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Application of Linear Programming Techniques for Staff Training

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Abstract:- ***The positive or negative outcome that an individual or a big firm experiences, depends mostly on the ability of making appropriate decision. This work includes the application of linear programming in the area of minimizing the cost of staff training. The method gives an optimum solution to all the models formulated. If data collected may not give a feasible solution, when such a situation occurs the model needs to be reformed to give an optimum solution. However, this study recommends to the management of the Vadodara Institute Of Engineering, the number of staff members (permanent and adhoc) to be sent for training program when there is need for such in the teaching and non-teaching sections of the institution.***

Keywords: **linear programming, management, training programme, constraint, objective function, minimize, model, operations research, simplex algorithm, software matlab**.

I. INTRODUCTION

Every day people are posed with options and choices to make. In the many actions and situations that individuals face each day, decisions have to be made. To some, decision making seems like a complicated and difficult thing to do. According to studies, a lot of people are poorer in coming up with decisions than they think. That is why leaders exist to take the role of decision makers for the group or team. Yet, a good knowledge of the concept of decision making, the skills needed, and some tools or techniques to be used will help in developing sound decisions. Decision making [5] is the study of determining and choosing among options or alternatives based on the preferences and values of the individual. An important factor in decision making is the existence of choices and options. Apart from considering these choices and identifying them, the more important actions to do are: Choosing the best alternative that can impact success and effectiveness. Picking a choice that is most suitable to a situation, individual goals, preference, lifestyle, values, and many other factors. Decision making is the process of reducing any hesitation or uncertainty about the available options in order to attain a practical and sensible choice. Part of making decisions is gathering information before making the best choice. Sometimes, people can still be unsure of the decisions made due to lack of sufficient research and knowledge of the alternatives. With good amount of knowledge, the risk probability of one decision is reduced. Also, uncertainty is lessened yet not totally eliminated. Because making of a decision [5] requires a high understanding ability of any situation. For the developments and application of specific operational research techniques to capture the optimal choice among several options of action available, which will include numerical values, linear programming (matlab) as a tool of operations research may be used where there is a need to formulate a mathematical model to represent the problem. In [1] author has explained detailed study of linear programming.

Process of decision making [4] includes following:-

- Identifying a problem
- Identifying decision criteria
- Allocating weights to criteria
- Developing alternatives
- Analyzing alternatives
- Selecting an alternative
- Implementing the alternative
- Evaluation (of decision effectiveness)

To make following decisions easier we need lpp tools from Operation Research. The practice of Operations Research (OR) approach must maintain with above said trends in the global age. It is said that OR approach does not frequently meet the needs of business and industry. Often the reasons for failure are behavioral in nature, and lack of implementation process, however, the definition, analysis, modeling and solution phases of creative problem solving abilities of the decision maker. Concentrating on the development and application of specific operations research techniques to determine the optimal choice among several courses of action, including the evaluation of specific numerical values (if required), we need to construct mathematical model . The formulation of a model is important because it represent the situation of system requiring competent decision-analysis. The term formulation referred to the process of converting the verbal description and numerical data into mathematical expressions, which represents the relationship among relevant decision variables, objective and constraints on the use of resources. Linear programming (LP) is a mathematical modeling technique useful for allocation of limited resources, such as labour, materials, machine, time, warehouse space, capital, energy, etc to several competing activities, such as products, services, job new equipment, projects etc, on a basis of given optimality . The word scarce resources mean resources that are not available in infinite quantity during the planning period. The criterion for optimality is either performance, return on investment, profit cost, utility, time, distance etc.

