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MANAGEMENT OF SURGICAL WAITING LISTS IN PUBLIC HOSPITALS[1,2]

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ABSTRACT

Hospitals are considered public utility companies and are supposed to be non-profit institutions; usually they function in a political and highly complex environment. Managerial authority is shared between doctors and administrators and each of the two groups aims to formulate its own individual policies and pursue objectives that may not coincide or may even be in direct opposition to one another.

This situation is certain to affect hospital performance and it must be taken into account when proposing any kind of results analysis. Improving the efficiency of Hospital performance establishing quantitative target values to those objectives, some of them involving intangible benefits, is the main objective of any Hospital Administration.

The purpose of this study is to analyze through the M.C.D.M. approach, the inner coherency of the goals expressed by administrative Authorities. Also, applying Multicriteria Decision techniques we intend to design the real performance of surgical services at a local general hospital offering the decision centre a suitable methodology that allows us to analyze whether or not it is possible to improve the running of the services, taking into account all the real constraints, e.g. space, staff availability and financial support.

Keywords: Multiobjective Programming, Dynamic Optimization, Decision-Making, Hospital Management.

[1]This work has been developed with the inestimable help of Arias, E; G. Clouté, P; Gordo, J.L. and Ramírez, A. from the hospital that give us data and P. Gladish, B. PHD. student.

[2]This work was presented at the 14th. International Conference on Multiple Criteria Decision Making, held at the University of Virginia, Charlottesville (USA), from 8 - 12 June, 1998.

1 Introduction

Many real world problems may be modelled as multicriteria decision problems and a variety of modelling approaches to the problem have been developed; in general health care literature, the usefulness of optimization models has been demonstrated for problems of different types in the area but most of them are not applicable to hospital administration, because they have not accounted for nonfinancial, intangible benefits such as improving quality of service or covering community requirements.

To present the model in this paper it is necessary to look briefly at The Spanish National Health Service: The Spanish Constitution assures the right to healthcare of all Spanish people. The Spanish National Health Service covers 98% of the population - and is mainly run by the public sector. Sixty per cent of health care funding comes from general taxation, 29,4% from social insurance and 4,5% from other sources. Public health care providers are paid through regional health services by INSALUD with global budgets.

In order to have some autonomous management, at the end of each year, hospital managers must draw up a document called *Management Contract,* that expresses the objectives to be reached during the next year and also intends to establish quantitative target values to those objectives. This contract must be ratified by the Department of Health.

The Government aims to decentralise responsibility for management, as it searches for a way to improve efficiency and effectiveness and to control public health costs. Public hospitals will have more autonomy than at present from central/regional government, especially in the areas of operational management and human resource policy.

Several measures will be taken to control the increase in health care expenditure. Nevertheless, the percentage of GDP spent on health care will grow moderately reaching 6,86% of GDP by 1998. It is believed that a competitive environment will be created inside the public sector which will help optimise access, quality and cost of health care delivery.

Equity would be the basis and the principal goal of a National Health Service, but the only possibilty of permanence as a Public Service is based on its efficiency. In order to preserve it, public sector management responsibilities will be further decentralised and increased and evaluation criteria will be introduced to measure the effectiveness and efficiency of providers.

There are many factors behind inefficient delivery of health care services and increasing costs,

among them the inefficient allocation of resources or the inefficient use of existing facilities. Some of these factors are social and political in nature and they are hard to change. This means that hospital administration has become a very complex management process and it is essential to apply modern management techniques to assure the efficient utilization of medical facilities and resources.

This study attempts to apply a management science technique to improve the efficiency of Hospital Administration. An efficient delivery of health services through a more scientific management could be developed using Multiobjective Programming (MP) techniques.

We aim to elaborate a multicriteria model to design the performance of two surgical services at a General Hospital. Through the MP approach we intend to offer the Decision Center a suitable methodology that allows it to plan surgical scheduling over one year in order to reduce both waiting list numbers and waiting time for each process, taking into account all the real constraints, e.g. space, staff availability and financial support.

2 Formulation of the problem

In the introduction we mentioned Management Contract which must set out the objectives for each hospital. For 1998 the main political goal in all of them is to reduce the waiting time for surgical processes .

During the year the maximun waiting time may be nine months, but at the end of 1998 no one will be required to be on a waiting list more than six months. So the challenge for all hospitals involves getting waiting time down but mantaining costs within certain limits.

To reach the previously mentioned objectives, hospitals are allowed to use several methods of operating scheduling:

1.-Within regular-operating hours.

2.-Overtime.

3.-Private hospital contracts.

