Goal Programming: An Application to Operating Cost Distribution of an Organization/Institution

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ABSTRACT

In the past few years, there has been a remarkable development in methodologies to solve multi-objective programming (MOP) problems. Goal programming has been one of the most widely used techniques considered in solving MOP problems because of its inherent flexibility in handling decision-making problems with several conflicting objectives and incomplete or imprecise information. In this paper we would discuss the application of Goal Programming in operating cost distribution of an organization/institution using St. Brother's Public School, Haryana, India as a case study. This paper shall help in making the masses aware of the use of Goal Programming in achieving the institution's aim economically and financially. For this case study, five goals are considered in the order of priorities namely; Employment benefits (salary and allowance), General Expenses, CAPEX (capital expenditure), Revenue and the Total budget. The data on the operating cost estimates (of year 2012 and 2013) of St. Brother's Public School, Haryana, India, is used to formulate a Goal Programming Problem and Weighted Pre-emptive Goal Programming method would be used to solve it. The process incorporates elements of operating cost and goal programming for budget reduction. It is also recommended that there should be a reliable operating cost monitoring team that could efficiently evaluate operating cost annually.

Keywords: Goal Programming, Operating Cost Distribution and Weighted Pre-emptive Goal Programming.

1. INTRODUCTION

Operating cost distribution is a difficult process that requires co-ordination and co-operation among multiple units in the organization/institution. It requires a team of active and reliable decision makers who can design an efficient and effective operating cost allocation model. Though such models exist, they do not work effectively due to existence of multiple conflicting objectives. Decision making within an organization is often characterized by an attempt to satisfy a set of potentially conflicting objectives as completely as possible in an environment composed of limited resources, divergent interests and an annoying priorities in order to deal with situations in which all objectives cannot be completely and/or simultaneously satisfied. And such decision making

capable of managing multiple conflicting goals and their priorities is the Goal Programming Model.

In daily life, so many examples are observed where the aim is to maximize and minimize (at the same time), a certain functions of one or more parameters.

Example:

- Senior manager under the gun to cut costs may decide that the best way to do so is to reduce head-count (number of people as staff). At the same time, they continue to send a message that the company's revenue-generation goals must be met. To fulfill the second goal, managers actually need more workers, which conflicts with the mandate to cut staff.
- Head of department of the institution may decide to increase CAPEX (Capital Expenditure) while simultaneously reducing the revenue.\

Ignizio [6], pointed out that actual real world problems invariably involve non-deterministic system for which a variety of conflicting inconsistent objectives exist. Goal Programming provides a way of finding a single optimal solution to such conflicting objectives simultaneously.

Simplicity and ease of use of Goal Programming has resulted in growth of its popularity in several areas such as: management of human resources, transportation, site selection, production, accounting and financial resource management, marketing and quality control, agriculture and forestry, and telecommunication [1]. Goal Programming provides more flexibility for modeling the estimation process; this flexibility provides the analyst with a platform from which his knowledge and experience can be an input to the parameter's estimation.

Goal Programming, was developed by [2]. Since then many researchers have done a lot of work about extensions of goal programming methodology (such as pre-emptive/lexicographic linear goal programming, integer goal programming (Schniederjans and Hoffman, 1992), extended lexicographic goal programming (Romero, 2001), etc.) and extensive surveys on fields of its applications ([8]; Schniederjans, 1995; [6] (such as production planning, capital budgeting planning, agricultural running planning, etc.).

2. OPERATING COST DISTRIBUTION

Operating costs are the expenses which are related to the operation of an institution or an organization or simply a business, or to the operation of a device, component, piece of equipment or facility. They are the cost of resourced used by an organization just to maintain its existence. Operating cost distribution, i.e.; budgeting:

- Provide a forecast of revenues and expenditure, i.e., construct a model of how a business might perform financially if certain strategies, events and plans are carried out.
- Enable the actual financial operation of the business.
- Establish the cost constraint for a project, program, or operation.

However, operating cost distribution emphasizes on the supremacy of the revenue constraint while budgeting, decision makers are constrained by limitation on revenue raising power and/or the perception of impending limitations and fears about the revenue sources(in Table 1)[4].

