Go Back

HDS: Health Department Simulator

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Abstract

Managing an health department which deals with a number of variable hospital applications, usually much more than the available human resources (doctors, nurses, …) and infrastructures (beds, laboratory instruments, …) is not an easy job. In addition, in order to supply hospital services, often with time constraints due to urgent situations, creates a complex environment for department manger. Just in time decisions become an essential necessity.

Building a "flight simulator" or better a "Hospital Department Simulator" can be seen with two major aims:

1. *The dynamic of process can be better understood, while constructing the dynamic model,*
2. *The effect of decisions can be evaluated in advance through running the simulator.*

The paper will describe both the structure of the model which has been developed to embed as much as possible the whole process of managing hospital applications against available resources (low of supply and demand), and a set of results produced in reply of what-if analysis.

Keywords: Health models, Flight Simulator, What-if analysis, Human resource management

1 Introduction

Managing any organisation which deals with limited resources and unlimited needs is a hard job! An health department in a big public hospital in Italy is very similar to above situation.

What can be done in such a situation is to approach the problem step by step with so called *good sense* and simplified process analysis without claiming to have the *magic wand* which offers any solution.

This is the spirit with which we have (and still are) approached (approaching) this project.

The health department we took in to account is a specialised division of a big hospital with autonomous management. As in many similar departments, the main problem seems to be that of not having enough resources to satisfy the patient applications in limited waiting time. In addition this department is organised not only to receive patients for normal hospitalisation but also to manage day hospital patients and to support with its resources also patients who request specialised visit which need to be supported by some particular laboratory or similar examinations. This situation implies the department manger to schedule continuously and dynamically in advance and possibly evaluate some what-if analysis in order to anticipate and hence govern some of incompatible scenarios which will unavoidableness occur.

System Dynamics analysis helped us to better understand the whole process and the simulation model built, seems to be a good tool, helpful to put in evidence all the main levers which the manager should take under control in order to do his work in the less worse way !

2 Model description

The simulator analyses the management of an health department in the following areas:

1. Patients application management
2. Health department human resource management
3. Health department other resource management

2.1 Patients application management

The model distinguishes between three different patient applications:

- Day hospital application,
- Doctor specialist examination,
- Normal hospitalise application.

The first one is carried out by two principle variables;

- The availability of health department personnel (Doctors, assistants, etc.) and
- The availability of other necessary resources for limited time period (rooms-beds, use of specific instruments, etc.).

The second patient application category is managed mainly by presence of specialist doctors.

Finally the hospitalise application depends specifically to the room availability and hence patient discharge time is influenced by hospital different resource availability.

Figure 1 depicts the main relations determining the dynamics of the " Patients application management" area.

The three patients application category are directly influenced by the so called *health department human resources factor* which is calculated through an algorithm in health department human resource management area.

2.2 Health department human resource management

This second area subsystem takes care of relations between the health department different personnel management.

The personnel is gathered in two different category:

a) Doctors, divided in two specialised group

b) Paramedical personnel, divided in three different groups

The gap of personnel is managed by an algorithm, through new personnel engagement taking into account the time to be spend, by each personnel type, in taking care of present and future patients application needs.

