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Application of Linear Programming techniques in Personnel Management

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Abstract : *No individual or organisation can succeed without making appropriate decision. Thus decision making in today's social and business environment has become a tedious task. It is proposed to apply linear programming techniques in the area of personnel management to minimize the cost of some training programme adopted by an institution which has a very good number of employees that include teaching and non- teaching staff. The institute desires to send its employees for a training programme essential for alround development at minimum cost.*

Keywords: *Business environment , Linear programming , Modelling, Organisation, Personnel management .*

I. INTRODUCTION

Linear programming is a mathematical modelling technique useful for allocation of limited resources such as labour, materials, machines, time, cost etc. to several compelling activities.

It is known that OR came into existence as a discipline during World War II to manage scarce resources. Although a particular model and technique of OR can be traced back as early as in World War I when Thomas Edison (1914-1915) made an effort to use a tactical game board for solution to minimize shipping losses from enemy submarines. About the same time A.K.Erlang, a Danish engineer carried out experiments to study the fluctuations in demand for telephone facilities using automatic dialling equipment.

The term OR was coined as a result of research on military operations during World War II. After that a group of specialists in Mathematics, Economics, Statistics, Engineering and other physical sciences were formed as special units within the armed forces to deal with strategic and tactical problems of various military problems. Following the success of this group OR became more useful. After World War II ended, efforts were made to apply OR approach to civilian problems related to business, industry, research and Development etc. Many operation researchers continued their research after World War; consequently many important advancements were made in OR techniques. In 1947, G.B. Dantzig developed the concept of linear programming and its solution.

II. Mathematical Formulation

The problem of linear programming may be stated as that of the optimization of linear objective function of the following type:

$Z= C_1X_1+ C_2X_2+ C_3X_3+\ldots\ldots\ldots\ldots\ldots\ldots+ C_nX_n$

Subject to the linear constraints of the form:

$a_{11}x_1+ a_{12}x_2+ a_{13}x_3+\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots+ a_{1n}x_n\ (\leq \text{ or } \geq)b_1$

$a_{21}x_1+ a_{22}x_2+ a_{23}x_3+\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots+ a_{2n}x_n\ (\leq \text{ or } \geq)b_2$

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$a_{m1}x_1+ a_{m2}x_2+ a_{m3}x_3+\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots +a_{mn}x_n\ (\leq \text{ or } \geq)b_m$

where $x_1, x_2, x_3 \ldots\ldots\ldots\ldots x_n \geq 0$

These are called the non-negative constraints.

The following variables are defined as:

1. Decision variables: These are junior and senior staff from the institution. It is represented by X_1 and X_2 respectively. These variables are used in the two models formulated under the academic and non academic staff of the institution.
   X_1 = Junior Staff, X_2 = Senior Staff
2. Objective Function: In any business set up the main aim is to minimize cost and in this case; it is a minimization problem because the cost of training of staff to the establishment has to be minimized. Therefore, the objective function is given by:
   Minimize: $Z= C_1X_1+ C_2X_2$

where C_1 and C_2 are average costs associated to training of junior and senior staff for academic and non-academic staff in the institution; for this study, the cost units are unity in both cases.

3. Constraints: The constraint for this study is the time available for training as the programme is in- service training.

Department	No. of Junior Staff	No. of Senior Staff
Non-Academic Unit		
Rectory	5	20
Bursary	8	5
Library	6	3
Registry	5	15
Services	3	30
Academic Unit		
School of Mgt. Studies		
Business Adm. Dept.	-	5
Accountancy Dept.	1	6
Marketing Dept.	1	10
Banking and Finance Dept.	2	3
School of Applied Science		
Food Tech. Dept.	4	10
Science Lab Tech. Dept.	3	9
Hotel and Catering Dept.	2	8
Secretarial Dept.	1	3
Computer Science Dept.	3	-
Mathematics and Statis. Dept.	-	2
School Offices	1	5
School of Engineering		
Mechanical Eng. Dept.	5	3
Electrical Eng. Dept.	2	3
Computer Eng. Dept.	1	3
Civil Eng. Dept.	1	12
School of Environmental Studies		
Building Tech. Dept.	2	1
Estate Mgt. Dept.	1	3
Quantity Surveying Dept.	1	10
Architectural Tech. Dept.	3	10

The proposed study will demonstrate usefulness of OR in social and economic problems.

