# A Budget Planning Model for Health Care Clinics

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***Abstract*— This paper is devoted to the application of goal programming to medical care planning. More specifically, the paper presents the goal programming approach to the budget planning of relatively small health care clinics.**

***Keywords—Goal Programming, Health Care, Capital Budgeting***

## I. INTRODUCTION

The development of group practice has been, in most cases, an attempt by physicians at economy, convenience, and efficiency. Group practice is a system for a cooperative practice of medicine among physicians for the purpose of pooling experience and specialties, facilities and equipment, technical and other supporting staff, and sharing operating expenses. In short, the purpose of group practice is the improvement of the quality, quantity, and effectiveness of medical care and the reduction of operating costs. Studies have noted that group doctors see more patients, have more free time to keep up with the latest research in their fields, have better equipment, and treat patients at a lower cost than the individual practitioner.

There have been four basic origins for today's group practices:

(i) Simple partnerships forming into complex varieties of partnerships, then moving into an integrated group practice;
(ii) The hospital staff where specialists practice within the hospital in an integrated manner (pressures of practice force the doctors to create their own office facilities close to the hospital for efficiency and convenience for themselves and their patients);
(iii) A sponsored group originated by a non medical third party, and
(iv) The organization of medical school facilities into group practice. No matter what the origin, however, they all end up looking more and more alike, each occupying and staffing a medical complex or medical center and each available to the general public on the basis of service.

The matter of economics, as earlier stated, has been a profound proponent for the trend toward group practice. These clinics benefit the patient, the health professions and the community and they also provide extended and better service in a convenient way and help attain consistency and continuity of treatment. They also give the physicians the opportunity for consultation, research and postgraduate study, a satisfactory income, alternating working days, nights and weekends, and paid vacations.

Various models have been developed for the efficient allocation of resources in general. The most popular approach appears to be goal programming. Goal programming allows the decision maker to specify targets and then attempts to find a solution that comes as close as possible to meeting these targets. Examples of goal programming models for Capital budgeting can be found in Hawkins and Adams [1]; Keown and Martin [2]; Capital investment analysis in Wacht and Whitford [3], Chae [5]; Cost analysis in Kenney and Lewis [6], Jensen [7].

## DATA OF THE PROBLEM

The characteristics of the budget planning model for the clinic are based upon many factors, such as the type of clinic, the medical specialty, the location and size of the clinic, etc. Hence, it is difficult to design a general model that can be applied to all types of clinics. However, once a budget planning model is developed, it can be modified to fit many other types of clinics.

This study was carried out to Mimhans hospital, Meerut. Some data was taken as hypothetical since which was not obtained from the hospital records. The scope of this study is limited, however, to the planning horizon of one year. It is felt that this limited scope will allow a clearer presentation of the model development. Once it is completed for a year, the basic model can be expanded for a longer planning horizon by forecasting parameter changes. It is solely concerned with the treatment of patients in need of neuro care on an out patient basis. Personnel employed by the clinic are:

8 Neuro Surgeons
2 Full-time and 4 Part-time Nurses
1 Full-time and 2 Part-time ultrasound Technicians
1 Full-time and 2 Part-time CT scan Technicians
1 Business Manager
8 Secretaries
2 Receptionists
4 Office Personnel
4 Maintenance Personnel

The doctors schedule their services in such a manner that they can see the majority of their patients at the clinic. However,

they are responsible for filling the neuro needs of two hospitals in the city. The doctors billing is handled through the clinic for all their services, and provide the sole income to the business itself.

Table 1. Clinic Personnel, Working Hours and Wages

| Position | No. of Employed | Hours/Week | Total Hours/ Position /Year | Salary/Hour | Salary after 10% increase | Priority for wage increase |
|---|---|---|---|---|---|---|
| Neuro Surgeon | 8 | 45 each | 18,720 | Rs 500 | Rs 550 | 12th |
| Full-time Nurse | 2 | 35 each | 3,640 | 60 | 66 | 6th |
| Part-time Nurse | 4 | 20 each | 4,160 | 50 | 55 | 7th |
| Full-time Ultrasound Tech. | 1 | 40 | 2,080 | 50 | 55 | 1st |
| Part-time Ultrasound Tech. | 2 | 20 each | 2,080 | 50 | 55 | 8th |
| Full-time C.T.Scan Tech. | 1 | 40 | 2,080 | 60 | 66 | 2nd |
| Part-time C.T.Scan Tech. | 2 | 20 each | 2,080 | 60 | 66 | 9th |
| Business Manager | 1 | 40 | 2,080 | 200 | 220 | 11th |
| Secretary | 8 | 40 each | 16,640 | 50 | 55 | 3rd |
| Business Office Personnel | 4 | 40 each | 8,320 | 40 | 44 | 5th |
| Receptionist | 2 | 40 each | 4,160 | 40 | 44 | 4th |
| Maintenance Personnel | 4 | 14 each | 2,912 | 30 | 33 | 10th |