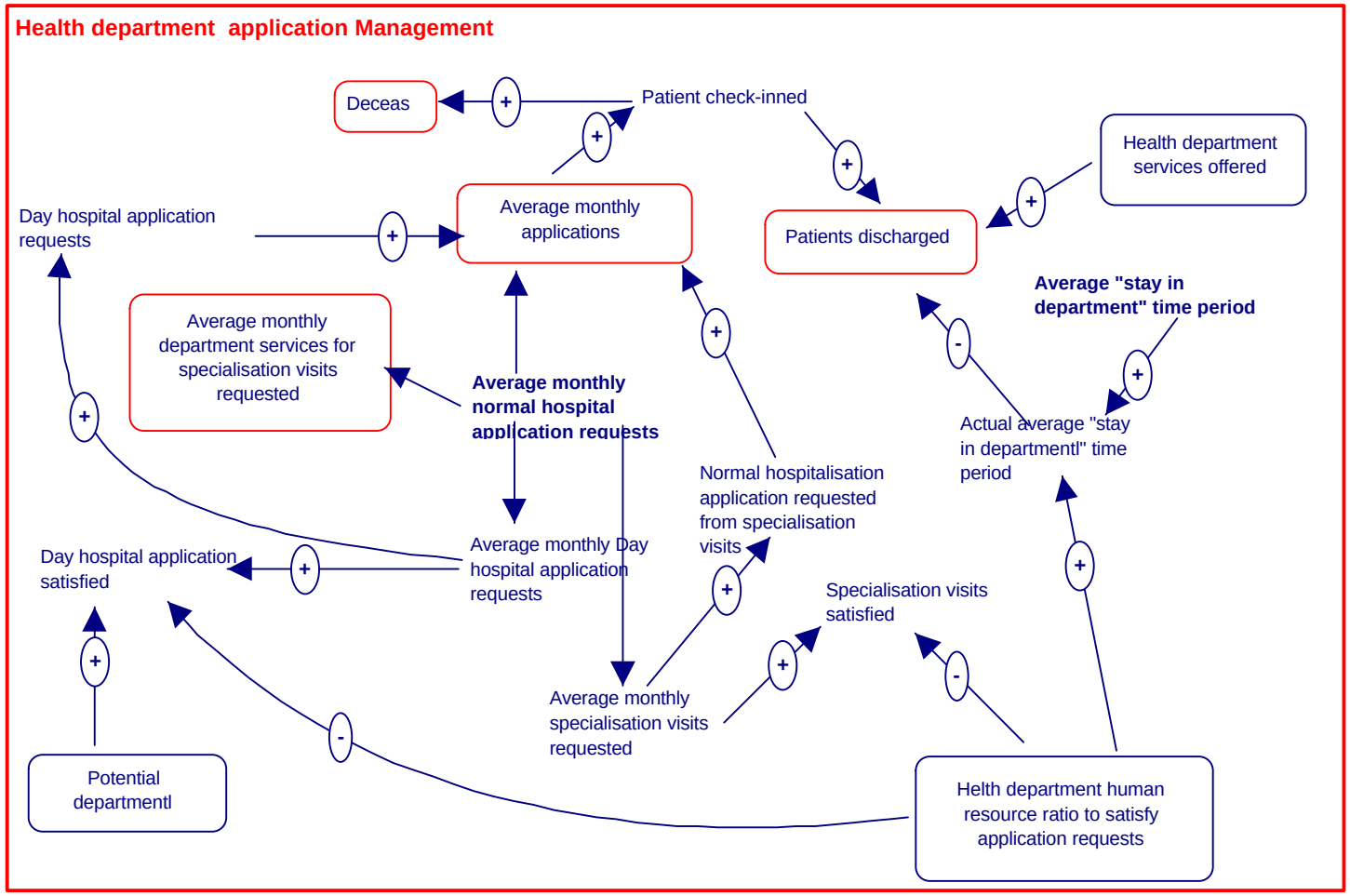

Figure 1 – Patients Application Management Influence diagram

In addition, as mentioned in previous paragraph, the algorithm is elaborated using *health department human resources*

factor which influences the patients check-in (day hospital, doctor specialist examination, normal hospitalise application) rate which itself is calculated on the base of two main elements:

- health department personnel needs and availability, expressed in day-person,
- an external weight parameter which is defined by each personnel category

Figure 2 depicts the main relations determining the dynamics of the " Hospital human resource management" area.

