. And use the algorithm that can reduce on the following reasons.

- ❖ The amount of expenditure on supply and goods warehouse from each source.
- ❖ Transport cost of transporting goods from each source to destination.

But one problem has to be noted here that from the production point of demand the number of demand can also be more than one go down, hence the following types of transportation problem can also be done in operational research.

a. Balance transport problem.
b. Unbalanced transport problem.

There is also a possible solution for a transport problem.

Aggregate supply = Aggregate demand

If we talk about the basic variable of the transport problem, then this (m+n-1) number should be. Possessing this possible solution is a (m+n-1) positive means.

1.1- What is linear programming?

Linear programming is a simple technique where we solve complex to complex problems by means of a linear worker, but the use of programming occurs every in our daily lives. When we leave our office from home, we prefer to go the shortest route. You use linear programming every day. If you operate a courier office then you have an efficient strategy for efficient delivery is required.

➢ ***Example of linear programming problem***.

❖ Suppose a postman has six lattes in one day to deliver a letters and his office is at point A and the point for delivered is P,Q,R,S,T,U,V which is to be delivered to him at six delivery points. But the main problem here is that we have to save both our petrol and time, so the delivery boy first takes the short cut. We understand this with the help of a picture fig (01)

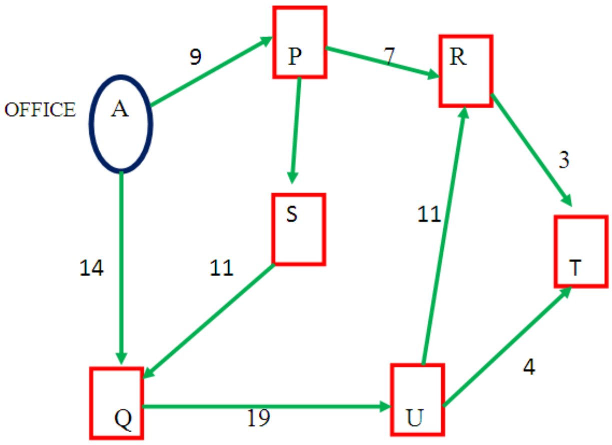

Fig (01)

That is the distributing person calculates different routes to go to all the six places and then the shortest route adopts which is called linear programming.
It is also clear from the above picture here that the postman has to deliver the letters to all six places and the process of choosing the best route is called Operation Research which has a way to operate the system.

❖ **Simplex Method -** this method is one of the most powerful and popular method for linear programming. Through this method we keep converting the values in the original step to get maximum value in the objective function. This function has a standard form of linear programming.

$Z= C_1X_1 + C_2X_2 + C_3X_3$ +----------------$+C_nX_n$

Subject to constraints

$a_{11}x_1+a_{12}x_2+$-----------------------------$+a_{1n}x_n \leq b_1$
$a_{21}x_1+a_{22}x_2+$-----------------------------$+a_{2n}x_n \leq b_2$

$a_{m1}x_1+a_{m2}x_2+$-----------------------------$+a_{mn}x_n \leq bm$

Where $x_i \geq 0$ and $b_i \geq 0$
Lazy variable add this question

$a_{11}x_1+a_{12}x_2+$-----------------------------$+a_{1n}x_n + s_1= b_1$
$a_{21}x_1+a_{22}x_2+$-----------------------------$+a_{2n}x_n + s_2 = b_2$

$a_{m1}x_1+a_{m2}x_2+$-----------------------------$+a_{mn}x_n + s_m = bm$

Where $s_i \geq 0$

Variable S_1, S_2, S_3-----------S_m is called Lazy variable

Which is a non-negative number that is added from and is added to remove the inequality?

1.2- **Transportation problem from one place to another place:**

This problem is related to large transportation to deliver goods from any supply point to any destination at minimum cost. Because each supply point has a fixed supply capacity, each destination has a certain level of demand, which transportation cost play a hung role to fulfill. This transportation problem is known as linear programming, which we try to simply with the help of linear programming. Linear programming is a power full programming that manages decision making in this way that builds mathematical models in to linear programming representing this problem and constructing it as a function.

