Maximizing Teaching Staffs with Respect to Faculties in University

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Abstract

Making appropriate decision can succeed in all organizations. In the area of personnel management, optimum number of personnel can be proposed by applying the linear programming techniques. The purpose of this paper is to show how linear programming methodology can help to design optimum number of teaching staffs in the institute. In this paper, to maximize the teaching staff with respect to the departments and faculties, the data sets for University of Computer Studies (Sittway) are sought. In this paper, the constraints of problem, specified objective, structured mathematical model are detailed. Systematic review was done by identifying the data from the department of student affairs in UCS (Sittway). To solve the problem, simplex method can be used or Excel Solver can be used to solve the LP model. From these results, the institute can achieve the optimum number of teaching staff in respective faculties.

Keywords: Linear Programming Model, Maximization, Minimization, Optimum, Simplex Method,

1. Introduction

Linear programming is a family of mathematical programming that is concerned with or useful for allocation of scarce or limited resources to several competing activities on the basis of given criterion of optimality. In statistics, linear programming (LP) is a special techniques employed in operations research for the purpose of optimization of linear function subject to linear equality and inequality constraint. Linear programming determines the way to achieve best outcome, such as maximum profit or minimum cost in a given mathematical model and given some list of requirement as a linear equation. Linear programming is an optimization technique for a system of linear constraints and a linear objective function. In linear programming, there are the decision variables, the constraints and the objective function. In statics, linear programming is a special technique employed in operations research for the purpose of optimization of linear function to linear equality and inequality constraint. An objective function defines the quantity to be optimized and the goal of linear programming is to find the values of variables that maximize or minimize the objective function [1]. The objective of this paper is to identify the linear programming method and to optimize the teaching staff in institute.

2. Methodology

2.1. Linear Programming Techniques

The development of linear programming has been ranked among the most important scientific advances of the mid-20th century. Today, it is a standard tool that has saved many thousands or millions of dollars for most companies or businesses. It's use in other sectors of society has been spreading rapidly [2]. Linear programming is a method to achieve the best outcome (such as maximize profit or lowest cost) in a mathematical model whose requirements are represented by linear relationship [3].

2.2. Linear Programming Model

2.2.1. A Standard Form of the Model

In particular, this model is to select the values for $x_1, x_2, \ldots, x_n$ so as to

$$Maximize\ Z = c_1x_1 + c_2x_2 + \cdots + c_nx_n \quad (1)$$

Subject to the restrictions

$$a_{11}x_1 + a_{12}x_2 + \cdots + a_{1n}x_n \leq b_1 \quad (2)$$

$$a_{21}x_1 + a_{22}x_2 + \cdots + a_{2n}x_n \leq b_2 \quad (3)$$

$$\vdots \qquad \vdots \qquad \vdots \qquad \vdots$$

$$a_{m1}x_1 + a_{m2}x_2 + \cdots + a_{mn}x_n \leq b_m \quad (4)$$

and

$x_1 \geq 0, x_2 \geq 0, \ldots, x_n \geq 0,$

2.2.2. Other Forms of the Model

$$Minimize\ Z = c_1x_1 + c_2x_2 + \cdots + c_nx_n \quad (5)$$

Subject to the restrictions

$$a_{i1}x_1 + a_{i2}x_2 + \cdots + a_{in}x_n \geq b_i \quad (6)$$

$$a_{i1}x_1 + a_{i2}x_2 + \cdots + a_{in}x_n = b_i \quad (7)$$

for all values of i.

2.3. Assumptions of Linear Programming

- Proportionality assumption: The contribution of each activity to the value of the objective function Z is proportional to the level of the activity x_j, as represented by the c_jx_j term in the objective function. Similarly, the contribution of each activity to the left-hand side of each functional constraint is proportional to the level of the activity x_j, as represented by the $a_{ij}x_j$ term in the constraint[2].
- Additivity assumption: Every function in a linear programming model (whether the objective function or the function on the left-hand side of a functional constraint) is the sum of the individual contributions of the respective activities [2].
- Divisibility assumption: Decision variables in a linear programming model are allowed to have any values, including non-integer values, that satisfy the functional and non-negativity constraints. Thus, these variables are not restricted to just integer values. Since each decision variable represents the level of some activity, it is being assumed that the activities can be run at fractional levels [2].
- Certainty assumption: The coefficients in the objective function c_j, the coefficients in the functional constraints a_{ij}, and the right hand sides of the functional constraints b_i. The value assigned to each parameter of a linear programming model is assumed to be a known constant [2].