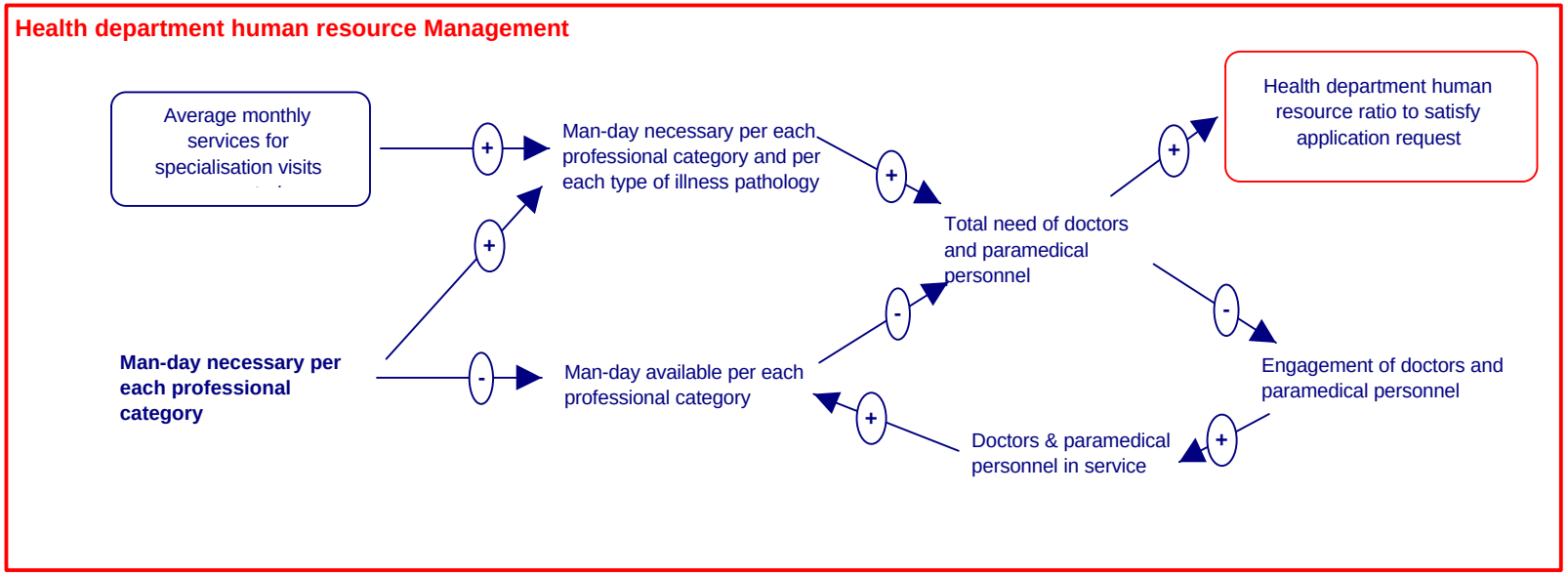

Figure 2 – Hospital human resource Management Influence diagram

2.3 Health department other resource management

The management of department services is detailed in the model by two vectors:

a) Application type (day hospital application, doctor specialist examination, normal hospitalise application),

b) Illness pathology type (alfa, beta, gama).

Hence the matrix which deals with the patient request of hospital services is always detailed with the above two dimensions (Application type, Illness pathology type).

As it can be seen in figure 3, the relations, even very simple, sufficiently represent the variables which influence both hospital other resources (beds and services) availability and need.

