Study of Role of Linear Programming Model in Management and Optimization of Operating Costs in an Organization

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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 (Schneiderjans and Hoffman, 1992), extended lexicographic goal programming (Romero, 2001), etc.) and extensive surveys on fields of its applications [8]; Schneiderjans, 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>
<thead>
<tr>
<th>Item</th>
<th>Incorporates</th>
<th>Aim (To)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment benefits</td>
<td>Wages, salaries and allowances of staff and employer's social security cost.</td>
<td>Increase</td>
</tr>
<tr>
<td>General Expenses</td>
<td>Raw materials (gas, fuel, labor, electricity), rent, advertising, insurance premium, taxes.</td>
<td>Reduce</td>
</tr>
<tr>
<td>CAPEX (Capital Expenditure)</td>
<td>Funds for maintenance of property (furniture, stationery, etc.), building, equipments.</td>
<td>Increase</td>
</tr>
<tr>
<td>Revenue (Turnover)</td>
<td>Sales, service revenue, fees earned, interest income.</td>
<td>Increase</td>
</tr>
<tr>
<td>Total budget</td>
<td>Capital expenditure, Revenue, Personnel cost, Overhead cost.</td>
<td>Reduce</td>
</tr>
</tbody>
</table>

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 Nirmal Industries, Ahmedabad, 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 Nirmal Industries, Ahmedabad, 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.

<table>
<thead>
<tr>
<th>Item</th>
<th>Aim (To)</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>The budgets are operated negligently due to unavailability of a reliable and active budget monitoring team.</td>
<td></td>
</tr>
<tr>
<td>If there were a robust allocation model, the problem of mismanagement would be solved to an extent.</td>
<td></td>
</tr>
</tbody>
</table>
aij = coefficient for the jth decision variable in the ith constraint  
Xj = decision variable  
w = weights of each goal  
d− = deviational variable representing the amount of under-achievement of ith goal  
d+ = deviational variable representing the amount of over-achievement of ith goal  

In case, goals are classified in k ranks, the preemptive priority factors (P1, P2, ..., and so on) should be assigned to deviational variables d− and d+ 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 preemptive 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 Nirmal Industries, Ahmedabad, India, mentioned in the published budget folder.  

11. Data Analysis and Technique used  
For analysis of the data collected from the Financial Planning and Management department of Nirmal Industries, Ahmedabad, India, (year 2016 and 2017) for this study, we would use the weighted preemptive GP method.  

12. Analysis of Data  
The summary of operating cost estimates of the institution Nirmal Industries, Ahmedabad, India, over the period 2016 and 2017, showing the rounded off values of Employment benefits, General expenses, CAPEX, Revenue, Total budget, are given as (in Table 2):  

<table>
<thead>
<tr>
<th>Goal</th>
<th>Allocation in □ Per Year</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2012</td>
<td>2013</td>
</tr>
<tr>
<td>Employment benefits</td>
<td>1300000</td>
<td>1350000</td>
</tr>
<tr>
<td>General expenses</td>
<td>300000</td>
<td>315000</td>
</tr>
<tr>
<td>CAPEX</td>
<td>1250000</td>
<td>1400000</td>
</tr>
<tr>
<td>Revenue</td>
<td>4500000</td>
<td>4700000</td>
</tr>
<tr>
<td>Total budget</td>
<td>7350000</td>
<td>7765000</td>
</tr>
</tbody>
</table>

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>
<thead>
<tr>
<th>Goal</th>
<th>Allocation in Million □ Per Year</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2016</td>
<td>2017</td>
</tr>
<tr>
<td>Employment benefits</td>
<td>1.3</td>
<td>1.35</td>
</tr>
<tr>
<td>General expenses</td>
<td>0.3</td>
<td>0.315</td>
</tr>
<tr>
<td>CAPEX</td>
<td>1.25</td>
<td>1.4</td>
</tr>
<tr>
<td>Revenue</td>
<td>4.5</td>
<td>4.7</td>
</tr>
<tr>
<td>Total budget</td>
<td>7.35</td>
<td>7.765</td>
</tr>
</tbody>
</table>

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+ (surplus variable in LP) can be removed from the objective function. If under-achievement is acceptable, d− (slack variable in LP) can be removed from the objective function. If exact achievement of the goal is derived, both d− and d+ 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 wk be the relative weights of the di variable in the kth 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>
<thead>
<tr>
<th>Goal</th>
<th>Allocation in Million □ Per Year</th>
<th>Total</th>
<th>Weights</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2016</td>
<td>2017</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employment Benefits</td>
<td>1.3</td>
<td>1.35</td>
<td>2.65</td>
<td>5</td>
</tr>
<tr>
<td>General Expenses</td>
<td>0.3</td>
<td>0.315</td>
<td>0.615</td>
<td>2</td>
</tr>
<tr>
<td>CAPEX</td>
<td>1.25</td>
<td>1.4</td>
<td>2.65</td>
<td>4</td>
</tr>
<tr>
<td>Revenue</td>
<td>4.5</td>
<td>4.7</td>
<td>9.2</td>
<td>3</td>
</tr>
<tr>
<td>Total Budget</td>
<td>7.35</td>
<td>7.765</td>
<td>15.115</td>
<td>6</td>
</tr>
</tbody>
</table>

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 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: $z = +2P2d2^- +4P3d3^- +6P4d4^- +6P4d5^-$

Subject to:

1. $1.3x1 + 1.35x2 + d1^+ - d1^- = 1.5$ (Employment benefits)
2. $0.3x1 + 0.35x2 + d2^+ - d2^- = 1$ (General expenses)
3. $1.25x1 + 1.4x2 + d3^- - d3^+ = 1.5$ (CAPEX)
4. $4.5x1 + 4.7x2 + d4^+ - d4^- = 5$ (Revenue)
5. $7.35x1 + 7.765x2 + d5^- - d5^+ = 9$ (Total budget)

$x1, x2, d1^+, d1^- , d2^+, d2^-, d3^+, d3^-, d4^+, d4^-, d5^+, d5^- > 0$

16. 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.

References