Application of Goal Programming inMedical Management

Dr.Abha Dave*

Abstract

Significant advances in the field of medical care management are observed in the recent years. The theory of goal programming (GP) can be used as an effective tool, particularly in the area of intelligent modeling and solution analysis. This paper studies a goal programming model for maximizing the profit of the hospital by determining maximum distribution of resources to patients.

Keywords: Goal programming, hospital, patients, resources, profit

Introduction

Hospitals always face problems regarding the balance of manpower and the available resources, since the number of patients and their time of arrival is always unpredictable. The cost of equipment's is increasing day-by-day and new researches lead to replacing the old ones, add to the difficulties. The resources need to be planned and allocated efficiently. In order to achieve all these the operation research can play an important part. The technique of goal programming can be a useful tool to develop and plan the resources

An extension of GP model for problems of multipleconflicting objectives was developed by Charnes and Copper [1]. They developed the powerful tool of Goal Programming, which draws upon the highly developed and tested techniques of Linear Programming in order to optimize several diversified goals. Goal programming is used to form the model for the problem and the problem is solved in different context. There is a large scope of goal programming in several other fields like human resource, finance, agriculture management, hospital administration, resource allocation etc. A GP model for a number of contradictory goals in natural resource allotment for management's decision problems. was given by Kenneth et al [2]. It was found that GP was a very flexible decision aiding tool to handle problems of linear programming with multiple goal preferences. Integer Goal Programming was applied by Fortenberry and Mitry [3],to facility location problem with multiple conflicting goals.J.K.Sharma and Ravindra Babu Ghanta [4] determined the optimum sequence for treatment of surgical patients for maximizing total contribution to profit. Management of agricultural resources using goal programming has been studied by Dave [4].

Operational Research finds its application in the various fields of medical care administration and development. OR has the ability to transform complex real world problems into mathematical models. These models can then be optimized and analyzed. These models relate to cost effectiveness and guidelines in public health, medical decision-making, treatment, developmentand design, resource allocation and utilization etc. for the hospital system.

*Associate Professor, Department of Mathematics. Al Jouf University, Al Jouf, Saudi Arabia
abhadave30@gmail.com, abhadave30@yahoo.com

In this paper we have used and developed the Goal programming model in order to optimize the combination of surgical patients and maximize the total contribution to profit.

Data Collection

We have taken a local maternity hospital for the collection of data. This hospital has an expertise of children surgeries. The surgery is minor in nature and the patients (children) do not need to stay in the hospital for long. These are conducted as outpatients and the patients can go back and resume their normal activities very soon. These surgeries are small and not have many complications. We have taken the following minor surgeries for our study

- Placement of ear tubes
- Hernia repairs
- Correction of bone fractures
- Removal of skin lesions
- Biopsy of growths

The required information is given in the following table: -

	Types of surgical patients					
	S_1	S_2	S_3	S_4	S_5	Capacity/Year
Operating Room	3	2	3	2	2	1850 hours
Recovery Room	5	3	7	6	5	3250 beds hours
Surgical Room	2	2	6	5	4	2020 beds days
Average contribution to profit (Rs.)	12500	12700	12300	13700	13900	
Average contribution to profit is taken hypothetically as the hospital is run by government and there is no profit						

Where S_1 = the number of ear tube patients
S_2 = the number of hernia patients
S_3 = the number of bone fracture patients
S_4 = the number of skin lesions patients
S_5 = the number of biopsy growth patients.
I_1 = idle hours of operating room
I_2 = idle hours of recovery room
I_3 = idle hours of surgical service beds

Goal Programming Model

In linear programming we one goal where as goal programming compromises of mathematical model programming with multiple goals. Goal programing contains all the basic methods of solving linear programming model with the addition of deviations between the goals that are to be achieved and the realized results. For this two non negative deviational variables d-, the amount by which the profit goal underachieves and d+: the profit goal that over-achieves are taken for the goal achievements.

