

## A RESOURCE ALLOCATION MODEL FOR HOSPITAL ADMINISTRATION

K.SIREESHA\*, Dr G. RAVINDRA BABU\*

**Abstract:** This Paper is devoted to the application of goal programming to medical care planning. More specially, the chapter presents a goal programming resource allocation model for hospital administration. It is possible to formulate a complex multi-year resource allocation model that serves the purpose of long-range horizon of one year. It is felt that this limited scope will allow a clearer representation of the model development. Once it is completed for one year, the basic model can be expanded for a longer planning horizon by forecasting parameter changes.

### Data of the Problem

In this study, Olive Hospital in Hyderabad city is selected for the model design. With no resident physicians, patients are generally admitted by their personal physicians or through the emergency ward. The hospital's emergency room is staffed by local doctors on a rotation basis according to an agreement with the hospital. The hospital has 125 beds and employs 86 employees, excluding local physicians. Tables 1, 2 and 3 outline the model variables and other pertinent information needed for this study.

The salaries given are an average of the salaries earned by each person in the individual personnel category. The figures for each category are arbitrarily determined upon the request of the hospital administrator. The personnel classifications were made in relation to the assignment of personnel expenses within the various accounting designations utilized by the hospital. Although a number of split assignments are possible and often practiced, an attempt is made here to minimize these for the model design.

**Table 1: Hospital Personnel, Desired Personnel Proportions, Average Salaries and Desired Pay Increases**

| Variable        | Position                        | Desired% of Total employees | Average salary In Rs/- | Desired % pay increase |
|-----------------|---------------------------------|-----------------------------|------------------------|------------------------|
| X <sub>1</sub>  | Nursing service administration  | 5.81                        | 89,700                 | 6                      |
| X <sub>2</sub>  | Medical & surgical nurse        | 27.9                        | 88,800                 | 7                      |
| X <sub>3</sub>  | Pediatric nurse                 | 3.49                        | 89,400                 | 8                      |
| X <sub>4</sub>  | Obstetric nurse                 | 4.65                        | 89,100                 | 6                      |
| X <sub>5</sub>  | Operating & recovery room Nurse | 4.65                        | 91,800                 | 8                      |
| X <sub>6</sub>  | Service & supply room nurse     | 2.33                        | 82,400                 | 7                      |
| X <sub>7</sub>  | Emergency room nurse            | 3.49                        | 90,000                 | 9                      |
| X <sub>8</sub>  | Intensive care nurse            | 2.33                        | 93,600                 | 10                     |
| X <sub>9</sub>  | Laboratory technician           | 4.65                        | 81,600                 | 5                      |
| X <sub>10</sub> | Pathologist                     | 3.49                        | 92,400                 | 10                     |
| X <sub>11</sub> | Cardiologist                    | 1.16                        | 91,200                 | 10                     |
| X <sub>12</sub> | Radiologist                     | 3.49                        | 1,96,800               | 10                     |
| X <sub>13</sub> | Dietician                       | 13.95                       | 85,000                 | 8                      |
| X <sub>14</sub> | Plant operation & maintenance   | 2.33                        | 82,200                 | 5                      |
| X <sub>15</sub> | House keeping                   | 8.14                        | 69,600                 | 5                      |
| X <sub>16</sub> | Laundry & linen                 | 1.16                        | 70,800                 | 5                      |
| X <sub>17</sub> | Administrative service          | 6.98                        | 90,600                 | 6                      |

**Table-2: Expenses**

| Variable       | Category   | Total for past year<br>In Rs | Total for coming<br>Year<br>(5% increase) |
|----------------|--|------------------------------|---|
| Y <sub>1</sub> | Nursing division                                   | 12,80,000                    | 13,44,000                                 |
| Y <sub>2</sub> | Physician's fee(emergency ward)                    | 16,40,000                    | 17,22,000                                 |
| Y <sub>3</sub> | General services(X-ray, medical<br>Supplies etc.,) | 18,30,000                    | 19,21,500                                 |
| Y <sub>4</sub> | Administration                                     | 4,60,000                     | 4,83,000                                  |
| Y <sub>5</sub> | Miscellaneous                                      | 14,50,000                    | 15,22,500                                 |

**Table-3: Reserves for coming year**

| Variable       | Category            | Amount Rs |
|----------------|---------------------|-----------|
| Z <sub>1</sub> | Radiology equipment | 2,40,000  |
| Z <sub>2</sub> | Contingency reserve | 5,80,000  |

**Goals And Their Priorities**

The administrator must determine the goals of the hospital and their priorities in order to accomplish the optimum allocation of resources. This process usually involves a group decision by the hospital administrator and the board of directors. The administrator lists the following goals in order of importance.

1. Secure the necessary manpower to provide adequate services to the patient. The administrator feels that the existing personnel will be sufficient to provide adequate services for the coming year.
2. Replace and/or acquire new equipment that is required to provide the services of the hospital [this figure should be in addition to funds provided by depreciation].
3. Provide adequate pay increases to all personnel in keeping with the economy and the community labor market [see table 1 for the administrator's desired pay increases].
4. Provide funds for expenses.
5. Achieve the desired distribution of each personnel category [see table-1]
6. Minimize costs and breakeven in the operation

**Formulation of Goal Constraints**

With the data defined in tables 1, 2 and 3, the G.P model constraints for resource allocation are formulated as follows.