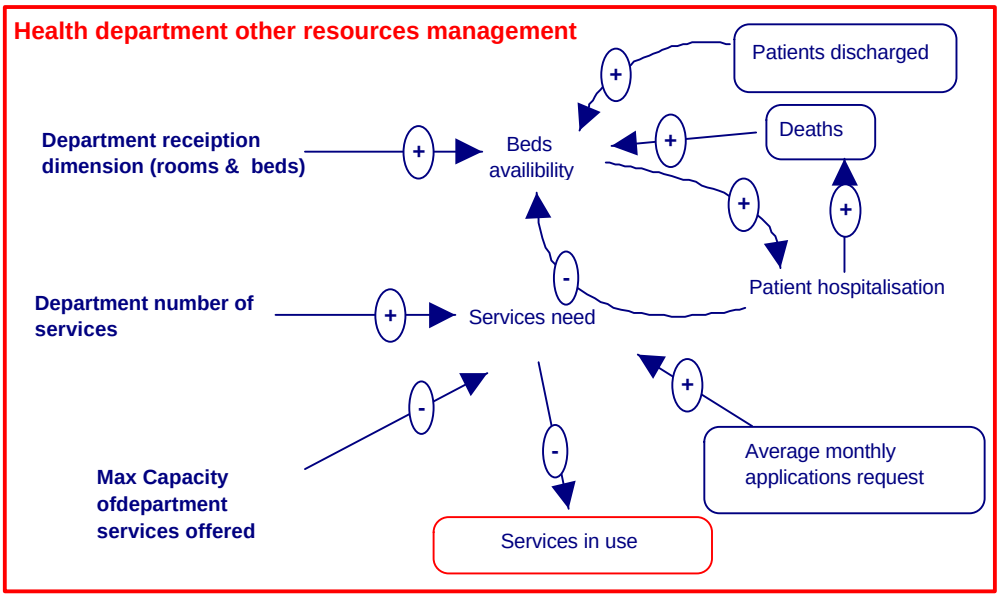

Figure 3 – Health department other resources Management Influence diagram

A simplified overall influence diagram representing the global interaction between the three above subsystems is shown in the following figure 4.