II. NEED FOR THIS STUDY

The purpose of this study is to help employees to develop maximum effectiveness in their present and

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future jobs. It also means that training is a continuous process [1], starting with the introduction of employees to their first jobs and continuing throughout their careers. Organization would then direct the training process toward a number of different but compatible objectives such as, employee orientation, skill development, attitude change and how to teach in better way. Employee training is a major undertaking for employers. Provide a report on how the management of Vadodara Institute Of Engineering, can have effective and judicious use of scarce resources when it comes to Staff training in the institution. The basic questions arises are

1. Is the current method which we use in staff selection for training favours all staff?
2. Is the resources available with us sufficient for staff training when the needs arises?
3. Does any other means of staff selection that can minimize cost of staff training?

III. HISTORY BEHIND LITERATUR

Linear programming can be viewed as part of a great revolutionary development which has given mankind the ability to state general goals and to lay out a path of detailed decisions to take in order to "best" achieve its goals when faced with practical situations of great complexity. Our tools for doing this are ways to formulate real-world problems in detailed mathematical terms (models), techniques for solving the models(algorithms) ,and engines for executing the steps of algorithms [2](computers and software).This ability began in 1947, shortly after World War II [2],and has been keeping pace ever since with the extra ordinary growth of computing power. So rapid has been the advance in decision science that few remember the contributions of the great pioneers that started it all. Some of their names are von Neumann, Kantorovich, Leontief, and Koopmans. The first two were famous mathematicians and the last received the Nobel Prize in economics. In the years from the time when it was first proposed in 1947 by the author (in connection with the planning activities of the military), linear programming and its many extensions have come into wide use. In teaching circles decision scientists (operations researchers and management scientists), as well as numerical analysts, mathematicians, and economists have written hundreds of books and an uncountable number of articles on the subject. Curiously, in spite of its wide applicability today to everyday problems, it was unknown prior to 1947. In 1949, exactly two years from the time the Linear programming was first conceived, the first conference (sometimes referred to as the Zero Symposium) on mathematical programming was held at the University of Chicago. Telling Koopmans, the organizer, later titled the proceedings of the conference, Activity Analysis of Production and Allocation Economists like Koopmans, Kenneth Arrow, Paul Samuelson, Leonid Hurwitz, Robert Dorfman, Nicholos Georgescu-Roegen, and Herbert Simon; mathematicians like Albert Tucker, Harold Kuhn, and DavidGale; and Air Force types like Marshall Wood, MurrayGeisler,all made contributions. The advent or rather the promise that the electronic computer would exist soon, the exposure of theoretical mathematicians and economists to real problems during the war, the interest in mechanizing the planning process, and last but not least the availability of money for such applied research all converged during the period 1947–1949. The time was ripe. The research accomplished in exactly two years is, one of the remarkable events of history. The proceedings of the conference remains to this very day an important basic reference, as classic The simplex method [6] turned out to be a powerful theoretical tool for proving theorems as well as a powerful computational tool. Much of the early research around 1950 by Alex Orden, Philip Wolfe at the Pentagon and by J.H. Edmonson as a class exercise in 1951 and by A. Charnes in 1952 was concerned with what to do if a degenerate solution is encountered. In the early 1950's many areas which we collectively call Mathematical Programming began to emerge. These sub fields grew rapidly with linear programming playing a fundamental role in their development. A few words will now be said about each of these. Earlier proposals such as those of von Neumann and Motzkin can also be viewed as interior methods. Commercial Applications were begun in 1952 by Charnes, Cooper and Mellon with their (now classical) optimal blending of petroleum products to make gasoline. Applications quickly spread too the commercial areas and soon eclipsed the military applications which started the field. Software The Role of Orchard-Hays.In1954, William Orchard-Hays of the Rand Corporation, wrote the first commercial-grade software for solving linear programs. Many took advantage of sparsity, and guarantee numerical stability were first implemented in his codes. As a result his software ideas dominated the field for many decades and made commercial applications possible. The importance of Orchard-Hays' contributions cannot be overstated for it stimulated the entire development of the field and transformed linear programming and its extensions for mankind interesting mathematical theory into a powerful tool that changed the way practical planning was done. Because of all these contributions in the field of LPP its become simple for us to apply LLP for day to day problem by making its mathematical model. In [2] author has explained detail study for the history behind linear programming.

