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Using goal programming for transportation planning decisions problem in petroleum companies

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ABSTRACT

In this paper we are revisits the transportation Problem in new perspective direction to design a model, to show the priority of Goal Programming can be applied to solve a transportation problem mechanism for one of the prominent petroleum firm in India. This paper discusses the evaluation of multiple conflicting goals in the multi-objective programming with minimizing total transportation cost in the petroleum firm with using of LGP.

A manufacturing company has several factories and it has to distribute its manufacturing goods to several distribution centers like godown, demand centers, consumers etc., the cost of transportation differs from place to place due to number of factors like local taxes, fuel taxes, labor etc., The problem is to transport all the manufactured goods to the godown and other centers. In such a manner, the total cost of transportation is minimum. In some examples instead of cost the profits on each item may differ from place to place.

From Reference [1]," The Optimal Distribution of Available Funds in Different Investment Categories by Dr. C.Ashok kumar and Dr.G.Ravindra Babu , Galaxy international interdisciplinary Research Journal, Volume 5 , issue 9, in 2017″ explains that the problem to distribute the manufacturing goods to the demand centers in such a way that the total profit is maximum. Transport models play an essential role in managing logistics and supply chain for cost reduction and service enhancement. Hitchcock first established transport problems in 1941. Different industry and business approaches have been used for the resolution of transportation problems, such as transport algorithms, linear programming, and generalized minimum cost network algorithms. The goal of all these approaches is to decrease the overall cost of transport.

From Reference [2] "Sales Management Through Goal Programming Model by C.Ashok Kumar , G.ravindra Babu, C.srinivas , international journal of Advances in Soft Computing Technology, Volume 3 , issue 1 in 2013 " ,The fundamental concept underlying most of these models' formulations is that management only tackles one goal, namely cost reduction. In reality, however, economic optimization is not just the goal of company management. Management often focuses more on other non-economic objectives that are important for their companies than the purpose of reducing costs and seeks cost reduction when seeking other non-economic goals.

In this study the linear goal programming technique that provides an analytical frame work by which a decision maker can optimize multiple and conflicting objectives.

From Reference [3] " Financial Soundness Of Selected Petroleum Companies Using Altman Z Score Model. By T.Srinivas, Pacific International Journal ,2016", explains that The backbone of any organization is financially sound. It means how they are procuring the funds and utilizing the same funds in a effective utilization. Therefore continuous monitoring is required to take corrective measures to meet the short term and long term requirements adequately.

Any financial statements are the source of information to the investors based on which the financial planning and decision making would takes places. The financial statements consist of profit & loss account and balance sheet. The Profit & loss Account provides data about operating activities of the business concern and it

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projects the profit & loss of the business. Where as balance sheet gives the information about the assets & liabilities of the business.

1. Data of the problem

The data for one of the oil industry companies in India has been collected for the purpose of this study. The supply chain starts from the refineries. At the refineries, crude oil is refined to manufacture finished oil products. This finished product is then shipped by train, road, and pipeline to various depot locations. Since all three modes of transport are not accessible at all warehouses, minimum transportation costs are considered by the methods available. As the main consumers of the petroleum products in India are the farmers and the transporters, the demand becomes more in the sowing and thrashing seasons.

From Reference [4]," Effectoveness And Illustration Of Distribution Systems And Supply Chain Management By T.Srinivas , IJECS ,2016 " explains that The modern logistic leader, use the tips like competitive pressures, mergers, acquisitions, new product lines and greater customer expectations, and so forth. This change is a cost of doing business in the latest "new economy". This research investigates the auction properties that influence efficiency (ability to maximize price and profit) as the distribution link of the supply chain. Also focuses on different key areas that are the roadmap to an effective, flexible and proactively responsive distribution operation. Also investigates the feasibility of using DEA to measure efficiency and rationalize a distribution network as an alternate approach to the conventional method of optimizing delivery routes and schedules for given supply chain management

The oil company used in this study produces the oil product at its two refineries located in northern region and supplies the product to fifteen depots located in the same regional states in northern India. To maintain confidentiality, the name of company and depots are not provided in this study Fig. 1.

Table 1(a) points out the monthly production capacity of the oil production and each depot's monthly demand and cost per metric tonne for the three plants Tables 1b and 1c

The company's strategy was to solve transport problems using standard transport algorithm or by implementing everyday linear programming problems, with a primary objective of cost reduction, and all other purposes are defined as limitations. However, in most cases, companies face multiple objectives; an alternative technique using the linear goal programming (LGP) model has been adopted. Even though all goals may not be exactly achieved under this technique, it provides the closest optimal solution satisfying the problem's given constraints.