Table 1: Aims of Operating Cost Distribution Model

Item	**Incorporates**	**Aim (To)**
Employment benefits	Wages, salaries and allowances of staff and employer's social security cost.	Increase
General Expenses	Raw materials (gas, fuel, labor, electricity), rent, advertising, insurance premium, taxes.	Reduce
CAPEX (Capital Expenditure)	Funds for maintenance of property (furniture, stationery, etc.), building, equipments.	Increase
Revenue (Turnover)	Sales, service revenue, fees earned, interest income.	Increase
Total budget	Capital expenditure, Revenue, Personnel cost, Overhead cost.	Reduce

3. OBJECTIVES OF THE STUDY

The objectives of this study are:

- To apply Goal programming model to Operating cost distribution of an organization/institution; a real world problem to find optimum solution among variety of conflicting goals of St. Brother's Public School, India.
- To minimize the total weights and priorities associated with meeting the requirements for optimal Operating cost allocation of the institution.

4. SIGNIFICANCE OF THE STUDY:

The knowledge gained from this study may:

Help the organization to achieve the goals of optimum utilization of funds available for its improvement.

Assist and guide decision makers of the institution in proper allocation of operating cost.

Guide in annual forecast of budget of the organization.

5. RESTRICTION OF THE STUDY

The study is restricted to the operating cost distribution of St. Brother's Public School, India. The operating cost estimates of the institution were used for the study. The scope of this study is restricted to applications of Goal Programming approach to real life manufacturing situations in the multi-objective environment.

6. STATEMENT OF THE PROBLEM

Managing the budget is a critical task for financial decision making.

- As a result of absence of a powerful quantitative allocation model, the capital and revenue are allocated inadequately, and without order of significance.
- The funds allocated to the organizations/institutions are usually mismanaged and are not utilized properly. This results in deceleration of the growth of the institution.
- The budgets are operated negligently due to unavailability of a reliable and active budget monitoring team.
- If there were a robust allocation model, the problem of mismanagement would be solved to an extent.

7. RESEARCH METHODOLOGY

The method of Goal Programming consists of formulating an objective function in which optimization comes as close as possible to specified goals. Ijiri (1965), developed the concept of priority factors, assigning different priority levels to goals and different weights for the goals at the same priority level. [8] and [5] have discussed the subject of goal programming which is an extension of linear programming (LP).

In GP, there is no single objective function as in LP. The deviations between the goals within the given set of constraints are minimized. The objective primarily contains deviational variables that represented in two dimensions in the objective functions, a positive and a negative deviation from each sub-goal and for constraint. The objective function becomes the minimization of these deviations, based on the relative importance or priority assigned to them.

8. GOAL PROGRAMMING FORMULATION

The formulation of GP model is similar to that of LP model.The general model can be stated as follows:

Minimize: $z = \sum_i w_i (d_i^- + d_i^+)$; i = 1, 2, …, m

Subject To: $\sum_j a_{ij} + d_i^- - d_i^+ = b_i$; i = 1, 2, …, m, j = 1, 2, …., n

and $x_j, d_i^-, d_i^+ \geq 0$; for all i, j

where,

b_i = m-component column expressing m goals

a_{ij} = coefficient for the j^{th} decision variable in the i^{th} constraint

x_j = decision variable

w_i = weights of each goal

d_i^- = deviational variable representing the amount of under-achievement of i^{th} goal

d_i^+ = deviational variable representing the amount of over-achievement of i^{th} goal

In case, goals are classified in k ranks, the pre-emptive priority factors (P_1, P_2, …. and so on) should be assigned to deviational variables $d_i^-$and d_i^+ according to their order of importance.

9. BASIC STEPS IN FORMULATING THE MODEL:

The basic steps involved in formulating a goal programming model are as follows:

- Determine decision variables (the x's)
- Determine the deviational variables (the d^+ s and d^- s)
- Specify the goals
- Determine the pre-emptive priorities and assign weights
- State the objective functions of the deviation to be minimized

10. SOURCE OF DATA COLLECTION:

The data for this study is collected from St. Brother's Public School, India, mentioned in the published budget folder.

11. DATA ANALYSIS TECHNIQUE USED:

For analysis of the data collected from the Financial Planning and Management department of St. Brother's Public School, India,(year 2012 and 2013) for this study, we would use the weighted pre-emptive GP method.

12. ANALYSIS OF DATA:

The summary of operating cost estimates of the institution St. Brother's Public School, India, over the period 2012 and 2013, showing the rounded off values of Employment benefits, General expenses, CAPEX, Revenue, Total budget, are given as (in Table 2):

Table 2: Outline of Operating Cost Estimates

Goal	Allocation in □ Per Year		Total
	2012	2013	
Employment benefits	1300000	1350000	2650000
General expenses	300000	315000	615000
CAPEX	1250000	1400000	2650000
Revenue	4500000	4700000	9200000
Total budget	7350000	7765000	15115000

The figures of the operating cost estimates are large enough to make the optimization process difficult. Therefore making them short results in the following coded estimates (in Table 3).