TABLE 2.PATIENTS, EXPENSES AND EQUIPMENT REPLACEMENT

***Patients***

Total patients last year = 29,500.00
Expected increase for coming year (8%) = 2,360.00
Total expected patients for planning year = 31,860.00
Average charge per patient = 621.42
(As Total Rs.1,83,31,916 last year)

***Expenses***

| | Total for the Past Year | Average per Patient | Average/Patient After 8% Increase |
|---|---|---|---|
| Ultra Sound | Rs. 3,83,500 | Rs. 13 | Rs. 14.04 |
| C.T.Scan | 19,20,000 | 65 | 70.29 |
| Medical Supplies | 4,13,000 | 14 | 15.12 |
| Administrative and Miscellaneous | 18,29,000 | 62 | 66.96 |

***Reserves for other Expenses***

1 UItra Sound Replacement Rs. 7,00,000
4 Computer 1, 00,000
Retirement Fund 10% of total salaries
Continuing Education of Doctors Rs.6,00,000
(Rs. 5,00,000 last year)

Tables 1 and 2 outline the pertinent information needed for this study. The salaries given are an average of the salaries earned by each person in the individual category. The number of hours stated as being the physician's weekly hours is necessarily an average; however, the physicians are salaried, so the figure given by multiplying the hours/ week by the salary/hour will be an accurate average for the eight doctor's income. Figures given for machines, medical and administrative and miscellaneous expenses are accurate. The total number of patients seen at the clinic is not a measure of individual patients, since it would be virtually impossible to determine this figure because of the number of patients who have more than one visit per year. This does not affect the accuracy of the model, however, since there is no contract or group plan billing system.

The information found in the tables is a compilation of operating revenues and expenses for the past year. In order to provide for the rising costs of the coming year, all of the figures for the categories that will be affected by this steady rise are multiplied by 1.08. This, of course, assumes an 8% increase in costs, which has been determined to be an accurate approximation. However, the average salary increase for the clinic's personnel is set at 10%.

GOAL VARIABLES

$x_1$ = New hourly pay rate for physicians
$x_2$ = New hourly pay rate for full-time nurse
$x_3$ = New hourly pay rate for part-time nurse
$x_4$ = New hourly pay rate for full-time Ultrasound technician
$x_5$ = New hourly pay rate for part-time Ultrasound technician
$x_6$ = New hourly pay rate for full-time C.T. Scan technician
$x_7$ = New hourly pay rate for part-time C.T. Scan technician
$x_8$ = New hourly pay rate for business manager
$x_9$ = New hourly pay rate for secretaries
$x_{10}$ = New hourly pay rate for office personnel
$x_{11}$ = New hourly pay rate for receptionists
$x_{12}$ = New hourly pay rate for maintenance personnel
$x_{13}$ = Retirement fund
$x_{14}$ = Fund for continuing education of physicians
$x_{15}$ = Expense for new ultrasound machine
$x_{16}$ = Expense for new computers
$y_1$ = Required no. of physicians' hours/year
$y_2$ = Required no. of full-time nurse hours/year

$y_3$ = Required no. of part-time nurse hours/year
$y_4$ = Required no. of full-time ultrasound technician hours/year
$y_5$ = Required no. of part-time ultrasound technician hrs/year
$y_6$ = Required no. of full-time C.T.Scan technician hours/year
$y_7$ = Required no. of part-time C.T.Scan technician hours/year
$y_8$ = Required no. of business manager's hours/year
$y_9$ = Required no. of secretaries' hours/year
$y_{10}$ = Required no. of business office personnel hours/year
$y_{11}$ = Required no. of receptionists' hours/year
$y_{12}$ = Required no. of maintenance personnel hours/year
$z_1$ = Ultra sound expenses per patient
$z_2$ = C.T. Scan expenses per patient
$z_3$ = Medical expenses per patient
$z_4$ = Administrative and miscellaneous expenses per patient
$z_5$ = Average charge per patient

