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Goal Programming for Health-Care Planning

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***Abstract*— In the complex financial environment, today's health–care industry requires administrators who are familiar with efficient method of allocating scare resources. Many health–care facilities have become similar to large business enterprises, which intend to achieve multiple and conflicting goals through integration and use of limited resources. The objective of this study was to develop the goal programming approach in the health-care field, and to determine the optimal sequence for treatment of surgical patients that maximizes the total contribution to profit.**

Keywords— Health-Care Services: Goal Programming.

INTRODUCTION

Operational Research models in the field of health-care often involve parameters, which depend on the behavior of human beings.

Health authorities need information for planning patient services. Most of the information requirements of health authorities relate to the activities of patients and the consequent health service workload [4]. In order to use this information in billing or budgeting services, these authorities need models to evaluate resource used by the patients and to estimate their future service need [3].

Arcangeli G. et al. [1] used multi objective model and discussed optimal adaptive control of treatment planning in radiation therapy. Blake et al. [5] have analyzed surgical process management – conceptual framework in surgical services management. Blake et al. [7] developed the goal programming model to resource allocation in acute – care hospitals. Problems of this type have quite often been investigated using Operational Research methods [8-16, 18], Lawrence et al. [17], Lee K.K.Y [19], Steffen Flessa [20], Vanda De Angelis et al. [21], have developed the multi-objective programming models for health-care planning and their areas of applications were adopted. In this paper we develop the goal-programming model, which determine the optimal sequence for treatment of surgical patients that maximizes the total contribution to profit.

There are many models, which are used in health-care [2, 6]. Goal Programming is one of the models in this context because it can describe the activities of individual goals. Goal Programming is a mathematical technique and a variation of Linear Programming. Goal Programming is an approach that is capable of handling decision-making problems having multiple, conflicting goals. The objective function of a Goal Programming model can be composed of non-homogeneous units of measurement, and includes only the deviational variables (d^- and d^+) that are complementary to each other.

The decision-maker's goals may be ranked based on priority. Goals of equal priority may be weighted differently in order of quantifiable assigned values. Therefore, the objective of Goal Programming is to minimize the summation of deviational variables (i.e. the desired goal levels), subject to a set of goals and systems constraints.

DATA OF THE PROBLEM:

The data is collected from Care Hospital, Hyderabad. This is specialized in performing six types of surgeries: Urology, General, Orthopedic, Plastic, ENT and Neurology. The performance of these surgeries is constrained by three resources: Operating Room hours, PACU (Post Anesthesia Care Unit) hours and SICU (Surgical Intensive Care Unit) hours.

The required information is given in the following table.

Table

	Types of Surgical Patients						Capacity/Year
	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6	
Operating Room (l_1)	8	5	4	2	2	1	2100 hours
PACU (l_2)	5	2	0	1	2	0	4300 bed hours
SICU (l_3)	3	3	4	1	0	1	3600 bed days
Average Profit (Rs)	1.25	1.3	1.2	2.1	2.25	3.0	Lakhs

Where Y_1 = Number of Urology Surgery patients.
Y_2= Number of General Surgery patients.
Y_3 = Number of Orthopedic Surgery patients.
Y_4 = Number of Plastic Surgery patients.
Y_5 = Number of ENT Surgery patients.
Y_6 = Number of Neurology Surgery patients.

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I_1 = Idle hours of the Operating Room.
I_2 = Idle hours of the PACU.
I_3 = Idle days of the SICU.

GOAL PROGRAMMING MODEL:

The goal-programming model developed is as follows:

Minimize $Z = P_1 (d_1^-) + P_2 (d_2^-) + P_3 (d_3^-) + P_4 (d_4^-)$

Subject to the constraints:

a) G_1: Target Profit

$1.25Y_1+1.30Y_2+1.20Y_3+2.10Y_4+2.25Y_5+3.00Y_6+ d_1^- + d_1^+ = 20.25$

b) G_2: Operating Room hours

$8Y_1+5Y_2+4Y_3+2Y_4+2Y_5+Y_6+ d_2^- + d_2^+ = 2100$

c) G_3: PACU bed-hours

$5Y_1+2Y_2+0Y_3+Y_4+2Y_5+0Y_6+ d_3^- + d_3^+ = 4300$

d) G_4: SICU bed-days

$3Y_1+3Y_2+4Y_3+Y_4+0Y_5+Y_6+ d_4^- + d_4^+ = 3600$

And $Y_1, Y_2, Y_3, Y_4, Y_5, Y_6 \geq 0$;

$d_1^-, d_1^+, d_2^-, d_2^+, d_3^-, d_3^+, d_4^-, d_4^+ \geq 0$.

The equations above however, require two slack variables, to allow the possible deviation above and below the goal achievement. Note that the d_1^- appears in the objective function with a P_1 coefficient. The reason is that, since first goal requires making at least Rs. 20, 25,000, there is no need to put any restriction on d_1^+. The objective of the second, third and fourth goals are to minimize the idle capacities of all the scare resources. This is done by including under-achievement variables d_2^-, d_3^- and d_4^- in the objective function with priority coefficients P_2, P_3 and P_4 respectively.

RESULT AND ANALYSIS

The solution values of decision variables (Y_i's) and deviational variables (d_i's) obtained by using QSB+ Computer Software interpreted as follows:

$Y_1 = 0$; $Y_2 = 425$; $Y_3 = 110$; $Y_4 = Y_5 = Y_6 = 0$;

$d_1^- = d_1^+ = 0$; $d_2^- = 1100$; $d_2^+ = 0$;

$d_3^- = d_3^+ = 0$; $d_4^- = 460$; $d_4^+ = 0$;

The solution values in accordance with priorities states that, the first priority goal for target profit is fully achieved (since $d_1^- = 0$). Concentrate more on General Surgery and Orthopedic Surgery patients. The best combination of these patients will be $Y_2 = 425$ and $Y_3 = 110$. Decrease the PACU bed hours by 1100 hrs (since $d_2^- = 1100$). Decrease the SICU bed-days by 460 days (since $d_4^- = 460$).

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