AN APPLICATION TO BUDGETARY ALLOCATION OF AN INSTITUTION FOR ADVANCED EDUCATION BY GOAL PROGRAMMING

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In this paper we discuss the application of Goal Programming in Budgetary allocation of Institutions of advanced education using Indu Group of Colleges,Vadodara as a case study. This paper shall effect positively to the reading commuity in that, it will inform the commonalities that with the use of Goal programming problems, the aims of an organization can be achieved financially and otherwise. Data on the budget estimates of Indu Group of Colleges,Vadodara were collected from Indu Group of Colleges,Vadodara of Account Department between 2011 and 2014. Five goals in the budget estimates of the Colleges namely; Personal cost, Overhead cost ,Capital expenditure, Revenue (internally generated) and the Total budget were considered for the study in order of precedence (priorities). The data collected were used to formulate a goal programming problem and the formulated problem was solved by using Simplex method (using TORA software). Based on the solution obtained, it was discovered that the optimum value of Z (Z = 0.83) satisfied goal 1(the personal cost goal), goal 3 (capital expenditure goal) and goal 5 (the total budget goal), but failed to stisfy goal 2 and goal 4, which are Overhead cost and Revenue goals respectively. From the findings, it was concluded that the Indu Group of Colleges should come within 0.83 Crore Rs. to satisfy goal 2 and goal 4, which are Overhead cost Rs.0.83 Crore in 2014 and should be reviewed upward annually, which should be properly and timely monitored by active Governmet budget monitoring team.

Keywords: Goal Programming, Budgetary Allocation, Aspiration level and Goal Programming Algorithm.

INTRODUCTION

Budgetary allocation is a complex task that requirescooperation among multiple functional units in any institution. There is need to have a sound knowledgeoforganizationalbudgetingprocessesinordertodesignanefficientandeffectivebudgetaryallocationmodel.Despite the fact that such allocation procedureexistsintheColleges,itisnotproperlystructureddueto the presence of multiple conflicting objectives.Aformaldecisionanalysisthatiscapableofhandlingmultipleconflictinggoalsthrough the useof priorities is the Goal Programming Model.Goal programming (GP) is an extension of LinearProgramming (LP) which is a mathematical tool tohandle multiple, normally conflicting objectives.

For example,

I. TheViceChancellorofany Indu Group of Colleges maydecide toincreasecapitalexpenditureandimultaneouslyreducerevenue.

II. AGovernorofanyGujaratStatemaypromised reducetheStatedebtandimultaneouslyoffertaxrelieftoworkers.

In such situations, it will be challenging to find a singlesolutionthatoptimizestheconflictingobjectives.GoalProgrammigprovides a way of striving toward such inconsistent objectives simultaneously.

According to Ignizio (1978), Goal Programming is a tool that has been proposed as a model and approach for analysis of problems involving multiple inconsistent objectives.He pointed out that actual real world problems invariably involve non-deterministic system forwhich a variety of conflicting non-commensurable objectives exist.

The major strength of Goal Programming is itssimplicity and ease of use. This accounts for the larger number of Goal Programming applications inmany and diverse areas such as inmarketing management,production,transporatation,human resources,financialmanagement,qualitycontrol,telecomunication,information techonology, agriculture; etc.

Goal programming problems can be solved by widelyavailable linear programming computer packages as either a single linear programming, or in the case oflexicographic variant, a series of connected linear programming.Goalprogramming can therefore handle relatively large number of variables,constraints and objectives.

TYPES OF GOALS

There are three possible types of goals:

I. A lower, one-sided Goal: - This goal sets a lower limit that we do not want to fall under (but exceeding the limit is acceptable)

II. An upper, one-sided Goal:- This goal sets an upper limit that we do not want to exceed (but falling under the limit is acceptable)

III. A two sided goal:- This goal sets specific targets that we do not want to fail on either side.

VARIANTS

Goalprogrammingformulationsordered the unwanted deviations into a number of priority levels, with the minimization of a deviation in a higher priority level being of infinitely more importance than any deviation in lower priority levels. This is known as preemptive goal programming.