III. Data Presentation

The data used for this study has been assumed.

List of staff in various units of departments of the institution -

(i) Non-Academic — Research Model

Min. $Z = x_1 + x_2$

S.t.
$5x_1 + 20x_2 \geq 120$ Rectory Dept.
$8x_1 + 5x_2 \geq 120$ Bursary Dept.
$6x_1 + 3x_2 \geq 120$ Library Dept.
$5x_1 + 15x_2 \geq 120$ Registry Dept.
$3x_1 + 30x_2 \geq 120$ Service Dept.
$x_1 , x_2 \geq 0$

(ii) Academic

Min. $Z = x_1 + x_2$

S.t.
$5x_1 \geq 5$ Business Adm. Dept.
$x_1 + 6x_2 \geq 5$ Accountancy Dept.
$x_1 + 10x_2 \geq 5$ Marketing Dept.
$2x_1 + 3x_2 \geq 5$ Banking and Finance Dept.
$x_1 , x_2 \geq 0$

(iii) School of Applied Science

Min. $Z = x_1 + x_2$

S.t.
$4x_1 + 10x_2 \geq 5$
$3x_1 + 9x_2 \geq 5$
$2x_1 + 8x_2 \geq 5$

$x_1 + 3x_2 \geq 5$
$3x_1 \geq 5$
$2x_2 \geq 5$
$x_1 + 5x_2 \geq 5$
$x_1 , x_2 \geq 0$

(iv) School of Engineering
Min. $Z = x_1 + x_2$
S.t. $5x_1 + 3x_2 \geq 5$
$2x_1 + 3x_2 \geq 5$
$x_1 + 3x_2 \geq 5$
$x_1 + 12x_2 \geq 5$
$x_1 , x_2 \geq 0$

(v) School of Environmental Studies
Min. $Z = x_1 + x_2$
S.t. $2x_1 + x_2 \geq 5$
$x_1 + 3x_2 \geq 5$
$x_1 + 10x_2 \geq 5$
$3x_1 + 10x_2 \geq 5$
$x_1 , x_2 \geq 0$

IV. Results

Non Academic Optimum

Solution $Z = 21.05$, $x_1 = 18.94$, $x_2 = 2.10$

Integer optimum $z = 21$, $x_1 = 19$, $x_2 = 2$

From the solution to the problem for non-academic staff using integer optimum solution, The minimized objective function is given as $z = 21$, x_1 (Junior staff) is 19 and x_2 (Senior staff) is 2 which implies that 19 junior staff and 2 senior staff from the non-academic staff should be sent for training programme which will cost 19 multiply by the cost of training Junior staff plus 2 multiply by the cost of training senior staff.

Academics

School of Management

Solution : Optimum $z = 2$, $x_1 = 1$, $x_2 = 1$

From the solution of the model for academic staff (School of Management) we find that one Junior staff and one senior staff should be sent for training programme which will cost 1 multiply by the cost of training Junior staff plus 1 multiply by the cost of training senior staff.

School of Applied Science

Solution optimum $Z = 4.16$, $x_1 = 1.66$, $x_2 = 2.5$

Integer optimum $Z = 4$, $x_1 = 2$, $x_2 = 3$

From the solution of the model we find that 2 junior staff and 3 senior staff should be sent for the training programme which will cost 2 multiply by the cost of training junior staff and 3 multiply by the cost of training senior staff.

V. Conclusion

The objective of this study is to apply the linear programming techniques in the effective use of resources for staff training in the institution. The study uses the Junior and Senior staff as decision variables. The results show that the no. of Junior and Senior staff from each unit (non-academic and academic) that should be sent for training programme can be reduced.

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