2.4. Simplex Algorithm

The steps of the simplex algorithm to obtain an optimal solution to a standard linear programming problem are as follows [3]:

- Step 1: Formulation of the mathematical model of the linear programming problem.
- Step 2: Set up the initial solution
- Step 3: Test for optimality
- Step 4: Select the variable to enter the basis
- Step 5: Test for feasibility (variable to leave the basis)
- Step 6: Finding the new solution
- Step 7: Repeat the procedure

Some observations on the simplex algorithm [4]:

- Simplex method is an iteration algorithm.
- Whenever possible, the initialization of the simplex method chooses the origin as the initial Corner Point Feasible solution.
- After the current CPF solution is identified, the simplex method examines each of the edges of the feasible region, that emanate from this CPF solution.
- The optimality test consists of simply of checking whether any of the edge give a positive rate improvement in Z. If more do, then the current CPF solution is optimal.

3. Procedural Overview

In this section, the linear programming model is applied to the number of students which is divided into the classrooms with respect to the first year to fifth year to optimize the teaching staff in the institute. The entries of student data are used. There are four faculties and one department in the institute. To formulate linear programming model, there are 48 periods in Faculty of Computing, 50 periods in Department of Language (English), 70 periods in Faculty of Computer Science, 41 periods in Faculty of Computer System and Technology and 34 periods in Faculty of Information Science to teach respectively. The objective function is to maximize the number of teaching staff in this institute.

3.1. Procedure with Data

This section explains the procedure with a corresponding data set. The required data set are sought. There are 15 periods to teach for each tutor and each assistant lecturer, 12 periods for each lecturer, 8 periods for each associate professor and 4 periods for each professor. Firstly, model the periods in the ratio of teaching staff and classrooms from first year to fifth year. The objective function is to maximize the teaching staff in the respective faculties.

3.2. Calculation

3.2.1. Requirements

Total periods for Faculty of Computing = 48
Total periods for Department of Language (English)=50
Total periods for Faculty of Computer Science = 70
Total periods for Faculty of Computer System and Technology = 41
Total periods for Faculty of Information Science = 34

3.2.2. Decision Variables

x_1= Total number of tutors
x_2= Total number of assistant lecturers
x_3= Total number of lecturers
x_4= Total number of associate professors
x_5= Total number of professors

3.2.3. Objective Function

The objective function for this problem is to maximize the teaching staffs. The maximize Z function is the linear function of number of tutors (x_1), number of assistant lecturers (x_2), number of lecturers (x_3), number of associate professors (x_4) and number of professors (x_5). To get the total teaching staff, the function Z is the summation of the total variables for number of teachers.

3.2.4. Subject to the restrictions

For Faculty of Computing, there are 48 periods to teach. And formulate the teaching periods and the total periods as the liner programming model. For Department of Language (English), there are 50 periods to teach. Also formulate the teaching periods and the total periods as the LP model. For Faculty of Computer Science, there are 70 periods, for Faculty of Computer System and Technology, there are 41 periods to teach and for Faculty of Information Science, there are 34 periods to teach. The linearly constraints are that the total sum of the periods with teaching staff is equal to the total periods. The LP models respectively are in the following:

3.2.4.1. For Faculty of Computing

$$Maximize\ Z = x_1 + x_2 + x_3 + x_4 + x_5 \quad (8)$$

Subject to the restrictions

$$12x_3 \leq 12 \quad (9)$$
$$15x_1 + 15x_2 \leq 28 \quad (10)$$
$$8x_4 + 4x_5 \leq 8 \quad (11)$$
$$15x_1 + 15x_2 + 12x_3 + 8x_4 + 4x_5 \leq 48 \quad (12)$$