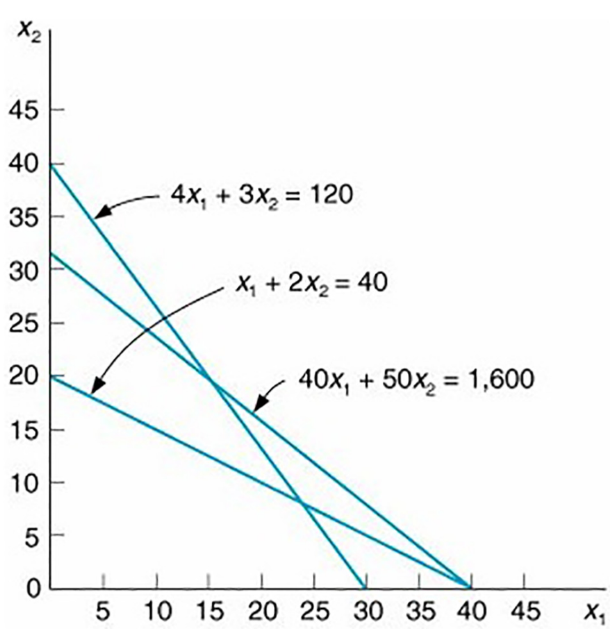

Fig. 1.

2. Working rule: Model formulation variables and constants

Decision variables, variables, and model formulation constants are defined as follows:

$X_{i,j}$ = the amount of oil to be transported from the i^{th} refinery to the j^{th} depot.

S_i = refinery output capability I

R_i = minimum quantity of oil for refinery I supply during the crisis period;

D_i = the order at the j depot

C_{ij} = transportation of the device from the i^{th} to the j^{th} depot.

TC = the overall cost of transport.

for I = 1, ..., m, j = l . . .., n

2.1. Constraints

(i) (a) Refineries have their output capacity installed. The refineries can only supply their production capacity. LGP supply constraints can be as follows:

$$\sum_{J=1}^{n} X_{i,j} + d_i^- + d_i^+ = S_i \forall i \cdots \quad (7.1)$$

(b) In the crisis phase, the target constraints can be established to ensure the minimum supply from the refineries:

$$\sum_{J=1}^{n} X_{i,j} + d_{m+i}^- - d_{m+i}^+ = R_i \forall i \cdots \quad (7.2)$$

(ii) The oil carried from refineries to the depots does not surpass the individual demand for the depots. The demand constraints can be set as follows

$$\sum_{J=1}^{n} X_{i,j} + d_{2m+j}^- - d_{m+j}^+ = D_j \forall j \cdots \quad (7.3)$$

(iii) A minimum quantity of oil should be transported from refinery I to depot j. The restriction of the goal may be as follows:

$$\sum_{i=1}^{n} X_{i,j} + d_{2m+n+j}^- - d_{2m+n+j}^+ = L_j \forall j \cdots \quad (7.4)$$

(iv) The budgetary limitation of overall transport costs can be written as follows:

$$\sum_{i=1}^{m} \sum_{i=1}^{n} X_{i,j} + d_{2m+n+j}^- - d_{2m+n+j}^+ = TC \cdots \quad (7.5)$$

2.2. The goals

Various management priorities are as follows in order of their importance:

P1 Achieve the minimum refinery supply number and minimum depot demand.

P2 Achieve the installed refinery output capacity and full depot demand.

P3 Reduce the overall cost of transport.

2.3. Goal constraints

The transportation problem LGP model constraints are formulated as follows:

Table 1a
Monthly Demand of Each Depot and Cost per Ton from Each Plant.

	To Depots	Capacity															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
From Refineries	1	41	145.1	147.1	124	272.3	196.4	255.8	153.8	46.1	107.6	119.8	72.8	408.6	370.6	414.5	100,000
	2	398.2	58.8	247.3	140.9	365.5	276.4	410.4	175.1	310.5	390	415.9	53.2	200.6	158.2	119.8	85,000
Min Demand	1260	165	3052	4220	8600	4030	10,720	5605	2015	2240	4500	15,600	1050	2018	1998		
Max Demand	2267	270	5352	6533	11,895	6140	16,724	7705	6588	6643	12,543	24,834	3663	6149	5244		

Table 1b
Decision Variable Analysis.