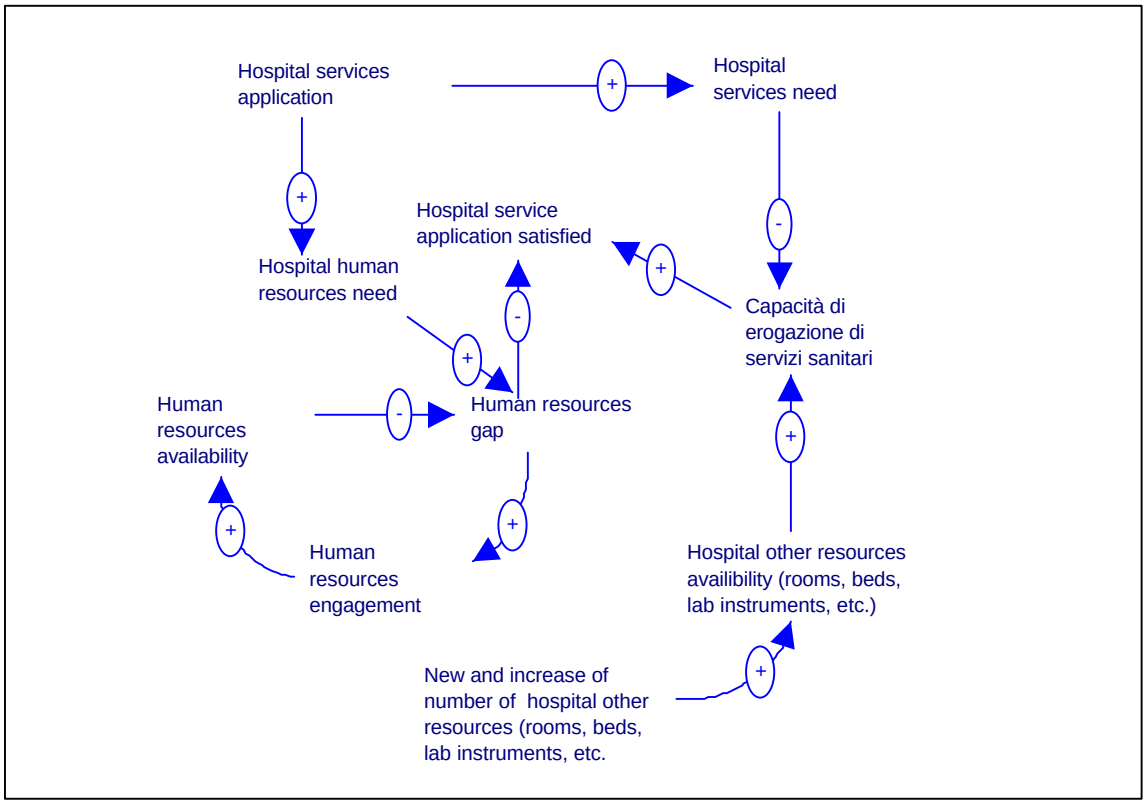

Figure 4 – Overall model Influence diagram

3 Description of the environment

Health Department Simulator (HDS) is developed in the first version in Powersim Constructor environment with two layers:

1) the front end,

2) the simulation model.

The front end is simple and intuitive and an exhaustive help on line is available. It contains complete scenarios (including sets of parameter values) or/and specific input levers, output results and simulation commands.

In figures 5 and 6 two front end windows are shown. One (figure 5)mainly represents a Scenario input data, and the other (figure 6), the results window where the user can choose to see different graphs or tables both during the simulation and at the end of model run.

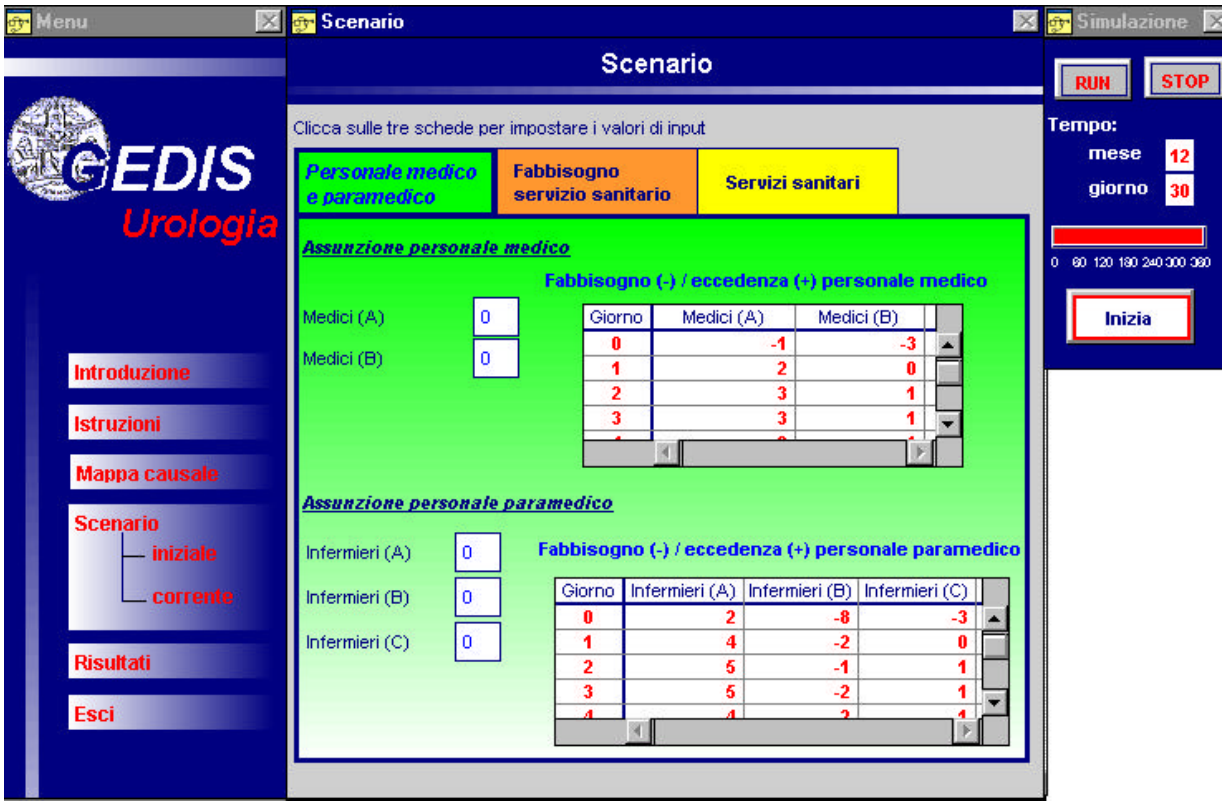

Figure 5 - HDS front end Scenario window

The HDS System Dynamics model simulates over a period time of 360 days (about 1 year)