Ignizio (1976) gave an algorithm that shows how aPreemptive Goal Programming(PGP) can be solved as a series of linear programming model. Preemptive Goal Programming (PGP) should be used when there is a clear priority ordering amongst the goals to be achieved.

BUDGETING

Revenue budgeting is an approach to the budget decision rather than a particular budget system.
However,revenue budgeting emphasizes on the preeminence of the revenue constraint in budgeting calculations. Decision makers are constrained by actual limitation on revenue raising power and/or the perception of impending limitations and fears about the revenue sources.

The goals are:

1. Toincreasepersonnelcost(salaryandallowance of staff).
2. To reduce overhead cost;
3. To increase capital expenditure;
4. To increase revenue (internally generated);
5. To reduce the total budget.

STATEMENT OF THE PROBLEM:

The statements of the problem are as follows:

- Capital andrevenuewereallocatedinadequatelyandwithoutorder of importance. This inadequate allocation was due to not using powerful quantitative allocation models. It is observed that allocated funds were not properly utilized with the result that money allocated for the laboratories for example is diverted into hostel maintenance. In the same vain, other diversions also take place.

- It is not a hidden fact that,the funds allocated to tertiary institutions are often mismanaged. Indu Group of College is not an exception. This under developed the growth of the institution.
- There is no active budget monitoring teamwith the result that budgets are allowed tooperate any how. If there were active budget monitoring teams the problems of mismanagement and improper utilization would be reduced.

THE OBJECTIVES OF THE STUDY

The objectives of the study are as follows:

- To apply goal programming model to a real-life budgeting situation to find a compromise solution among the different conflicting goals of the Indu Group of Colleges.
- To minimize the total weights associated with meeting the annual budget requirements of the institution.

SIGNIFICANCE OF THE STUDY

The insight gained from this study will:

- Guide and assist decision makers of the institution in achieving the institution goals of optimum utilization of funds in improving the institution.
- Guide the institution in budgeting;
- Helptheinstitutiontoforecastitsbudget annually;
- Assist in Optimization/Operational Research students for further research.

LIMITATION OF THE STUDY

The study is limited to the budgetary allocation of Indu Group of Colleges.The budget estimates of the colleges were used for the study. It is also limited to Goal Programming Problems.

LITERATURE REVIEW

Multi-Objective and Multi-Criteria DecisionAnalysis

Taha(2003) said that goal programming technique is for solving multiple-objective models and the aim is to convert the original multiple objective into a single goal.Tipparate (2005) stated that goal programming extended itself by reengineering many of the prior single objective linear programming with multiple and /or conflicting(traded-off) objectives.

Wikipedia (2006) described goal programming as abranch of multiple objective programming (MOP),which in turn is a branch of multi-criteria decisionanalysis (MCDA),also known as multiple criteria decision making (MCDM).

It is also thought of as ageneralization of linear programming to handle multiple conflicting objective measures Each of these measures is given a goal or target value to beachieved.

According toWinston (1994),Suppose a decision maker has an additive linear cost function of the form:

$$C(x_1, x_2, \ldots, x_n) = c_1x_1 + c_2x_2 + \ldots + c_nx_n.$$

A decision maker with this type of cost function can often use goal programming to determine his decision.He observed that a cost function of the above form defines the same trade off between eachpair of attributes x_i and x_j

Chowdary and Slomp(2002) considered goal programming as an appropriate powerful and flexible technique for decision analysis of the troubled modern decision maker who is burdened with achieving multiple conflicting objectives under complex environmental constraints.

RESEARCH METHODOLOGY/DATACOLLECTION

GOAL FORMATION:

Let $f_i(x)$ be the mathematical representation of theobjectives which can be linear or nonlinear (usuallylinear). Let g_i be t he aspiration level, three possiblegoals are

I. $f_i(x) \geq g_i$
II. $f_i(x) \leq g_i$
III. $f_i(x) = g_i$

In regular Linear Programming, these would be hardconstraints but in Goal programming, we measure the deviation from the goal.

