International Journal of Scientific Research in Science, Engineering and Technology (www.ijsrset.com)
© 2020 IJSRSET | Volume 7 | Issue 3 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
DOI : https://doi.org/10.32628/IJSRSET207345

# Deciding Optimum Size to Manage Scheduling for Institution

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ABSTRACT

Teaching is essential for all education systems. Shifting the teaching schedule is also necessary to teachers in the university. Excellent time schedule improves the work effectively. To manage the time schedule, the student-teacher ratio is the important role. Student-teacher ratio is the number of students who attend a school or university divided by the number of teachers in the institution [1]. The purpose of this study is to decide the optimum size of teachers to teach in the university. Firstly, the required data are sought from the department of student affairs from University of Computer Studies (Sittway). Daily shift required teachers to teach are determined. They work five consecutive days and have two consecutive days off. Their five days of work can start on any day of the week and the schedule rotates. Then model the linear programming problem and solve this by using Simplex method (minimization case) or by using Excel solver.

**Keywords:** Linear Programming, Maximization, Minimization, Operations Research, Optimum Size, Personnel Management, Teaching Staff

## I. INTRODUCTION

The most common type of application involves the general problem of allocating limited resources among competing activities in a best possible (i.e. optimal) way. Linear programming is an optimization technique for a system of linear constraints and a linear objective function. Linear programming is useful for allocation of limited resources to several competing activities on the basis of given criterion of optimality. Linear programming is one of the most frequently and successfully applied mathematical approaches to managerial decisions. In linear programming, there are the decision variables, the constraints and the objective function. To get the optimal result, such as maximum profit or minimum cost, linear programming model is the best way. The technique of linear programming is used in agriculture, industry, transportation, economics, health system, behavioral and social science and the military. 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 [2]. A remarkably efficient solution procedure, called the simplex method, is available for solving linear programming problems of even enormous size. The objective of this paper is to identify the linear programming method to optimize the number of teaching staff and the shift plan using the time table in the university.

## II. METHODOLOGY

### A. Linear Programming

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. Linear programming is a method to achieve the best outcome in a mathematical model whose requirements are represented by linear relationship [4]. All paragraphs must be indented.

### B. Linear Programming Model

The general structure of LP model consists essentially of three components. There are the activities (variables) and their relationship, the objective function and the constraints. There are the steps to formulate mathematical model.

- Step 1: Define decision variables.
- Step 2: Formulating all the constraints imposed by the resource availability and express them as linear equality or inequality in terms of decision variables defined in step 1.
- Step 3: Defining the objective function that determines to maximize or minimize. Then express it as a linear function of decision variables multiplied by their profit or cost contributions.

#### 1) A Standard Form of the Model

The mathematical model for this general problem of allocating resources (constraints) to activities (variables) can be formulated. In particular, this model is to select the values for $x_1, x_2, \ldots\ldots, x_n$ so as to

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

Subject to the restrictions

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

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

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

and

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

#### 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.

*Z*= value of overall measure of performance

$x_j$= level of activity j (for *j=1,2,..,n*)

$c_j$= increase in Z that would result from each unit increase in level of activity *j*.

$b_j$ = amount of resource *i* that is available for allocation to activities (for *i=1,2,..,m*)

$a_{ij}$=amount of resource *i* consumed by each unit of activity *j*.

### C. Assumptions of Linear Programming

The following four basic assumptions are necessary for all linear programming models [3]:

- Certainty: In all LP models, it is assumed that all model parameters such as availability of resources, profit (or cost) contribution of a unit of decision variable and consumption of resources by a unit of decision variable must be known and constant.
- Divisibility: The solution values of decision variables and resources are assumed to have either whole numbers (integers) or mixed numbers (integer and fractional).
- Additivity: The value of the objective function for the given values of decision variables and the total sum of resources used, must be equal to the sum of the contributions (profit or cost) earned from each decision variable and the sum of the resources used by each decision variable respectively.
- Linearity: All relationships in the LP model (i.e. in both objective function and constraints) must be linear. For any decision variable, the amount of particular resource say i used and its contribution to the cost in objective function must be proportional to its amount.

### D. Simplex Method

The steps of the simplex algorithm to obtain an optimal solution to a standard linear programming problem are as follows [4]:

- 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

## III.PROCEDURAL OVERVIEW

In this section, the linear programming model is demonstrated and it is applied to decide the optimum number of teachers who start to work each day from Monday to Sunday to enter into the classrooms. There are seven days to teach in this university as there are extra classrooms for Diploma in Computer Studies, D.C.Sc.

### A. Procedure with Data

In order to better understand the process of using linear programming and how the data is reached, this section explains the procedure with a corresponding data set so as to better work. The required data set are sought. There are seven variables for daily requirements. To formulate linear programming model, there are at least 49 teachers to teach on Monday, at least 48 teachers on Tuesday, at least 45 teachers on Wednesday, at least 48 teachers on Thursday, at least 38 teachers on Friday, at least 15 teachers on Saturday and at least 15 teachers on Sunday respectively. The teachers who start to work on any day is between 0 and 30. The objective function is to minimize the number of teachers needed to teach. And this study will find the optimum size in daily required teachers in this institute.

### B. Calculation

1) Requirements

There are 49 people who are the amount of teachers needed to teach on Monday.

There are 48 people who are the amount of teachers needed to teach on Tuesday.

There are 45 people who are the amount of teachers needed to teach on Wednesday.

There are 48 people who are the amount of teachers needed to teach on Thursday.

There are 38 people who are the amount of teachers needed to teach on Friday.

There are 15 people who are the amount of teachers needed to teach on Saturday.

There are 15 people who are the amount of teachers needed to teach on Sunday.