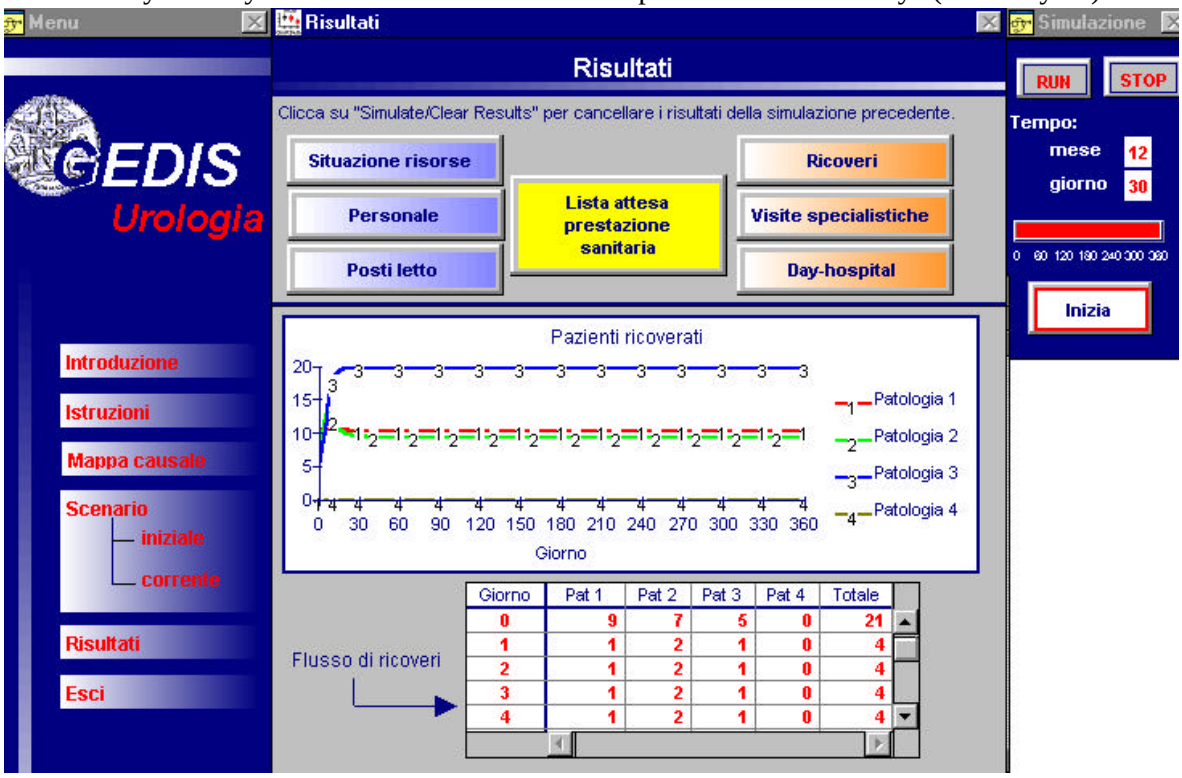

Figure 6- HDS front end Results window

with the simulation step of one day and decisions can be performed every 30 days (0ne month).

All simulation data (both user's decisions and relative simulation results) are recorded into the model in order to allow users to elaborate them after each run.

4 A what-if analysis performed through HDS

Here below with a description of an initial scenario and a what-if hypothesis, two possible solutions are evaluated through the model and the results are shown by different graphs.