## THE GOALS

The business manager must determine the economic goals of the clinic for the coming year in order to establish the budget planning model. The business manager lists the following goals in descending order of importance:

1. Provide job security to all personnel by avoiding underutilization of their regular working hours.
2. Provide an adequate (10%) wage increase to all personnel in keeping with the economic trend (see table (1) for priority weights).
3. Provide funds for expense per patient.
4. Provide funds for equipment replacements.
5. Provide reserve for the retirement fund.
6. Provide funds for continuing education fund.
7. Achieve the break even goal in the operation.

## FORMULATION OF GOAL CONSTRAINTS

With the data defined in Table (1) & (2), the GP model constraints for budget planning are formulated as follows:

**(A) Wages:** It is desired that all personnel receive a 10% increase over the past year.

$$x_1 + d_1^- - d_1^+ = Rs\,550$$
$$x_2 + d_2^- - d_2^+ = 66$$
$$x_3 + d_3^- - d_3^+ = 55$$
$$x_4 + d_4^- - d_4^+ = 55$$
$$x_5 + d_5^- - d_5^+ = 55$$
$$x_6 + d_6^- - d_6^+ = 66$$
$$x_7 + d_7^- - d_7^+ = 66$$
$$x_8 + d_8^- - d_8^+ = 220$$
$$x_9 + d_9^- - d_9^+ = 55$$
$$x_{10} + d_{10}^- - d_{10}^+ = 44$$
$$x_{11} + d_{11}^- - d_{11}^+ = 44$$
$$x_{12} + d_{12}^- - d_{12}^+ = 33$$

*(B) Expenses*

***(i) Retirement Fund***

The retirement fund = 10% of the total yearly salaries

$$x_{13} - 0.10[18{,}720\,x_1 + 3640x_2 + 4160x_3 + 2080x_4 + 2080x_5 + 2080x_6 + 2080x_7 + 2080x_8 + 16{,}640x_9 + 8320x_{10} + 4160x_{11} + 2912x_{12}] + d_{13}^- - d_{13}^+ = 0$$

***(ii) Continuing Education fund***

$$x_{14} + d_{14}^- - d_{14}^+ = Rs.6{,}00{,}000$$

***(iii) Ultra-Sound Replacement Fund***

The estimated cost for a new machine is Rs 8,50,000. The estimated salvage on old equipment is Rs 1,50,000.

$$x_{15} + d_{15}^- - d_{15}^+ = Rs.7{,}00{,}000$$

***(iv) Computer Replacement Fund***

Four new computers are needed at the cost of Rs 40,000 each. The estimated total salvage on old equipments is Rs. 60,000.

$$x_{16} + d_{16}^- - d_{16}^+ = Rs.1{,}00{,}000$$

***(C) Personnel Requirement***

It is determined that the present personnel manpower level will be adequate to provide satisfactory service to the patients.

$$y_1 + d_{17}^- - d_{17}^+ = 18{,}720$$
$$y_2 + d_{18}^- - d_{18}^+ = 3{,}640$$
$$y_3 + d_{19}^- - d_{19}^+ = 4{,}160$$
$$y_4 + d_{20}^- - d_{20}^+ = 2{,}080$$
$$y_5 + d_{21}^- - d_{21}^+ = 2{,}080$$
$$y_6 + d_{22}^- - d_{22}^+ = 2{,}080$$
$$y_7 + d_{23}^- - d_{23}^+ = 2{,}080$$
$$y_8 + d_{24}^- - d_{24}^+ = 2{,}080$$
$$y_9 + d_{25}^- - d_{25}^+ = 16{,}640$$
$$y_{10} + d_{26}^- - d_{26}^+ = 8{,}320$$
$$y_{11} + d_{27}^- - d_{27}^+ = 4{,}160$$
$$y_{12} + d_{28}^- - d_{28}^+ = 2{,}912$$

***(D) Expenses per Patient***

The expenses per patient are broken down into four classifications: ultra sound expenses, C.T.Scan expenses, medical expenses, and administrative &miscellaneous expenses.