IV. METHOD TO APPLY

Linear Programming is a mathematical tool for getting the optimal or the best solution for a given objective function (aim). Technically, Linear Programming may be formally defined as a method of optimizing [3] (i.e. maximizing or minimizing) a linear function including all constraints in the form of linear equations. Basic term or form of LPP is as follows:-

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Objective Function (Maximize or Minimize)

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

Non-Negative Linear Constraints

$$a_{11}X_1 + a_{12}X_2 + \cdots \ldots \ldots + a_{1n}X_n (\leq or \geq) b_1$$
$$a_{21}X_1 + a_{22}X_2 + \cdots \ldots \ldots + a_{2n}X_n (\leq or \geq) b_2$$
$$a_{m1}X_1 + a_{m2}X_2 + \cdots \ldots \ldots + a_{mn}X_n (\leq or \geq) b_m$$

Linear Programming algorithm consists of different kinds of variables based on situation such variables are as follows:-

I.

DECISION VARAIBLES: - They are permanent and adhoc staff members from the vadodara institute of engineering. It is represented by X_1 and X_2 respectively. These variables are used in the three models formulated under the teaching and non-teaching staff of the Institute.

OBJECTIVE FUNCTION:- : In any kind of business set up the main aim is to minimize cost and maximize the profit and in this case; it is a minimization problem because the cost of training of staff members 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 permanent and adhoc staff members for teaching and non-teaching staff in the vadodara institute of engineering; for this study, the cost is consider as unity.

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

ASSUMPTIONS FOR MODEL

The followings are the assumptions for the models in this research work [3].

(a)The unit cost of training is unity; this is because data on the exact cost on each staff trained could not be extracted from the source of data collection.

(b)The available time used is in days (5 days) in the teaching and non-teaching staff model. This arises as a result of the nature of the data, sometimes the days are converted to hours for uniformity of result.

Table 1: - List of Staff members in Various Departments of the Vadodara Institute Of Engineering (Dec-2013,Permanent and Adhoc)

Departments	Permanent Staff Members	Adhoc Staff Members
Teaching Staff		
Engineering Department		
Computer Engineering	4	28
Information & Technology	2	14
Mechanical Engineering	3	15
Electronic & Communication	4	12
Electrical Engineering	2	18
Civil Engineering	6	2
General Department		
Mathematics	5	8
Physics	1	2
Communication & skills	1	1
Management	0	5
Non-Teaching Staff		
Library	1	1
Admin	2	3

IV. RESEARCH MODELS

Models are based on assumption

X_1 = Permanent staff members and X_2 = Adhoc Staff members

, for both teaching and non-teaching sections.

Non-Teaching Staff

Minimize: $Z=X_1 + X_2$

Subject to constraints:

$$X_1 + X_2 \geq 5(Library)$$
$$2X_1 + 3X_2 \geq 5(Admin)$$
$$X_1, X_2 \geq 0$$

Teaching Staff

Engineering Department

Minimize: $Z=X_1 + X_2$

Subject to constraints:

$$4X_1 + 28X_2 \geq 5(Computer\ Engineering)$$
$$2X_1 + 14X_2 \geq 5(Information\ \&\ Technology)$$
$$3X_1 + 15X_2 \geq 5(Mechanical\ Engineering)$$
$$4X_1 + 12X_2 \geq 5(Electronic\ \&\ Communication)$$
$$2X_1 + 18X_2 \geq 5(Electrical\ Engineering)$$
$$6X_1 + 2X_2 \geq 5(Civil\ Engineering)$$
$$X_1, X_2 \geq 0$$

Teaching Staff

General Department

Minimize: $Z=X_1 + X_2$

Subject to constraints:

$$5X_1 + 8X_2 \geq 5(Mathematics)$$
$$X_1 + 2X_2 \geq 5(Physics)$$
$$X_1 + X_2 \geq 5(Communication\ \&\ skills)$$
$$5X_2 \geq 5(Management)$$

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$X_1, X_2 \geq 0$

V. RESULTS

The models were analyzed using computer software MATLAB (R2009a-32 bit). The results are in the form of integer optimum solution. The integer optimum solution is obtained because the decision variables are representing human beings where we cannot have decimals or fraction of human beings.

