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FORMULATION OF LINEAR PROGRAMMING PROBLEMS BY USING REAL LIFE PROBLEMS

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Abstract: This paper demonstrates the formulation of linear programming problem by using real-life problems. As the linear programming problem method are also applicable in higher level institutions to grow in institution, we need experienced teaching faculties, skilful administration as well as number of students also play an important role. In this problem we will maximize the profit of university against number of students required for optimal solution.

Index Terms – Linear Programming Problem

I. INTRODUCTION

A LPP is the problem of optimizing (maximizing or minimizing) of a linear function which is subject to a set of condition (teaching staff, subjects, number of students) which are expressed as a system of linear inequalities or equation.

The paper concerned for university-based problem that is one of the applications of Linear Programming problem. During the Second World War there was need of a technique which can be resolved the problem related to allocation of military resources the “**SIMPLEX METHOD**” to make decisions in management more efficiently created by George Dantzig intended to tackle the business issues and financial improvement after the second great war.

T.C Koopmans in 1951, propose the special linear programming solution to resolve the problem related to planning the optimal movement of ships back and forth across the Atlantic during the war.

[2] we had seen that how to use LP method in gold and plastic industry for maximizing the profit. [4], we can use this technique for optimization of the available resources and arrange them for maximum output. [8] is an also a real-life problem here linear programming is used for optimal use of raw material in Gorretta bakery limited, Nigeria for the purpose of profit maximization. [10] here also linear programming is used for profit maximization in product-mix company.

In present scenario linear programming problem is useful during the pandemic COVID-19 in assigning the hospital and medical centers. Whereas most of the institution has faced heavy loss in their incomes here we are solving the problem of a university to reduce the loss and maximize the profit in given sources.

II. BASIC COMPONENTS OF A LPP MODEL



III. MODEL FORMULATION

Decision variables – Decision variables are the unknown quantities and when we find the solution of Linear problem they are estimated as the output.

Objective Function – Objective functions are those real valued functions whose value can be maximized or minimized based on given constraints.

Constraints – Constraints are used to restrict the value of decision variables and helps to find the optimal solution.

Non-Negative Constraints – every decision variable in linear programming model should be positive and and if the constraints are negative then we should multiply the equation by -1 to make them positive

IV. MATHEMATICAL FORMULATION OF LPP MODEL

The general linear programming problem is stated in the following form:

Optimize (Maximum. or Minimum.) $Z = c_1A_1 + c_2A_2 + \dots + c_nA_n$

subject to constraints,

$$\begin{aligned}
 &k_{11}A_1 + k_{12}A_2 + \dots + k_{1n}A_n (\leq, =, \geq) l_1 \\
 &k_{21}A_1 + k_{22}A_2 + \dots + k_{2n}A_n (\leq, =, \geq) l_2 \\
 &\vdots \\
 &\vdots \\
 &\vdots \\
 &k_{m1}A_1 + k_{m2}A_2 + \dots + k_{mn}A_n (\leq, =, \geq) l_m \\
 &\text{and } A_1, A_2, \dots, A_n \geq 0
 \end{aligned}$$

Another representation of the above formulation is as follows:

$Z = \sum_{j=1}^n c_j A_j$ (Objective function) (1)

subject to constraints

$\sum_{j=1}^n k_{ij} A_j (\leq, =, \geq) l_i ; i = 1, 2, \dots, m.$ (Constraints) (2)

and $A_j \geq 0 ; j = 1, 2, \dots,$ (3)

Here,

- c_j s represents the per unit profit of x_j (decision variable).
- k_{ij} 's represent the amount of resource
- l_i represents the total availability

These coefficients can be positive, negative or zero.

constraint may take only one of the three possible forms

- Less than or equal to \leq
- Equal to $=$
- Greater than or equal to \geq

V. SIMPLEX METHOD

Simplex method is one of the techniques of Linear Programming problem it is used for calculating optimal solution of the problem. Its procedure helps to determine optimal solution from the set of feasible solution in systematic order of steps.

The standard form of the LP problem is expressed as:

Optimize (Max or Min) $Z = c_1A_1 + c_2A_2 + \dots + c_nA_n + 0.s_1 + 0.s_2 + 0.s_3 + \dots + 0s_m$

subject to the linear constraints

$$k_{11}A_1 + k_{12}A_2 + \dots + k_{1n}A_n + s_1 = l_1$$

$$k_{21}A_1 + k_{22}A_2 + \dots + k_{2n}A_n + s_2 = l_2$$

$$\begin{matrix} \cdot & \cdot & & \cdot & \cdot \\ \cdot & \cdot & & \cdot & \cdot \\ \cdot & \cdot & & \cdot & \cdot \\ \cdot & \cdot & & \cdot & \cdot \end{matrix}$$

$$k_{m1}A_1 + k_{m2}A_2 + \dots + k_{mn}A_n + s_m = l_m$$

and $A_1, A_2, \dots, A_n, s_1, s_2, \dots, s_m \geq 0$

Another representation of the above standard form is as follows:

$$Z = \sum_{j=1}^n c_j A_j + \sum_{i=1}^m 0s_i \quad \text{(Objective function)}$$

$$\sum_{j=1}^n k_{ij} A_j + s_i = l_i \quad ; i=1,2,\dots,m \quad \text{(Constraints)}$$

and $A_j, s_i \geq 0$, for all i and j (Non-negativity conditions)

In matrix notations the standard form is expressed as: Optimize (Maximum or Minimum) $Z = cA + 0s$ subject to constraints $aA + s = b$, and $A, s \geq 0$ where, $c = (c_1, c_2, \dots, c_n)$ is the row vector, $A = (A_1, A_2, \dots, A_n)^T$, $l = (l_1, l_2, \dots, l_m)^T$ and $s = (s_1, s_2, \dots, s_m)$ are column vectors, and A is the $m \times n$ matrix of coefficients, a_{ij} of variables A_1, A_2, \dots, A_n in the constraints.