***(i) Ultra-Sound Expenses per Patient***

$$z_1 + d_{29}^- - d_{29}^+ = 14.04$$

***(ii) C.T. Scan Expenses per Patient***

$$z_2 + d_{30}^- - d_{30}^+ = 70.29$$

***(iii) Medical Expenses per Patient***

$$z_3 + d_{31}^- - d_{31}^+ = 15.12$$

***(iv) Administrative and Miscellaneous Expenses per Patient***

$$z_4 + d_{32}^- - d_{32}^+ = 66.96$$

***(E) Break-Even Constraint***

In order to determine the reasonable charge ($z_5$) that will provide enough resources to achieve desired goals, a breakeven constraint must be introduced. This constraint can used to determine the required charge per patient to achieve all the goals.

$$31{,}860z_5 - [(18{,}720x_1 + 3{,}640x_2 + 4{,}160x_3 + 2{,}080x_4 + 2{,}080x_5 + 2{,}080x_6 + 2{,}080x_7 + 2{,}080x_8 + 16{,}640x_9 + 8{,}320x_{10} + 4{,}160x_{11} + 2{,}912x_{12})] + (x_{13} + x_{14} + x_{15} + x_{16}) + (31{,}860z_1 + 31{,}860z_2 + 31{,}860z_3 + 31{,}860z_4)] + d_{33}^- - d_{33}^+ = 0$$

**Objective Function**

The objective function for the model is:

$$MinZ = P_1 \sum_{i=17}^{28} d_i^- + (12P_2d_4^- + 11P_2d_6^- + 10P_2d_9^- + 9P_2d_{11}^- + 8P_2d_{10}^- + 7P_2d_2^- + 6P_2d_3^- + 5P_2d_5^- + 4P_2d_7^- + 3P_2d_{12}^- + 2P_2d_8^- + P_2d_1^-) + P_3(d_{29}^- + d_{30}^- + d_{31}^- + d_{32}^-) + P_4(d_{15}^- + d_{16}^-) + P_5((d_{13}^-) + P_6(d_{14}^-) + P_7(d_{33}^- + d_{33}^+)$$

## RESULTS AND DISCUSSION

The above model is solved to determine the input requirements necessary to achieve all the goals presented by the business manager. Consequently, the break even goal is rated as the least important. The LGP problem used in the study contains 99 variables (decision and deviational) and 33 constraints. The solution of the problem is obtained by using the QSB+ software package (based on modified simplex method). The solution of the problem is as follows:

| Goal Attainment | Achieved/Not Achieved |
|---|---|
| Job Security | Achieved |
| Wage Increase | Achieved |
| Patient Expenses | Achieved |
| Equipment Replacement | Achieved |
| Retirement Fund | Achieved |
| Continuing Education Fund | Achieved |
| Breakeven | Achieved |

**Variables:**

| | | |
|---|---|---|
| $x_1$=550 | $x_{12}$=33 | $y_7$=2,080 |
| $x_2$=66 | $x_{13}$=13,28,641 | $y_8$=2,080 |
| $x_3$=55 | $x_{14}$=6,00,000 | $y_9$=16,640 |
| $x_4$=55 | $x_{15}$=7,00,000 | $y_{10}$=8,320 |
| $x_5$=55 | $x_{16}$=1,00,000 | $y_{11}$=4,160 |
| $x_6$=66 | $y_1$=18,720 | $y_{12}$=2,912 |
| $x_7$=66 | $y_2$=3,640 | $z_1$=14.04 |
| $x_8$=220 | $y_3$=4,160 | $z_2$=70.29 |
| $x_9$=55 | $y_4$=2,080 | $z_3$=15.12 |
| $x_{10}$=44 | $y_5$=2,080 | $z_4$=15.12 |
| $x_{11}$=440 | $y_6$=2,080 | $z_5$=669.07 |

The solution of the model indicates that all goals are achieved at the total cost of Rs. 2,13,16,878. The charge per patient ($z_5$) required to breakeven is Rs 669.07, which is a 7.66% increase from the last year's figure of Rs621.42. Since the break even in the operation is treated as the goal with the lowest priority factor, the solution identifies the input requirements necessary to attain all the goals. It is clear that the set of goals defined by the business manager are quite realistic as they can be completely attained with a charge per patient that is only 7.66% above the last year's figure.

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