Goal Programming Formulation

The general form of the goal programming model is given by

$$\min Z = \sum_{i=1}^{m} (d_i^+ + d_i^-)$$

Subject to

$$\sum_{\substack{i=1 \\ j=1}}^{n,m} a_{ij} x_j + d_i^- - d_i^+ = b_i$$

$$d_i^+; d_i^-; x_j \geq 0$$

$$\min Z = \sum_{i=1}^{m} P_i(d_i^+ + d_i^-)$$

Subject to

$$\sum_{j=1}^{m} (a_{ij} x_j + d_i^- - d_i^+) = g_i$$

$$d_i^+; d_i^-; x_j \geq 0$$

$$i = 1,2,\ldots n; j = 1,2,\ldots,m$$

If the original i^{th} inequality is of the form ≤ and its $d_{i+} > 0$, then the i^{th} goal will not be satisfied.
However, d_{i+} and d_{i-} allow us to meet or violate the i^{th} goal at will.A good compromise solution aims at minimizing the amount by which each goal is violated.
In the weights method, the single objective functionis the weighted sum of the functions representing the goals of the problem. Where p_i is the preemptive factor/priority level assigned to each relative goal in rank order (that is $p_1 > p_2 > \ldots > p_n$).
The weights goal programming and the preemptive or lexicographic goal programming can be combined in model.
The weights and rank model according to Kwaketal (1991) is given by

$$\min Z = \sum_{i=1}^{n} P_i \sum_{j=1}^{m} (w_{ik}^+ d_i^+ + w_{ik}^- d_i^-)$$

Subject to

$$\sum_{j=1}^{m} (a_{ij} x_j + d_i^- - d_i^+) = g_i$$

$$d_i^+; d_i^-; x_j \geq 0$$

$$i = 1,2,\ldots n; j = 1,2,\ldots,m$$

THE BASIC STEPS IN FORMULATING GOALPROGRAMMING MODEL

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

I. Determine the decision variables;
II. Specify goals including goal types (one-way or two-way goal) and their targets;
III. Determine the pre-emptive priorities;
IV. Determine the relative weights;
V. State the minimization objective functions of the deviation; State other given requirements, example, technological constraints, non-negativity (linear goal programming;) Finally, make sure that the model can exactly specify the decision maker's preferences.

SOURCESOFDATACOLLECTIONFORANALYSIS

The data used in this research are of the secondary type as it exists in the published budgets and unpublished budget folder. The data for this study were collected from the Indu Group of Colleges Account Department.

DATA ANALYSIS TECHNIQUE

In this study, the goal formulation and weights goal by the simplex method (Big–M) by Tora package was used to analyze the weighted goal programming formulation.

Table 1 Outline of the budget estimates for the three years

ALLOCATION IN RUPEES(CRORE) / YEAR				
ITEM(GOAL)	2012	2013	2014	TOTAL
PERSONNEL COST	1,10,00,000	1,29,98,700	1,49,02,560	3,89,01,260
OVERHEAD COST	85,14,600	66,99,980	1,04,00,000	2,56,14,580
CAPITAL EXPENDITURE	36,54,000	21,50,000	24,63,780	82,67,780
REVENUE (INTERNALLY GENERATED)	2,41,10,050	2,53,00,500	2,82,00,000	7,76,10,550
TOTAL	4,72,78,650	4,71,49,180	5,59,66,340	15,03,94,170

Summary of The Budget Estimates Over TheThree Years (2012 – 2014)

Table 1 gives the budget estimates summary of the institution over the period from 2012-2014 showing the personnel cost,overhead cost,capital expenditure and revenue. programming methods were used.

Coded Budget Estimates over the Period of Three Years (2012-2014)

Table 2 Coded budget estimate for years 2012 –2014

ALLOCATION IN RUPEES(CRORER) / YEAR				
ITEM(GOAL)	2012	2013	2014	TOTAL
PERSONNEL COST	1.1	1.3	1.49	3.89
OVERHEAD COST	0.85	0.67	1.04	2.56
CAPITAL EXPENDITURE	0.36	0.21	0.25	0.82
REVENUE (INTERNALLY GENERATED)	2.41	2.53	2.82	7.76
TOTAL	4.72	4.71	5.60	15.03

Assignment of Weights to the Goals:

goal i. The most important goal has the largest weight and so on.
Let w_i be the weight for goal i, that could rangefrom 2, 4, 6,… the most important goal has the highest weight and so on.