We are working with data from two hospital services: *Oftalmology.and Orthopedic surgery and Traumatology.* In the former we will study one process **Cataracts** and for the second we

will consider three processes: **Hallux Valgus, Knee Operations and Osteoarthritis.**

2.1 Program Variables and data

In order to reflect the dynamic waiting list of these four processes, we will define the following variables:

Table 1: *Program Variables* (i=1,2,...,12):

	Program State Variables	Program Decision Variables		
Process	Waiting List at 1st. of ith-month	Regular	Overtime	Private
Cataracts	CL_{i+1}	CR_i	CO_i	
Hallux Valgus	HL_{i+1}	HR_i		HP_i
Knee operations	KL_{i+1}	KR_i		KP_i
Osteoarthritis.	OL_{i+1}	OR_i		

CR_i,HR_i, KR_i OR_i represent the number of each process scheduled within regular-operating hours; CO_i the number of Cataracts done on overtime and HP_i, and KP_i the number of Hallux Valgus and Knee operations done in Private hospitals respectively; all of them during the jth month, i=1, 2, ...12.

We denote by: CL_1=480; HL_1=199; KL_1=132; OL_1=128 *the initial state* of the waiting list at 1 January 1998.

The Hospital has some monthly estimations about patient flow for each process, during the present year; they are expresed in table 2, *expected admissions*, and in table 3 *expected exit* without surgical process:

Table 2: *Admission*

Process/mths	1	2	3	4	5	6	7	8	9	10	11	12
Cataracts	84	85	82	94	78	104	125	42	78	98	94	86
Hallux Valgus	28	28	22	22	34	45	31	12	20	24	12	33
Knee Operations	21	22	18	15	30	18	15	12	24	18	21	13
Osteoarthritis	10	22	15	14	30	24	5	5	17	34	14	21

Table 3: *Exit*

Process/mth	1	2	3	4	5	6	7	8	9	10	11	12
Cataracts	1	13	16	16	20	37	53	12	19	20	17	7
Hallux Valgus	4	8	13	6	10	31	22	3	5	12	9	19
Knee Operations	3	5	4	3	10	14	4	0	7	9	1	5
Osteoarthritis	5	2	9	7	9	7	7	5	7	13	2	5

We denote by CA_i, HA_i, KA_i and OA_i the number of expected admissions for each process and for each month.

CE_i, HE_i, KE_i and OE_i represent the number of expected exit without surgical process for each process and for each month.

To assure spatial requirements, we take into account the time spent in each process : $CT = 80$; $HT = 80$; $KT = 120$; $OT = 160$ expresed in minutes, and the global availability of Operating Rooms by month and service, also expresed in minutes:

Table 4: *Operating Rooms Time*

Time/mths	1	2	3	4	5	6	7	8	9	10	11	12
$Oftal.(OQ_i)$	6000	6400	6240	5280	6400	6400	2640	3280	2640	7200	6400	4480
$Traumt(TQ_i)$	4640	4800	4800	4160	4800	4800	3680	3360	3200	5440	4800	4160

There are also monthly upper limits established for operating scheduling in some processes:

Table 5: *Monthly Upper Limits*

months	1	2	3	4	5	6	7	8	9	10	11	12
Overtime Cataracts	0	0	68	40	64	72	0	0	44	52	48	24
Private Hallux Valgus	0	20	25	35	35	35	35	35	35	35	35	35
Private Knee operations	0	0	8	21	21	20	20	20	20	10	10	0

Also we know the proccess *costs* of each way of scheduling, expressed in pesetas

Table 6: *Costs*

	Cataracts	Hallux Valgus	Knee operations	Osteoarthritis.
Regular	110852	125899	287973	853338
Overtime	123733			
Private		106605	141120	

We are going to denote by: CRC, HRC, KRC AND ORC the cost of each process on regular time; COC the cost of cataracts on overtime; HPC and KPC are the cost for Knee Operations and Osteoarthritis in a private hospital.

2.1.1 Constraints

a) *State equations*, i=1, 2, ...12.

$$\begin{aligned} CL(i+1) &= CL_i + CA_i - CE_i - CR_i - CO_i \\ HL(i+1) &= HL_i + HA_i - HE_i - HR_i - HP_i \\ KL(i+1) &= KL_i + KA_i - KE_i - KR_i - KP_i \\ OL(i+1) &= OL_i + OA_i - OE_i - OR_i \end{aligned}$$

b) *Operating Room by services:*

These constraints only affect operation plans in regular hours:

b-1 Oftalmology: $80CR_i \leq OQ_i$; i=1,...,12

b.2. Traumatology:

$$80HR_i + 125KR_i + 160OR_i \leq TQ_i \qquad i = 1, ..., 12$$

See OQ_i and TQ_i data on table 4.