Non-Teaching Staff

Optimum:Z=4.99, $X_1 = 2.39$, $X_2 = 2.60$, Integer Optimum:Z=5, $X_1\,(\text{Permanent staff}) = 2, X_2\,(\text{Adhoc staff}) = 3$.From the solution to the model for non-teaching staff using integer optimum solution, the minimized objective function is given as Z = 5, which says that 2 of the permanent staff and 3 of the adhoc staff from the non-teaching staff should be send for training programme which will cost 2 multiply by the cost of training permanent staff plus 3 multiply by the cost of training adhoc staff. Following result obtained by using matlab.

Teaching Staff

Engineering Department

Optimum:Z=0.90,$X_1 = 0.75, X_2 = 0.25$,Integer Optimum:Z=1,$X_1\,(\text{Permanent staff}) = 1$, $X_2\,(\text{Adhoc staff}) = 0$.From the solution to the model for teaching staff (engineering department) using integer optimum solution, the minimized objective function is given as Z = 1, which says that 1 of the permanent staff and non of the adhoc staff from the teaching staff should be send for training programme which will cost 1 multiply by the cost of training permanent staff .Following result obtained by using matlab.

Teaching Staff

General Department

Optimum: Z=4.99, $X_1 = 2.00, X_2 = 2.99$,Integer Optimum: Z=5, $X_1\,(\text{Permanent staff}) = 2, X_2\,(\text{Adhoc staff}) = 3$.From the solution to the model for teaching staff(general department) using integer optimum solution, the minimized objective function is given as Z = 5, which says that 2 of the permanent staff and 3 of the adhoc staff from the teaching staff should be send for training programme which will cost 2 multiply by the cost of training permanent staff plus 3 multiply by the cost of training adhoc staff. Following result obtained by using mat lab.

VI. CONCLISION

The objective of this study is to apply the linear programming techniques in the effective use of resources for staff training in Vadodara Institute of Engineering from the non-teaching and teaching units of the institution. Following research uses the different numbers of permanent and adhoc staff members from the various departments under these units in formulating the model. The analysis was carried out using computer software MATLAB (R2009a-32 bit). Results we obtained by using another LPP methods are not unique for permanent and adhoc staff members from non-teaching staff unit and general department from teaching staff unit respectively but objective remains optimum, than also model can be adjusted to give an optimum solution by increasing numbers of staff members to achieve the desired objective. The results from these models shows that the number of permanent and adhoc staff from each unit (Non-Teaching and Teaching) that should be send for training program can be reduced, and it is optimum.

VII. RECOMMENDATIONS

The researchers strongly recommends to the management of the institution that whenever there is a program that is compulsory for the staff to attend in non-teaching and teaching units of the institution they can use these results to achieve their aim by minimizing their cost of training. From the non-teaching unit where there are two (2) departments (Library, Admin.). The management should send two (2) permanent and three (3) adhoc staff members for the training that last for five (5) days. This can be achieved by using a Big M Method also. From the teaching units, where there are two (2) departments (Engineering, General).The management should send two (2) permanent and three (3)adhoc staff members for the training that last for five (5) days from general department and one(1) permanent from engineering department. From the non-teaching staff and from the general department of teaching staff there is no feasible solution to the model formulated from the data obtained, therefore the model can be adjusted to give an optimum solution and before was achieved there is need to increase the number staff members in both non-teaching unit and general department of teaching unit to get feasible (unique) solution.

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