VI. PROBLEM

A university represents three faculties. These faculties are placed on three different subjects. The time to recover one unit of each of the three subjects and the daily capacity of three subjects are given below in the table:

SUBJECTS ⇒	Operation Research	Statistics	Pure Mathematics	Hrs/ Week
FACULTIES ↓	A ₁	A ₂	A ₃	
F ₁ Faculty 1	2	3	2	30
F ₂ Faculty 2	4	-	3	24
F ₃ Faculty 3	2	5	-	12
Profit	4 Lakhs	8 lakhs	12 lakhs	

Here X₁, X₂, X₃ subjects and F₁, F₂, F₃ our faculties profit from every stream is given in the above problem. We need to find out how many students should take admission in each stream to maximise the profit of university?

VII. SOLUTION

Maximize $Z = 4 A_1 + 8 A_2 + 12 A_3$
 subjects to constraints: $2 A_1 + 3 A_2 + 2 A_3 \leq 30$
 $4 A_1 + 3 A_3 \leq 24$
 $2 A_1 + 5 A_2 \leq 12$

For the maximum solution we need to introduce the slack variable s₁, s₂ and s₃, hence

Maximize: $Z = 4 A_1 + 8 A_2 + 12 A_3 + 0.s_1 + 0.s_2 + 0.s_3$
 $: 2 A_1 + 3 A_2 + 2 A_3 + 1.s_1 + 0.s_2 + 0.s_3 = 30.$
 $4 A_1 + 3 A_3 + 0.s_1 + 1.s_2 + 0.s_3 = 24$
 $2 A_1 + 5 A_2 + 0.s_1 + 0.s_2 + 1.s_3 = 12$

B.V	C _j	4	8	2	0	0	0	X _B	X _B /Y _K
	C _B	A ₁	A ₂	A ₃	s ₁	s ₂	s ₃		
s ₁	0	2	3	2	1	0	0	30	30/3 =10
s ₂	0	4	0	3	0	1	0	24	-
s ₃	0	2	5	0	0	0	1	12	12/5 =2.4
Z _j - C _j		-4	-8	-2	0	0	0		
Now the selected element is 5 so the selected column will be 2 nd column and the selected row will be 3 rd row because in Z _j - C _j is -8 is the most negative number.									
s ₁	0	4/5	0	2	1	0	-3/5	114/5	114/10 =11.4
s ₂	0	4	0	3	0	1	0	24	24/3 = 8
A ₂	8	2/5	1	0	0	0	1/5	12/5	-
Z _j - C _j		-4/5	0	-2	0	0	8/5		
Similarly here the selected element is 3 and the 3 rd column is selected column And 2 nd row is also selected because in Z _j - C _j is -2 is the most negative number									
s ₁	0	-28/15	0	0	1	-2/3	-3/5	34/5	-
A ₃	2	4/3	0	1	0	1/3	0	8	8
A ₂	8	2/5	1	0	0	0	1/5	12/5	12/5= 2.4 =2
Z _j - C _j		4/3	0	0	0	2/3	8/5		

Thus, the optimal solution or values are:

$$A_1 = 0, A_2 = 8, A_3 = 2 \text{ and Maximum } Z = 88 \text{ lakhs}$$

SPECIAL CASES

- Some linear problems have an alternative or multiple optimal solution.
- Some linear problems have an infeasible linear solution.
- Some linear problems have unbounded solution.

VIII. CONCLUSION

We use linear programming methodology to ensure that finite sources are used without any waste and solution of problem is the best possible result for it. Here, in the above problem we find optimal solution for university's profit in the given teaching faculties and sources (subjects' specialization). According to our optimal solution for the maximum gain, if no student admitted in Operations Research stream and then only remaining two branches are enough to run the department with maximum profit.

Since every institute wants to maximize their total profit by minimizing their total loss so they need the best linear programming model for each problem and by using linear programming techniques they can reach to the optimal solution. This model is also applicable for hospitals, manufacturing plants, MNC's etc

IX. References

- [1] Berhe Zewde Aregawi, "Formulating and Solving a Linear Programming Model for Product- Mix Linear Problems with n Products". Vol. 6, issue 2.
- [2] B.I., Ezema and U., Amakon, "Optimizing profit with the linear programming Model: A case on Golden plastic industry limited enugu", Inter disciplinary Journal of Research in Business Vol 4, Is. 2 (2012) PP 37-49
- [3] Workie, G. (2017). The optimization problem of product mix and Linear programming applications: Study in apparel Industry. Open Science Journal, Vol. 2(2)
- [4] F., Majeke, "Incorporating Crop rotation requirements in a linear programming model: A case study of a rural farmer in Bindura, Zimbabwe", International Researcher Journal, Vol. 2, Is. 2 (2013) PP 101-105.
- [5] Sengupta, Debajyoti (2016). Determination of optimum product mix for profit maximization using linear programming. International journal of Engineering Research and Applications, vol. 6(1), pp. 01-05
- [6] N.P., Akpan, & I.A., Iwok, "Linear programming for optimal use of Raw materials in Bakery", International Journal of Mathematics and statistics Invention (IJMSI), Vol. 4, Is. 8 (2016) PP 51 – 57.
- [7] Myo W.W., "A Real-Life Application of Linear Programming", Dagon University Journal, Vol.4,2012.
- [8] Waheed BabatundeYahya, MuhammedKabirGarba, Samuel Oluwasuyilge, Adekunle Ezekiel Adeyosoy, "Profit maximization in a product mix company using linear programming", European Journal of Business and management Vol. 4, No. 17 (2012) PP 126-131.