Table 3: Coded Operating Cost Estimates

Goal	Allocation in Million □ Per Year		Total
	2012	2013	
Employment benefits	1.3	1.35	2.65
General expenses	0.3	0.315	0.615
CAPEX	1.25	1.4	2.65
Revenue	4.5	4.7	9.2
Total budget	7.35	7.765	15.115

13. ASSIGNMENT OF WEIGHTS AND PRIORITIES

The decision maker must analyze each one of the m goals in terms of whether under or over – achievement of the goal is satisfactory, then assign weights and priorities accordingly. If over-achievement is acceptable d_i^+ (surplus variable in LP) can be removed from the objective function. If under-achievement is acceptable, d_i^- (slack variable in LP) can be removed from the objective function. If exact achievement of the goal is derived, both d_i^- and d_i^+ must be included in the objective function and ranked according to their pre-emptive priority factors from the most important to the least important.

Let $w_{i,K}$ be the relative weights of the d_i variable in the k^{th} priority level for goal i, that could range from 2,3,4,5,6, the most important goal has the highest weight(in Table 4).

Table 4: Coded Operating Cost Estimates with Weights and Priorities

Goal	Allocation in Million □ Per Year		Total	Weights	Priority
	2012	2013			
Employment Benefits	1.3	1.35	2.65	5	P_1
General Expenses	0.3	0.315	0.615	2	P_2
CAPEX	1.25	1.4	2.65	4	P_3
Revenue	4.5	4.7	9.2	3	P_3
Total Budget	7.35	7.765	15.115	6	P_4

14. TARGET VALUE OF GOALS:

The target value of the goals of the budget of the institution are :

- Increase employment benefits at least up to 1.5 million □ per year.
- Reduce general expenses at most up to 1 million □ per year.
- Increase CAPEX at least up to 1.5 million □ per year.
- Increase revenue at least up to 5 million □ per year.
- Reduce Total budget up to 9 million □ per year.

15. GOAL FORMULATION

Let, x_1 = amount allocated in 2012

x_2 = amount allocated in 2013

Here, x_1, x_2 are the decision variables. For this problem, the goals would appear as:

$1.3\ x_1 + 1.35\ x_2 \geq 1.5$ (Employment benefits constraint)

$0.3\ x_1 + 0.35\ x_2 \leq 1$ (General expenses constraint)

$1.25\ x_1 + 1.4\ x_2 \geq 1.5$ (CAPEX constraint)

$4.5\ x_1 + 4.7\ x_2 \geq 5$ (Revenue constraint)

$7.35\ x_1 + 7.765\ x_2 \leq 9$ (Total budget constraint)

$x_1, x_2 \geq 0$

16. GOAL PROGRAMMING FORMULATION

Let, d_i^- = the negative deviation variable for under-achieving the i^{th} goal

d_i^+ = the positive deviation variable for over-achieving the i^{th} goal

The weighted pre-emptive goal programming model can be formulated as:

Minimize: $z = 5P_1d_1^+ + 2P_2d_2^- + 4P_3d_3^+ + 3P_3d_4^+ + 6P_4d_5^-$ (Objective function)

Subject to:

$1.3\ x_1 + 1.35\ x_2 + d_1^- - d_1^+ = 1.5$ (Employment benefits)

$0.3\ x_1 + 0.35\ x_2 + d_2^- - d_2^+ = 1$ (General expenses)

$1.25\ x_1 + 1.4\ x_2 + d_3^- - d_3^+ = 1.5$ (CAPEX)

$4.5\ x_1 + 4.7\ x_2 + d_4^- - d_4^+ = 5$ (Revenue)

$7.35\ x_1 + 7.765\ x_2 + d_5^- - d_5^+ = 9$ (Total budget)

$x_1, x_2, d_1^+, d_1^-, d_2^+, d_2^-, d_3^+, d_3^-, d_4^+, d_4^-, d_5^+, d_5^- \geq 0$

17. CONCLUSION

The complexity of operating cost distribution is a challenge to decision makers as well as researchers. This goal programming model could be a powerful tool, allowing to model the collective decision making process adapted to the context of budgeting. This model would allow a direct fusion of the decision makers with the goal of developing satisfactory solutions. We would try to solve the problem using LINGO software or LINDO API software. It is also recommended that the budget should be properly managed and utilized. An active operating cost monitoring team should monitor the operating cost of the institution timely.

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