1.3- **Transportation Networks :**

linear programming is set up to reduce cost and cater to each part, while polymer production of petroleum plants does not exceed the maximum capacity here the following conclusions can be drawn via the transportation network. Show in fig (02)

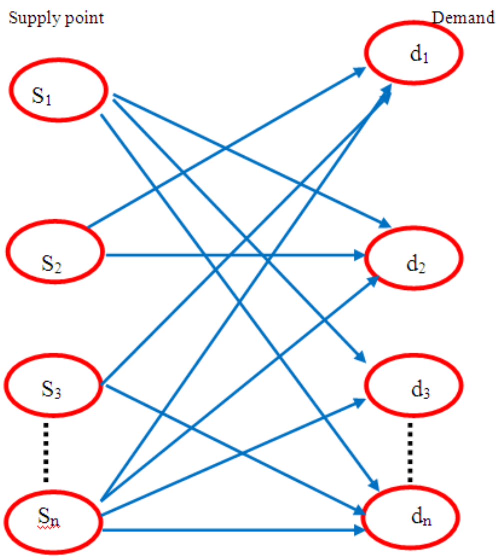

Fig (02)
(Network Representation of transport problem

- N – There is a set of supply points from which the output is shipped; it can supply only a maximum of Si units in the supply Point.
- A set of demand destination 'j' is a set on which the product is given. Demand destination must receive at least Dj of the product set.
- Each plant product at supply point' i 'and shipped to demand destination at j incur a variable cost o

Mathematics form of a linear programming based on the network in figure number is designed in which X_{ij} is the supply point according to the demand of the destination. Which is shown in the following formula to reduce any transportation cost the question here solve two problems.

$$\text{Min} \quad \sum_{i=1}^{i=n} \sum_{j=1}^{i=m} C_{ij}\, x_{ij} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{------------}(1)$$

Supply constraints

$$\sum_{j=1}^{i=n} X_{ij} \le S_i \quad , \text{where } i= 1 ,2 ,3\text{---}n\text{------}(2)$$

And demand

$$\sum_{i=1}^{j=m} X_{ij} = d_j \qquad \text{where } j= 1 ,2 ,3\text{----}n\text{----}(3)$$

But in the condition here X_{ij} should be negative

$$X_{ij} \ge 0 \text{ where } \quad i =1 ,2 ,3\text{--------}n$$
$$J =1 ,2 ,3 \text{-----------}n$$

Objective is to choose value of X_{ij} so as to, Transport cost = $C_{11}X_{11}+C_{12}X_{12}+C_{13}X_{13}+$----------------$+C_{1n}X_{1n}$

And supply problems

- Supply pint first , S_1: $X_{11}+X_{12}+X_{13}+$----------------X_{1n}
- Supply pint second , S_2: $X_{21}+X_{22}+X_{23}+$----------------X_{2n}

- And , Supply pint n , S_n: $X_{n1}+X_{n2}+X_{n3}+$----------------X_{nn}

And decrease in demand

- Demand destination first, d_1: $X_{11}+X_{21}+X_{31}+$----------X_{n1}
- Demand destination Second,d_2: $X_{12}+X_{22}+X_{33}+$-----------X_{n2}

- And Demand destination n, d_n: $X_{1n}+X_{2n}+X_{3n}+$----------X_{nn}

Mostly or observed, when linear programming is used in mathematical models, it is always in the variable and variable is always used in evaluation, therefore using mathematical excel sheet makes mathematical calculation easier, thus the data sheet of the transformation problem is as follows.
Using a data sheet that contains a very variable amount, we can easily solve it as shown in the table (01) below

	A	B	C	D	E	F	G	H	I
1									
2					Destinations				
3	Cost		D_1	D_2		D_n			
4	Source$_1$		C_{11}	C_{12}		C_{1n}			
5	Source$_2$		C_{21}	C_{22}		C_{2n}			
6									
7	Source $_n$		C_{n1}	C_{n2}		C_{nn}			
8									
9	quantity		Destinations						
10			D_1	D_2		D_n			
11	Source$_1$		X_{11}	X_{12}		X_{1n}		$\leq$	S_1
12	Source$_2$		X_{21}	X_{22}		X_{2n}		$\leq$	S_2
13									
14	Source $_n$		X_{n1}	X_{n2}		X_{nn}		$\leq$	S_n
15	Total								
16									Total
17	Demand		d_1	d_2		d_n			

Table (01)

Details calculation for the excel sheet in cell G_{11}, G_{12}, G_{13} and G_{14} are show in table and the calculation for cell C15, D15, E15, and F15 are summarized in fig ---and finally the minimum transport cost is calculated,
Cell G_{11}, G_{12}, G_{13} and G_{14}

Cells	
G_{11}	= sum (G_{11} : F_{11})
G_{12}	= sum (C_{12} : F_{12})
G_{13}	= sum (C_{13} : F_{13})
G_{14}	= sum (C_{14} : F_{14})

The changing value in the excel sheet makes it clear that the nearest solutions and the quantity of point for the transport cost of production from each supply point (C_4:F_7) is subject to supply (A_1:F_{14}) and demand constrains.