**Personnel Requirement**

The hospital presently employs 86 persons and the administrator feels that the existing personnel must be retained in order to provide satisfactory services to the patient.

$$\sum_{i=1}^{17} x_i + d_1^- - d_1^+ = 86$$

**New equipment**

A new x-ray equipment is required if the x-ray service is to be continued for the coming year. The new equipment is estimated to cost Rs 2, 40, 000. Also it is desired to reserve Rs 5,80,000 in the contingency fund for emergencies.

$$z_1 + d_2^- - d_2^+ = 2, 40, 00$$

$$z_2 + d_3^- - d_3^+ = 5, 80, 000$$

**Employee pay increase**

The administrator feels that the minimum pay increase should be 5% and the maximum should be 10% for any given personnel category. The figure before each group of variables (also see table-1) is the personnel pay increase.

$$0.05(81,600 x_9 + 82,200 x_{14} + 69,600 x_{15} + 70,800 x_{16}) + 0.06(89,700 x_1 + 89,100 x_4 + 90,600 x_{17}) + 0.07(88,800$$

$$\begin{aligned}
 &X_2 + 82,400 X_6 + 0.08(89,400 X_3 + 91,800 X_5 + 85,000 X_{13}) \\
 &+ 0.09(90,000 X_7) + 0.10(93,600 X_7 + 92,400 X_{10} + 91,200 \\
 &X_{11} + 1,96,800 X_{12}) + d_4^- - d_4^+ = Z_3
 \end{aligned}
 \tag{i}$$

**1. Funds for expenses**

A) Nursing division fund

$$Y_1 + d_5^- - d_5^+ = 13, 44, 000$$

b) Fund for physician’s fee

$$Y_2 + d_6^- - d_6^+ = 17, 22, 000$$

c) General services fund

$$Y_3 + d_7^- - d_7^+ = 19, 21, 500$$

D) Administrative expenses

$$Y_4 + d_8^- - d_8^+ = 4, 83, 000$$

e) Miscellaneous expenses

$$Y_5 + d_9^- - d_9^+ = 15, 22, 500$$

2. According to the trend of demand for hospital services, the administrator has established the desired number of employees in each personnel classification as a proportion of the total employees as shown in table-1. If we denote  $a_i$  as the desired no of employees in the category as a proportion of the total no of employees, 17 separate equations can be expressed by a general equation as

$$X_i - a_i + d_{i+9}^- - d_{i+9}^+ = 0 \quad (i=1, 2, 3, \dots, 17)$$

For example, for the desired number of nurses in the nursing service administration, the constraint will be

$$X_{1-5} + d_{10}^- - d_{10}^+ = 0$$

**Cost minimization**

The total cost for the hospital operation is calculated in this constraint. Hence, this constraint identifies the resource requirements to achieve the set of goals presented by the administrator. If a certain maximum resource is previously determined, it could be used so as to identify the degree of goal achievements with the given resources. In order to simplify the constraint, let  $b_j$  represent the average

salary figure for the  $j^{th}$  personnel category as shown in table-1 (i.e. Rs 89,700 for the nursing service administration etc.,).

Then the cost minimization constraint will be

$$\sum_{i=1}^{17} b_i X_i + \sum_{i=1}^5 Y_i + \sum_{i=1}^2 Z_i + d_{27}^- - d_{27}^+ = 0$$

**Objective Function**

The objective function for the model is

$$\begin{aligned}
 \text{Minimize } Z = &p_1 d_1^- + p_2 (d_3^- + d_3^+) + p_3 d_4^- + p_4 \sum_{i=5}^9 d_i^- + \\
 &p_5 \sum_{i=10}^{26} d_i^- + p_6 d_{27}^+
 \end{aligned}$$

**Result and Analysis**

The LPG problem used in the study contains 79 variables (decision and deviational), 27 constraints and 6 priorities (goals). The solution is obtained by using QSB+ software. The solution of the problem is given in table-9.4

**Table-9.4: Result Analysis**

|  |           |                |
|--|-----------|----------------|
| Goal attainment  |           |                |
| Manpower for service   | ( $p_1$ ) | : Achieved     |
| Equipment acquisition  | ( $p_2$ ) | : Achieved     |
| Employee pay increase  | ( $p_3$ ) | : Achieved     |
| Expenses   | ( $p_4$ ) | : Achieved     |
| Distribution of personnel  | ( $p_5$ ) | : Achieved     |
| Minimize cost  | ( $p_6$ ) | : Not Achieved |
| $X_1 = 5, X_2 = 24, X_3 = 3, X_4 = 4, X_5 = 4, X_6 = 2, X_7 = 3, X_8 = 2, X_9 = 4, X_{10} = 3, X_{11} = 1, X_{12} = 3, X_{13} = 12, X_{14} = 2, X_{15} = 7, X_{16} = 1, X_{17} = 6$<br>$Y_1 = 13,44,000, Y_2 = 17,22,000, Y_3 = 19,21,500, Y_4 = 4,83,000, Y_5 = 15,22,500$<br>$Z_1 = 2, 40,000, Z_2 = 5, 80,000, Z_3 = 5, 65,402$<br>$d_{27}^+ = 1, 55, 77,700$ |           |                |

The solution of the above model indicates that all the goals can be achieved at the total cost of Rs. 1, 55, 77,700. Since cost minimization is treated as the goal with the lowest priority factor, it is impossible to minimize to the cost to zero.

**Conclusion:** In this study, Olive Hospital, Hyderabad city was selected for the model design.

With no emergency physicians, patients are generally admitted by their personal physicians or through the emergency ward. The hospital's emergency room is staffed by local doctors on a rotational basis according to an agreement with the hospital. The linear goal programming problem is in the study contains 79 variables, 27 constraints and 6 priorities.

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1 Department of Science and Humanities,  
MLR Institute of Technology, Dundigal, Hyderabad, A.P., India.  
2 Department of Computer Science and Engineering,  
Avanthi Group of Institutions, Hyderabad, A.P India.