In obtaining the solution of the model, for deviational variables d- and d+ are given positive values for at most one of the variables.. As for any problem profit cannot over achieved and under achieved at the same time. The value of the two deviational variables will be zero when the goal is achieved exactly. If one or other variables will be zero then the goal cannot be attained. The model formed in our case is as follows:

$$\text{Minimize } Z = \sum Pj\,(di+ + di-) : j = 1,2,3,\ldots\ldots n.$$

Subject to

$$\sum (aijxij) - di+ + di- = bi : i = 1,2,3\ldots m$$

Methodology and Model Structure

In this study, a goal programming model is constructed for determining important constraints of operating room hours, recovery room hours and surgical service hours. All this was identified through the review of literature and interview with experts. The determination of objective function is based on constraints. The model containing 5 constraints is given below:-

$$\text{Minimize } Z = P1\,(d1-) + P2\,(d2-) + P3(d3-) + P4(d4-)$$

Subject to constraints

$12{,}500\,S1 + 12{,}700\,S2 + 12{,}300\,S3 + 13{,}700\,S4 + 13{,}900\,S5 + d1- - d1+ = 1{,}24{,}24000$ Target profit

$3S1 + 2S2 + 3S3 + 2S4 + 2S5 + d2- - d2+ = 1850$ operating room hours

$5S1 + 3S2 + 7S3 + 6S4 + 5S5 + d3- - d3+ = 3250$ recovery room hours

$2S1 + 2S2 + 6S3 + 5S4 + 4S5 + d4- - d4+ = 2020$ surgical room hours

$S1, S2, S3, S4, S5, d1-, d1+, d2-, d2+, d3-, d3+, d4-, d4+ \geq 0.$

Where d1-, d1+, d2-, d2+, d3-, d3+, d4-, d4+ are the slack variables representing the difference between the solution variables and goal achievements. Two slack variables are required in the above equations in order to allow the possible deviation above and below the goal achievements. Pi and di appear together in the objective function, since the first goal requires at least making1,24,24000 and there is no need to put restriction on d1+. The objective of the second, third and

fourth goal is to minimize the idle capacities of all the scarce resources including under achievement variables, d2-, d3- , d4- respectively, without inserting the over achievement variables.

Solutions and Conclusions

Solutions are obtained for the decision variables (Si's) and deviational variables (di's). The solutions obtained in accordance with the Priorities (Pi's) are given below:

S1 = 0, S2 = 790, S3 =90, S4 = S5 = S6 =0, d1- = 0, d1+ = 0 , d2- = 0 , d2+ =0 ,
d3- =250, d3+=d4- = d4+ =0
The first priority goal for (target profit) is fully achieved (since d1- =0).

Treating only hernia patients and bone fracture patients. We find that the best combination of these patients will be 790 hernia patients and 90 bone fracture patients.
Since d3- =250,this will decrease the recovery room hours by 250 hours.

On the basis of model of the goal program the results of the input were compared with output to get the optimum allocations of resources. Resource allocation plays a very important role in health care since the resources are limited and need to be utilized to the optimum. Excel solver methods for goal programming can be used to find the solution values of the decision variables Si'sand di's. The solution value can be obtained in accordance with the priorities. In the present study due to lac of availability of some records some goal objectives could not be calculated. In order to get the accurate results the data should be collected and analyzed regularly.

References

1) *Charnes and W.W. Cooper.. Goal Programming and Multiple Objectives Optimizations. European Journal of Operational Research (1977),1: pp. 39*
2) *E. B. Kenneth and E. T. Bartlett.. Resource allocation through Goal programming, Journal of range management (1995), 28(6).*
3) *Fortenberry, J; Mitra, A. (1986). A multiple criteria approach to the location allocation problem. Comp. Ind. Eng. 10: 77-87.*
4) *J.K. Sharma and Ravindra Babu Ganta.. Optimization of Health-Care Resources through Goal Programming. The Journal of Indian Management and Strategy,Vol.7, No.1,January-March, 2002. pp 55*
5) *Dave. Abha (2015) Goal Programming Applications in Agricultural Management, IRJET, vol2, Issue7.*