Decision Variable	Value	Decision Variable	Value	Decision Variable	Value	Decision Variable	Value
$X_{1,1}$	2267	$X_{1,9}$	2088	$X_{2,2}$	166.75	$X_{2,10}$	0
$X_{1,2}$	103.25	$X_{1,10}$	2413	$X_{2,3}$	2152.4	$X_{2,11}$	0
$X_{1,3}$	3199.6	$X_{1,11}$	4503	$X_{2,4}$	3393.5	$X_{2,12}$	14,200
$X_{1,4}$	3139.5	$X_{1,12}$	10,634	$X_{2,5}$	5090	$X_{2,13}$	1113
$X_{1,5}$	6805	$X_{1,13}$	0	$X_{2,6}$	2030	$X_{2,14}$	2129
$X_{1,6}$	4110	$X_{1,14}$	0	$X_{2,7}$	0	$X_{2,15}$	2005
$X_{1,7}$	16,724	$X_{1,15}$	0	$X_{2,8}$	2055		
$X_{1,8}$	5650	$X_{2,1}$	0	$X_{2,9}$	0		

Table 1c
Analysis of Objective Function.

Priority	Achievement
P_1	Achieved
P_2	Achieved
P_3	Achieved

2.4. Supply constraints

(i) (a) Both refineries have their production capacity installed. The refineries cannot have more than their ability. LGP supply constraints can be as follows:

$$\sum\nolimits_{J=1}^{15} X_{1,j} + d_i^- + d_i^+ = 100000 \forall i \cdots \tag{7.6}$$

$$\sum\nolimits_{J=1}^{15} X_{2,j} + d_i^- + d_i^+ = 85000 \forall i \cdots \tag{7.7}$$

(b) In the crisis era, the target restrictions can be presented as follows to ensure the minimum supply from refineries:

$$\sum\nolimits_{J=1}^{15} X_{1,j} + d_3^- - d_3^+ = 40000 \forall i \cdots \tag{7.8}$$

$$\sum\nolimits_{J=1}^{15} X_{2,j} + d_4^- - d_4^+ = 34000 \forall i \cdots \tag{7.9}$$

2.5. Demand constraints

(ii) The refined oil transported from the refineries to depots does not individually surpass the requirement for deposits. The LGP demand constraints can be given as follows:

$$\sum\nolimits_{i=1}^{2} X_{i,1} + d_5^- - d_5^+ = 2267 \cdots \tag{7.10}$$

$$\sum\nolimits_{i=1}^{2} X_{i,2} + d_6^- - d_6^+ = 270 \cdots \tag{7.11}$$

$$\sum\nolimits_{i=1}^{2} X_{i,3} + d_7^- - d_7^+ = 5352 \cdots \tag{7.12}$$

$$\sum\nolimits_{i=1}^{2} X_{i,4} + d_8^- - d_8^+ = 6533 \cdots \tag{7.13}$$

$$\sum\nolimits_{i=1}^{2} X_{i,5} + d_9^- - d_9^+ = 5352 \cdots \tag{7.14}$$

$$\sum\nolimits_{i=1}^{2} X_{i,6} + d_{10}^- - d_{10}^+ = 6140 \cdots \tag{7.15}$$

$$\sum\nolimits_{i=1}^{2} X_{i,7} + d_{11}^- - d_{11}^+ = 16724 \cdots \tag{7.16}$$

$$\sum\nolimits_{i=1}^{2} X_{i,8} + d_{12}^- - d_{12}^+ = 7705 \cdots \tag{7.17}$$

$$\sum\nolimits_{i=1}^{2} X_{i,9} + d_{13}^- - d_{13}^+ = 6588 \cdots \tag{7.18}$$

$$\sum\nolimits_{i=1}^{2} X_{i,10} + d_{14}^- - d_{14}^+ = 6643 \cdots \tag{7.19}$$

$$\sum\nolimits_{i=1}^{2} X_{i,11} + d_{15}^- - d_{15}^+ = 12543 \cdots \tag{7.20}$$

$$\sum\nolimits_{i=1}^{2} X_{i,12} + d_{16}^- - d_{16}^+ = 24834 \cdots \tag{7.21}$$

$$\sum\nolimits_{i=1}^{2} X_{i,13} + d_{17}^- - d_{17}^+ = 3663 \cdots \tag{7.22}$$

$$\sum\nolimits_{i=1}^{2} X_{i,14} + d_{18}^- - d_{18}^+ = 6149 \cdots \tag{7.23}$$

$$\sum\nolimits_{i=1}^{2} X_{i,15} + d_{19}^- - d_{19}^+ = 5244 \cdots \tag{7.24}$$