Coded Budget Estimates And The Assigned Weights To The Goals

The table below gives the coded budget estimateand the assigned weights to the goals.

ALLOCATION IN RUPEES(CRORER) / YEAR					
ITEM(GOAL)	2012	2013	2014	TOTAL	WEIGHTS
PERSONNEL COST	1.1	1.3	1.49	3.89	8
OVERHEAD COST	0.85	0.67	1.04	2.56	2
CAPITALEXPENDITURE	0.36	0.21	0.25	0.82	6
REVENUE(INTERNALLY GENERATED)	2.41	2.53	2.82	7.76	4
TOTAL	4.72	4.71	5.60	15.03	10

ASPIRATION LEVEL (Target Value) of the Goals

The goals statements of the budget of the institution were as follows:
Goal 1: Raise Personnel Cost (Salary and allowances of staff) by at least Rs.3 Cr per annum;
Goal 2: Reduce Overhead cost by at most Rs.2.6 Cr per annum;
Goal 3: Raise capital expenditure by at least Rs. 0.7 Cr per annum;
Goal 4: Raise revenue (internally generated) by at least Rs.10 Cr per annum;
Goal 5: Reduce the total Budget by at least Rs.10 Cr per annum.

THE GOAL FORMULATION

Let ,
x_1 = Amount budgeted in the fiscal year 2012
x_2 = Amount budgeted in the fiscal year 2013
x_3 = Amount budgeted in the fiscal year 2014
x_1, x_2, and x_3 are the decision variables.

The goals can be stated mathematically as follows:

$1.1x_1 + 1.3x_2 + 1.49x_3 \geq 3$ (Personnel costconstraint)
$0.85x_1 + 0.67x_2 + 1.04x_3 \leq 2.6$ (Overhead costconstraint)
$0.36x_1 + 0.21x_2 + 0.25x_3 \geq 0.7$ (Capital expenditureconstraint)
$2.4x_1 + 2.53x_2 + 2.82x_3 \geq 10$ (Revenue constraint)
$4.72x_1 + 4.71x_2 + 5.6x_3 \leq 10$ (Budget constraint)

$x_1, x_2, x_3 \geq 0$

THE GOAL PROGRAMMING FORMULATION
Table 4

Basic	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	RX
				d_1^-	d_1^+	d_2^-	d_2^+	d_3^-	d_1^+	d_4^-	d_4^+	d_5^-	d_5^+	
Constrain1	1.1	1.3	1.49	1	-1	0	0	0	0	0	0	0	0	3
Constrain2	0.85	0.67	1.04	0	0	1	-1	0	0	0	0	0	0	2.6
Constrain3	0.36	0.21	0.25	0	0	0	0	1	-1	0	0	0	0	0.7
Constrain4	2.41	2.53	2.82	0	0	0	0	0	0	1	-1	0	0	10
Constrain5	4.72	4.71	5.6	0	0	0	0	0	0	0	0	1	-1	10
Min Z	0	0	0	0	8	2	0	0	6	0	4	10	0	

Let ,
d_{i+} = amount by which we numerically exceedthe ith goal.
d_{i-} = amount by which we are numerically less thanthe ith goal
d_{i+} and d_{i-} are referred to as deviational variables.

Let ~~Z~~ be the weighted sum associated with meeting the annual budget requirements.
Using the weighted goal programming model stated in (2), the goal programming formulation can be mathematically stated as follows:

Min ~~Z~~ = $8d_{1+} + 2d_{2-} + 6d_{3+} + 4d_{4+} + 10d_{5-}$ (Objective function) ... (i)
Subject to:
$1.1x_1 + 1.3x_2 + 1.49x_3 + d_{1-} - d_{1+} = 3$ (ii)
$0.85x_1 + 0.67x_2 + 1.04x_3 + d_{2-} - d_{2+} = 2.6$ (iii)
$0.36x_1 + 0.21x_2 + 0.25x_3 + d_{3-} - d_{3+} = 0.7$ (iv)
$2.41x_1 + 2.53x_2 + 2.82x_3 + d_{4-} - d_{4+} = 10$ (v)
$4.72x_1 + 4.71x_2 + 5.6x_3 + d_{5-} - d_{5+} = 10$ (vi)

$x_1, x_2, x_3, d_1^+, d_{2+}, d_{3+}, d_{4+}, d_{5+}, d_{1-}, d_{2-}, d_{3-}, d_{4-}, d_{i-} \geq 0.$

The Input Data

Table 4, gives the input data for the analysis of budgetary allocation in Indu Group Colleges from 2012 –2014 inclusive.