c) *Bound to the number of processes on private and over time scheduling:*

$CO_i \leq l_i$; $HP_i \leq m_i$; $KP_i \leq n_i$ i=1,...,12

Table 7

	1	2	3	4	5	6	7	8	9	10	11	12
l_i	0	0	68	40	64	72	0	0	44	52	48	24
m_i	0	20	25	35	35	35	35	35	35	35	35	35
n_i	0	0	8	21	21	20	20	20	20	10	10	0

d) *Waiting list time upper limit: no more than nine months:* With the following ecuations we reflect that along the year the maximun time for patients to be in waiting list should be nine months.

$$\sum_{i=1}^{k}(CR_i + CO_i) \geq a_k$$

$$\sum_{i=1}^{k}(HR_i + HP_i) \geq b_k$$

$$\sum_{i=1}^{k}(KR_i + KP_i) \geq c_k$$

$$\sum_{i=1}^{k} OR_i \geq K_k$$

where parameters are defined in **Table 8**

months	1	2	3	4	5	6	7	8	9	10	11	12
a_k	11	26	50	116	153	224	309	398	480	556	628	694
b_k	9	24	62	92	103	130	153	165	199	223	243	252
c_k	4	23	35	49	59	82	100	119	132	150	167	181
K_k	3	17	34	38	42	61	94	107	128	133	153	159

e) *No more than six months waiting at the end of 1998.:*

$$CL_{13} \leq 395 \; ; \; HL_{13} \leq 69 \; ; \; KL_{13} \leq 77 \; ; \; OL_{13} \leq 57.$$

f) *All the variables would be general integers.*

2.1.2 Objectives functions

The priority objective in this problem is, as we have said, to minimize waiting list time at the end of 1998, then:

$$\min \quad f_1 = 80CL_{13} + 80HL_{13} + 120KL_{13} + 160OL_{13}$$

The second objective is to minimize operational costs

$$\min \quad f_2 = 110852(\sum_{i=1}^{12} CRi) + 125899(\sum_{i=1}^{12} HRi) + 287973\left(\sum_{i=1}^{12} KRi\right) + 853338\left(\sum_{i=1}^{12} ORi\right)$$
$$+123733(\sum_{i=1}^{12} COi) + 106605(\sum_{i=1}^{12} HPi) + 141120\left(\sum_{i=1}^{12} KPi\right)$$

Once all the equations have been developed we may model the problem as a bi-objective one which was developed through the weighted approach. We use weights reflecting Decision Maker's opinion: 0.8 for the first one and 0.2 for the second.

In order to solve the problem of homogeneity of objectives it is convenient to normalize the weights before introduce them in the joint function. The normalization procedure to be used will consist on dividing every weighting coefficient by the difference between anti-ideal and ideal points.

2.1.3 Results

The problem was computing using HYPERLINDO and integer variables. We have found the optimal solution of th integer program with th Integer Programing Optimality Tolerance (IPTOL), with IPTOL equal 0.0045. That means that this solution is no more than 0.0045 worse than the true optimal solution.

The problem dimension hinders to make explicit the complet solution: we will specify the objectives values of significative variables in **table 9.**

Process/moths	1	2	3	4	5	6	7	8	9	10	11	12
Cataracts Regular	75	80	78	66	80	80	33	41	33	90	80	56
Cataracts Overtime			68	40	74	72			44	52	48	24
Hallux Valgus Regular	10	4	3	0	0	0	0	0	0	0	0	0
Hallux Valgus Private		20	25	35	35	35	35	35	35	33	35	35
Knee Op. Regular	4	20	38	0	0	0	20	28	0	0	0	34
Knee Op. Private			8	21	21	20	20	20	20	10	10	
Osteoarthritis Regular	21	13	0	26	30	30	8	0	20	34	30	0
Monthly Waiting List	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Cataracts	481	473	393	365	279	194	233	222	204	140	89	88
Hallux Valgus	213	209	190	171	160	139	113	87	67	46	21	0
Knee Opeations	146	143	111	102	101	85	56	20	17	16	26	0
Osteoarthritis.	112	119	125	106	97	84	74	74	64	51	22	49

An upper bound of activity has been reached. And the most restrictive constrain was also verified, i.e., no one patient will be more than six months on waiting list at the end of 1998.

3 Conclusions

An important property in our model is the fact that can be easily made adaptive, in the sense that in every month in the year,where we have new information about current waiting list or updated forecasting for admision/exit of patients, it is possible to adapt the model in such a way that it incorporates the new information in substitution of the old one and we can obtain updated values after optimization, from that month to the end of the year.

The obtained results have been introduced and commented on with the decision maker. Even though we have yet to do a deeper study, the decisor maker´s opinion is very positive (he had previously doubted whether he would be able to comply with all the conditions laid down by the Health Ministry, particulary those related to six months maximun waiting time after the 30th of June).

We asked him specifically about whether there had been a problem of bed availability in the results coming out of Traumatology surgical processes (which require hospitalization). He replied that, in general, there had been no problems of this kind , any difficulties could, in principle, be dealt with easily.

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