(iii) The refined oil exported from the refineries to the depots should not be below the depots' minimum demand. The LGP demand constraints can be given as follows:

$$\sum\nolimits_{i=1}^{2} X_{i,1} + d_{20}^- - d_{20}^+ = 1260 \cdots \tag{7.25}$$

$$\sum\nolimits_{i=1}^{2} X_{i,2} + d_{21}^- - d_{21}^+ = 165 \cdots \tag{7.26}$$

$$\sum\nolimits_{i=1}^{2} X_{i,3} + d_{22}^- - d_{22}^+ = 3052 \cdots \tag{7.27}$$

$$\sum\nolimits_{i=1}^{2} X_{i,4} + d_{23}^- - d_{23}^+ = 4220 \cdots \tag{7.28}$$

$$\sum\nolimits_{i=1}^{2} X_{i,5} + d_{24}^- - d_{24}^+ = 8600 \cdots \tag{7.29}$$

$$\sum_{i=1}^{2} X_{i,6} + d_{25}^{-} - d_{25}^{+} = 4030 \cdots \quad (7.30)$$

$$\sum_{i=1}^{2} X_{i,7} + d_{26}^{-} - d_{26}^{+} = 10720 \cdots \quad (7.31)$$

$$\sum_{i=1}^{2} X_{i,8} + d_{27}^{-} - d_{27}^{+} = 5605 \cdots \quad (7.32)$$

$$\sum_{i=1}^{2} X_{i,9} + d_{28}^{-} - d_{28}^{+} = 2015 \cdots \quad (7.33)$$

$$\sum_{i=1}^{2} X_{i,10} + d_{29}^{-} - d_{29}^{+} = 2240 \cdots \quad (7.34)$$

$$\sum_{i=1}^{2} X_{i,11} + d_{30}^{-} - d_{30}^{+} = 4500 \cdots \quad (7.35)$$

$$\sum_{i=1}^{2} X_{i,12} + d_{31}^{-} - d_{31}^{+} = 15600 \cdots \quad (7.36)$$

$$\sum_{i=1}^{2} X_{i,13} + d_{32}^{-} - d_{32}^{+} = 1050 \cdots \quad (7.37)$$

$$\sum_{i=1}^{2} X_{i,14} + d_{33}^{-} - d_{33}^{+} = 2018 \cdots \quad (7.38)$$

$$\sum_{i=1}^{2} X_{i,15} + d_{34}^{-} - d_{34}^{+} = 1998 \cdots \quad (7.39)$$

(iv) The actual cost of transport does not exceed the sum predicted.

Rs. 19,254,710

$$\sum_{i=1}^{2} \sum_{i=1}^{15} C_{i,j} X_{i,j} + d_{35}^{-} - d_{35}^{+} = 19254710 \cdots \quad (7.40)$$

2.6. The objective Function

The problem's priority structure is as follows:

$$\textbf{\textit{MinimizeP}}1\left[2d_3^- + 2d_4^- + \boldsymbol{d}_{20}^- + \boldsymbol{d}_{21}^- + \boldsymbol{d}_{22}^- + \boldsymbol{d}_{23}^- + \boldsymbol{d}_{24}^- + \boldsymbol{d}_{25}^- + \boldsymbol{d}_{26}^- + \boldsymbol{d}_{27}^- + \boldsymbol{d}_{28}^- + \boldsymbol{d}_{29}^- + \boldsymbol{d}_{30}^- + \boldsymbol{d}_{31}^- + \boldsymbol{d}_{32}^- + \boldsymbol{d}_{33}^- + \boldsymbol{d}_{34}^-\right]$$

$$\textbf{\textit{MinimizeP}}2\boldsymbol{d}_1^- + \boldsymbol{d}_2^- + \boldsymbol{d}_3^- + \boldsymbol{d}_4^- + \boldsymbol{d}_5^- + \boldsymbol{d}_6^- + \boldsymbol{d}_7^- + \boldsymbol{d}_8^- + \boldsymbol{d}_9^- + \boldsymbol{d}_{10}^- + \boldsymbol{d}_{11}^- + \boldsymbol{d}_{12}^- + \boldsymbol{d}_{13}^- + \boldsymbol{d}_{14}^- + \boldsymbol{d}_{15}^- + \boldsymbol{d}_{16}^- + \boldsymbol{d}_{17}^- + \boldsymbol{d}_{18}^- + \boldsymbol{d}_{19}^-$$

$$\textbf{\textit{Minimize P}}_{\boldsymbol{3}}\left[\boldsymbol{d}_{35}^+\right]$$

3. Results and analysis

GP transport's current issue involves 30 variables, 35 restrictions, five objectives, and an objective feature. The problem is solved with the software package QSB + . The consequence is as follows:

4. Conclusion

A study has been discussed in this paper, continuing in the previous studies, which clearly shows that in case of multiple conflicting goals the multi-objective programming like GP should be used in spite of single objective as minimizing total transportation cost, parallel to other objectives, outlined by the company that makes the problem as multi-objective. The solution is given with the use of LGP. Significantly, the study indicates that the managers should receive the priority structure of goals to achieve the goals much closely.

CRediT authorship contribution statement

Dr C. Ashok kumar: Data collection , Conceptualization , Experimental Work . **Thiruchinapalli Srinivas:** Writing Original Draft , Methodology Testing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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