Footnote

In the above input data,
Let,
$x_5 = d_{1+}$, $x_7 = d_{2+}$, $x_9 = d_{3+}$, $x_{11} = d_4^+$ and $x_{13} = d_{5+}$.
Let,
$x_4 = d_{1-}$, $x_6 = d_{2-}$, $x_8 = d_{3-}$, $x_{10} = d_{4-}$ and $x_{12} = d_{5-}$.
The Tora software was applied on Table 4 to obtain the table below.

Basic	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	RX_{14}	RX_{15}	RX_{16}	RX_{17}	RX_{18}	Soln.
				d_1^-	d_1^+	d_2^-	d_2^+	d_3^-	d_1^+	d_4^-	d_4^+	d_5^-	d_5^+						
Z Min	0	-0.47	0	-1.24	-6.76	0	-2	-0.94	-5.06	0	-4	-10	0	-101.24	-98	-100.94	-100	-100	0.83
X_{13}	0	0.15	0	3.2	-3.2	0	0	3.34	-3.34	0	0	-1	1	3.2	0	3.34	0	-1	1.93
X_6	0	-0.23	0	-0.62	0.62	1	-1	-0.47	0.47	0	0	0	0	-0.62	1	-0.47	0	0	0.41
X_1	1	-0.05	0	-0.96	0.96	0	0	5.7	-5.7	0	0	0	0	-0.96	0	5.7	0	0	1.12
X_{10}	0	0.08	0	-1.58	1.58	0	0	-1.87	1.87	1	-1	0	0	-1.58	0	-1.87	1	0	3.95
X_3	0	0.91	1	1.38	-1.38	0	0	-4.21	4.21	0	0	0	0	1.38	0	-4.21	0	0	1.19

Interpretation Of The Solution

The application of the simplex method (Big M –Method) by Tora package, gives the optimum solution as follows: ~~Z~~ = 0.83, x_1 = 1.12, x_2 = 0, x_3 = 1.19 d_{1+} = 0.0, d_{2+} = 0, d_{3+} = 0.0, d_{4+} = 0, d_{5+} = 1.93, d_{1-} = 0.0, d_{2-} = 0.41, d_3 = 0, d_4 = 3.95 and d_{5-} = 0.

Since the value of ~~Z~~ is not equal to zero, the solution satisfies goal 1, goal 3, and goal 5, but fails to satisfy goal 2 which is the Overhead cost and goal 4 which is the Revenue goal.Predominantly,for d_{2-} = 0.41,it means that overhead cost level(target) of Rs.2.6 crore has a shortfall of 0.41 crore rupees in the Overhead cost;which indicates that the actual overhead cost should be Rs.2.19 crore and for d_4= 1.12, it means that the Revenue goal level(target) of Rs.10 crore exceeded the Revenue goal by Rs.1.12 crore; which indicates that the actual revenue should be Rs.8.88 crore On the other hand, the budget goal of at least Rs.10 crore is not violated as d_{5-} = 0.

CONCLUSION:

This study, examined the budgeting system of Indu Group of Colleges using goal programming model. The results demonstrated that all the goals formulated were met,except the overhead cost and revenue target. The Institution's minimum budget should be Rs.2.36 crore to meet goal 2 and 4 which are the overhead cost and the revenue goals. Optimistically, it can be said that the Institution has not performed below expectation, the institution should continue with their budget allocation formula with increased adaptation to new scientific techniques.

REFERENCES

1. Operation Research, Taha (2003)
2. Tora Software, version 2.2
3. Balance sheets of Indu Group of colleges
4. Wikipedia (2006)