3.2.4.2. For Department of Language (English)

$$Maximize\ Z = x_1 + x_2 + x_3 + x_4 + x_5 \quad (13)$$

Subject to the restrictions

$$15x_1 + 15x_2 \leq 24 \quad (14)$$
$$12x_3 \leq 16 \quad (15)$$
$$8x_4 + 4x_5 \leq 8 \quad (16)$$
$$15x_1 + 15x_2 + 12x_3 + 8x_4 + 4x_5 \leq 50 \quad (17)$$

3.2.4.3. For Faculty of Computer Science

$$Maximize\ Z = x_1 + x_2 + x_3 + x_4 + x_5 \quad (18)$$

Subject to the restrictions

$$8x_4 + 4x_5 \leq 12 \quad (19)$$
$$15x_1 + 15x_2 \leq 28 \quad (20)$$
$$12x_3 + 4x_5 \leq 16 \quad (21)$$
$$15x_1 \leq 14 \quad (22)$$
$$15x_1 + 15x_2 + 12x_3 + 8x_4 + 4x_5 \leq 70 \quad (23)$$

3.2.4.4. For Faculty of Computer System and Technology

$$Maximize\ Z = x_1 + x_2 + x_3 + x_4 + x_5 \quad (24)$$

Subject to the restrictions

$$8x_4 + 4x_5 \leq 6 \quad (25)$$
$$12x_3 \leq 16 \quad (26)$$
$$15x_1 + 15x_2 \leq 19 \quad (27)$$
$$15x_1 + 15x_2 + 12x_3 + 8x_4 + 4x_5 \leq 41 \quad (28)$$

3.2.4.5. For Faculty of Information Science

$$Maximize\ Z = x_1 + x_2 + x_3 + x_4 + x_5 \quad (29)$$

Subject to the restrictions

$$12x_3 \leq 12 \quad (30)$$
$$15x_1 + 15x_2 \leq 14 \quad (31)$$
$$8x_4 + 4x_5 \leq 8 \quad (32)$$
$$15x_1 + 15x_2 + 12x_3 + 8x_4 + 4x_5 \leq 34 \quad (33)$$

4. Results

For the respective faculties, simplex method is used to find the feasible solutions. Solving problem gives

feasible solution. There are the summarized results in the following.
Results of optimal solution:

For Faculty of Computing,
Optimum number of teaching staffs = 4.9
Teaching staffs are:
1. 2 staffs of tutor or assistant lecturer.
2. 1 staff of lecturer.
3. 2 staffs of professor or 1 staff of associate professor.

For Department of Language (English),
Optimum number of teaching staffs 4.9
Teaching staffs are:
1. 2 staffs of tutor or assistant lecturer.
2. 1 staff of lecturer.
3. 2 staffs of professor or 1 staff of associate professor.

For Faculty of Computer Science,
Optimum number of teaching staffs = 6.2
Teaching staffs are:
1. 1 staff of tutor.
2. 1 staff of assistant lecturer.
3. 1 staff of lecturer.
4. 3 staffs of professors or 1 staff of associate professor and 2 staffs of professors.

For Faculty of Computer System and Technology,
Optimum number of teaching staffs = 4.1
Teaching staffs are:
1. 1 staff of tutor or assistant lecturer.
2. 1 staff of lecturer.
3. 2 staffs of professors or 1 staff of associate professor.

For Faculty of Information Science,
Optimum number of teaching staffs = 3.9
Teaching staffs are:
1. 1 staff of tutor or assistant lecturer.
2. 1 staff of lecturer.
3. 2 staffs of professor or 1 staff of associate professor.

This paper can help to decide the optimum teaching staff with respect to faculties in this institute.

5. Conclusion

This paper has found the optimum number of teaching staffs with data processing which are obtained from the Department of Student Affairs from University of Computer Studies (Sittway) by the use of linear programming model. By anticipating these results, the principal in the institute can decide how to manage to set the staff. This paper addressed the problem of how the model should design the teaching staff with periods in the institute in order to maximize the staffs. Mathematical modeling using linear programming may be applied to problems related to optimized resource allocation in this institute. A problem of this nature was identified as a linear programming, formulated in mathematical terms and solved by simplex method or by using Excel solver. Thus, the obtained results in this paper show how many staffs can assign to teach in this institute.

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