2) Decision Variables

$x_1$ = amount of teachers who start to work on Monday,

$x_2$ = amount of teachers who start to work on Tuesday,

$x_3$ = amount of teachers who start to work on Wednesday,

$x_4$ = amount of teachers who start to work on Thursday,

$x_5$ = amount of teachers who start to work on Friday,

$x_6$ = amount of teachers who start to work on Saturday,

$x_7$ = amount of teachers who start to work on Sunday

3) Objective Function

The objective function for this problem is to optimize the minimum number of teaching staffs from Monday to Sunday in university. The minimize Z function is the summation of the linear function of teacher size who start to work on Monday ($x_1$), teacher size who start to work on Tuesday ($x_2$), teacher size who start to work on Wednesday ($x_3$), teacher size who start to work on Thursday ($x_4$), teacher size who start to work on Friday ($x_5$), teacher size who start to work on Saturday ($x_6$) and teacher size who start to work on Sunday ($x_7$). To get the total teaching staff, the function Z is the summation of the total variables for number of teachers in respective days.

4) Subject to the restrictions

On Monday, there are 49 teachers to teach. They are people who start to work on Monday, Thursday, Friday, Saturday and Sunday. On Tuesday, there are 48 teachers to teach. They are people who start to work on Monday, Tuesday, Friday, Saturday and Sunday. On Wednesday, there are 45 teachers to teach. They are people who start to work on Monday, Tuesday, Wednesday, Saturday and Sunday. On Thursday, there are 48 teachers to teach. They are people who start to work on Monday, Tuesday, Wednesday, Thursday and Sunday. On Friday, there are 38 teachers to teach. They are people who start to work on Monday, Tuesday, Wednesday, Thursday and Friday. On Saturday, there are 15 teachers to teach. They are people who start to work on Tuesday, Wednesday, Thursday, Friday and Saturday. On Sunday, there are 15 teachers to teach. They are people who start to work on Wednesday, Thursday, Friday, Saturday and Sunday. The linearly constraints are that the total sum of the teachers who start to work on any day is equal to the total teachers. The LP model respectively is in the following.

The objective function is the total number of teaching staffs needed to teach from Monday to Sunday. This is the summation of the variables that is assigned as the amount of teachers who start to work on each day.

$$Minimize\ Z = x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_7 \quad (8)$$

Subject to the restrictions

On Monday restriction

$$x_1 + x_4 + x_5 + x_6 + x_7 \geq 49 \quad (9)$$

On Tuesday restriction

$$x_1 + x_2 + x_5 + x_6 + x_7 \geq 48 \quad (10)$$

On Wednesday restriction

$$x_1 + x_2 + x_3 + x_6 + x_7 \geq 45 \quad (11)$$

On Thursday restriction

$$x_1 + x_2 + x_3 + x_4 + x_7 \geq 48 \quad (12)$$

On Friday restriction

$$x_1 + x_2 + x_3 + x_4 + x_5 \geq 38 \quad (13)$$

On Saturday restriction

$$x_2 + x_3 + x_4 + x_5 + x_6 \geq 15 \quad (14)$$

On Sunday restriction

$$x_3 + x_4 + x_5 + x_6 + x_7 \geq 15 \quad (15)$$

$$0 \leq x_j \leq 25 \quad (16)$$

And $x_j \geq 0, j = 1,2,3,4,5,6,7$

## IV.RESULTS

To solve this problem, simplex method is used to find the feasible solutions. To get feasible solution, the Excel Solver is used. Solving problem gives feasible solution. There are the summarized results in the following.

Results of optimal solution:

Minimum size (optimum size of teachers) = 53.5

This result means that the total minimum amount of teachers needed to work in this university are 53.5 numbers.

Teachers who tart to work on Monday=25

This result means that there are 25 teachers who start to work on Monday.

Teachers who tart to work on Tuesday=4.5

This result means that there are 4.5 teachers who start to work on Tuesday.

Teachers who start to work on Wednesday=0

This result means that there is no teacher who start to work on Wednesday.

Teachers who start to work on Thursday=5.5

This result means that there are 5.5 teachers who start to work on Thursday.

Teachers who start to work on Friday=3

This result means that there are 3 teachers who start to work on Friday.

Teachers who start to work on Saturday=2

This result means that there are 2 teachers who start to work on Saturday.

Teachers who start to work on Sunday=13.5
This result means that there are 13.5 teachers who start to work on Sunday.

This paper can help to manage and shift the optimum number of teachers in the university. The summarized results are shown in Table 1.

TABLE I

| Total Amount of Teachers | Amount of teachers who start to work on | | | | | | |
|---|---|---|---|---|---|---|---|
| | Monday | Tuesday | Wednesda | Thursday | Friday | Saturday | Sunday |
| 53.5 | 25 | 4.5 | 0 | 5.5 | 3 | 2 | 13.5 |

## V. CONCLUSION

This paper will be concerned with the optimum size of teachers for University of Computer Studies (Sittway). This study has found the optimum number of teaching staffs who start to work on any day 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 shift. This paper addressed the problem of how the model should design the teaching staff with periods in the institute in order to minimize the staffs. Thus, the obtained results in this paper show how many staffs can assign to teach in this institute. This paper is also applied to manage the shift resident doctors who work in government hospital.

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Ank Phyu Win , "Deciding Optimum Size to Manage Scheduling for Institution", International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET), Online ISSN : 2394-4099, Print ISSN : 2395-1990, Volume 7 Issue 3, pp. 184-188, May-June 2020. Available at doi : https://doi.org/10.32628/IJSRSET207345
Journal URL : http://ijsrset.com/IJSRSET207345