If we talk about Bharat petroleum, a trading company, it works for buying and selling petrol in large quantities, it also sells its producers to the neighboring country along with the whole of India

Here the shipping cost from the polymer from transporting petro chemical plants to different places is shown in table (2), (3), (4)

Production capacity table

Petrol plant	Production capacity
P_1	110
P_2	85
P_3	100
P_4	105

Table (02)

Shipment table

Destination	Shipment quantity
Afghanistan D_1	190
Nepal D_2	95
Bhutan D_3	45
Bangladesh D_4	70

Table (03)

Unit cost shipment

Petroleum plant	Afghanistan D_1	Nepal D_2	Bhutan D_3	Bangladesh D_4
P_1	210	315	110	500
P_2	380	320	155	660
P_3	310	255	155	580
P_4	515	410	215	720

Table (04)

➢ **Mathematics formulation -**

The mathematical formulation of the transportation problem for this study is aim at determine the optimum allocation of production capacity to each demand destination to minimum cost of transportation. There are four petrol producing plants and four demand destination under consideration

There i= 1, 2, 3, -------------and j= 1, 2, 3, -------------

Let

X_{ij}= amount to be shipped from petrol production plant (i)

To demand destination (j)

C_{ij} = unit cost of shipped from petrol production plant (i)

To demand destination (j)

This objective function is mathematically expressed as follows

The minimum shipping cost = C11

$X_{11}+C_{12}X_{12}+C_{13}X_{13}+C_{14}X_{14}+C_{21}X_{21}+C_{22}X_{22}+C_{23}X_{23}+C_{24}X_{24}+C_{31}X_{31}+C_{22}X_{22}+C_{33}X_{33}+C_{34}X_{34}+C_{41}X_{41}+C_{42}X_{42}+C_{43}X_{43}+C_{44}X_{44}$

The above restriction are expressed by linear programming

Supply constraint

- 110 supply from P_1: $X_{11}+X_{12}+X_{13}+X_{14}$
- 85 supply from P_2: $X_{21}+X_{22}+X_{23}+X_{24}$

- 100 supply from P_3: $X_{31}+X_{32}+X_{33}+X_{34}$
- 105 supply from P_4: $X_{41}+X_{42}+X_{43}+X_{44}$

And Demand

- 190 Demand for D_1: $X_{11}+X_{12}+X_{13}+X_{14}$
- 95 Demand for D_2: $X_{21}+X_{22}+X_{23}+X_{24}$
- 45 Demand for D_3: $X_{31}+X_{32}+X_{33}+X_{34}$
- 70 Demand for D_4: $X_{41}+X_{42}+X_{43}+X_{44}$

Following liner programming use of formulation in show table 05

1	A	B	C	D	E	F	G	H
	DESTINATIONS							
2	COST	D_1	D_2	D_3	D_4			
3	P_1	210	315	110	500			
4	P_2	380	320	155	660			
5	P_3	310	255	158	580			
6	P_4	515	410	215	720			
7	DESTINATIONS							
8	QUANITY	D_1	D_2	D_3	D_4			
9								
10	P_1	110	0	0	0	110	≤	110
11	P_2	0	35	0	50	85	≤	85
12	P_3	80	5	15	0	100	≤	100
13	P_4	0	55	30	20	105	≤	105
14	TOTAL	190	95	45	70			
15		=	=	=	=			
16	DEMAND	190	95	45	70			

Table (05)

These petrol company face two constraints the total supply by each plant cannot exceed the plant's capacity, secondly each destination will receive the required quantity of petrol to meet its demand,

Use of linear programming

$210X_{11}+315X_{12}+110X_{13}+500X_{14}+380X_{21}+320X_{22}+155X_{23}+660X_{24}+310X_{31}+255X_{22}+158X_{33}+580X_{34}+515X_{41}+410X_{42}+215X_{43}+720X_{44}$

II. Conclusion

The study of this paper highlights the minimization of transportation cost with the help of linear programming, in this paper we have tried to explain about the linear programming used in daily life with some examples and an attempt has also been made to explain how the petrol company can reduce its transportation cost. If the operation is done effectively and efficiently, then transportation cost can be possible even at minimum cost.

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