4.1 Initial scenario

The model has been calibrated so that in a regular (ordinary) situation, the number of health department human resources (doctors, nurses, etc.) and other resources (rooms, beds, services needed, etc.) are "dimensioned" in order to manage always within 7 days waiting list, once a stable monthly number of applications per each type of illness pathology (1 to 4) and per each application category (regular, day hospital, specialisation visits) occurs.

The what-if analysis simply lies in evaluating how to manage, the resources, best once, due to different reasons, the illnesses pathology 3 and 4, have an unstable trend of monthly applications, through the whole year (see figure 7).

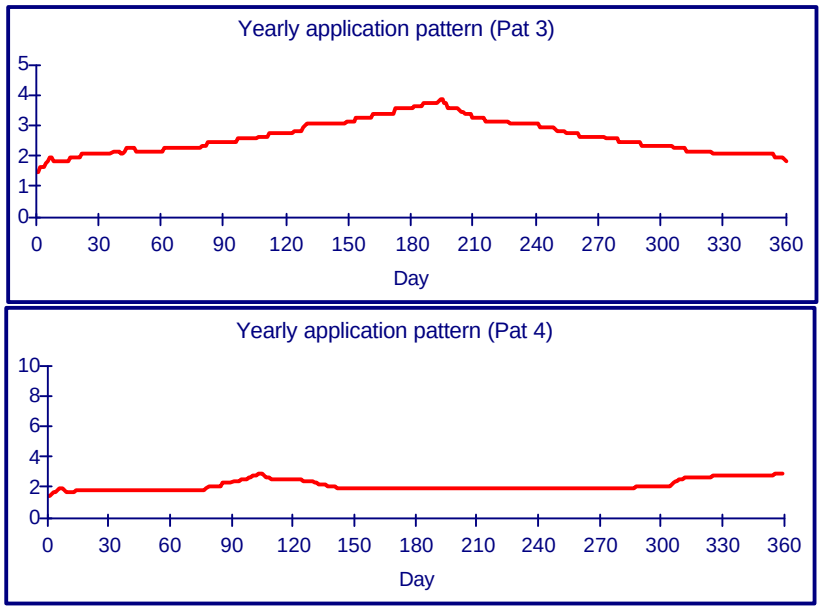

Figure 7 –Pathology 3 & 4 yearly application pattern

HDS model, once ran with the above yearly application pattern hypothesis, puts in evidence, particularly for the pathology 3, the overcoming time constraint of waiting list (at most 7 days) many times during the months of June-August (see figure 8, days 180-240).

In this situation the health department *manager* needs to act in advance and in the best way (minimum patients inconvenience, maximum service quality and possibly less department costs).

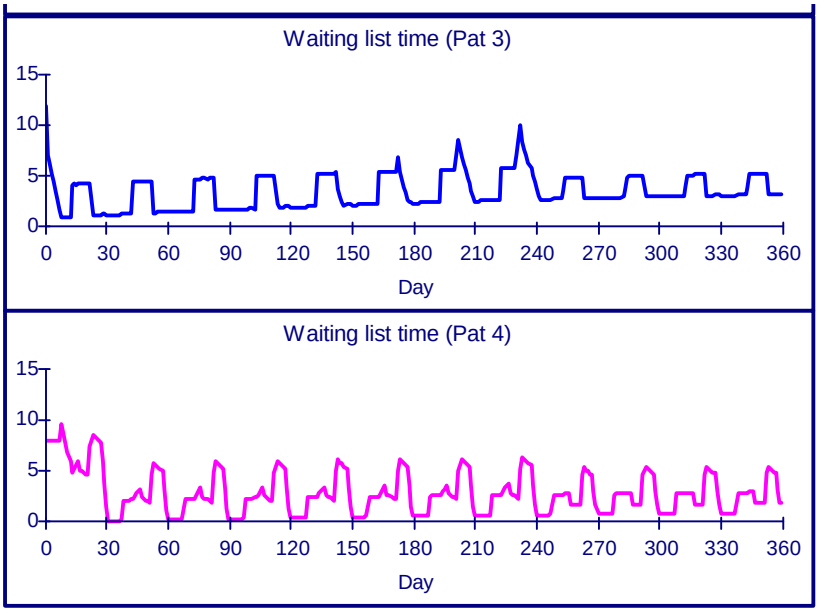

Figure 8 – Waiting list time for Pathology 3 & 4

HDS model, in fact, can help the *manager* in evaluating different solutions, taking in to account different scenarios. The model main levers on which the *manager* can work on are the following:

- Maximum number of available room-beds and their distribution management
- Personnel (doctors, nurses, staff) engagements and their distribution assignment
- Number of available services necessary to treat different illness pathology and their management

Hereby we analyse two different strategies:

1) Easy but expensive; mainly increasing the number of available room-beds and their distribution
2) Complex but cheaper; balancing human and other resources management plus continuos room-beds distribution management

In order to evaluate the cost to reach the desire solution, through different approaches, in figure 9 the management cost of the department in the normal regime is shown.

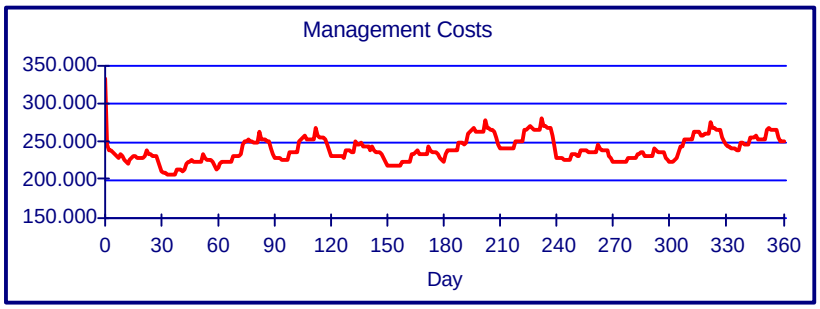

Figure 9 –Management cost during the normal regime

4.2 First solution : Easy but expensive

As one of the bottle neck variable of the model is concentrated on maximum number of room-beds available in the department; in order to decrease the waiting list time , particularly in the critical period of simulation, a simple action is to create the condition to increase the number of beds for the critical period.

The solution depicted in figure 10 which represents the waiting list time for pathology 3, once the maximum number of beds available is increased by 10 units, has a significant cost management impact (figure 11).

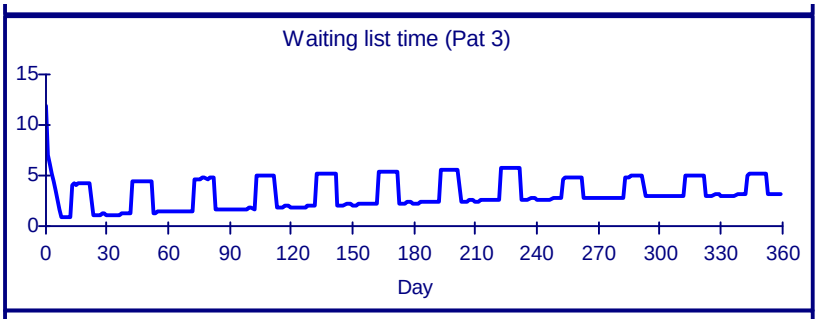

Figure 10 – Waiting list time for Pathology 3 with the solution *Easy but expensive*

Figure 11 –Management cost with the solution *Easy but expensive*

4.3 The second solution: Complex but cheaper

The second possible alternative is approached due to a better management of overall available resources:

- an "optimum" number of human resources necessary to manage the department applications
- an adequate management of other resources necessary to specific pathology applications
- a minimum unit increase of total beds availability

As it can be seen in figure 12 , almost the same waiting list time result, as the above solution (compare to figure 10) can be reached with, may be, a little bit of *elaborated* management but surely much less (compared to figure 11) management cost (figure 13).

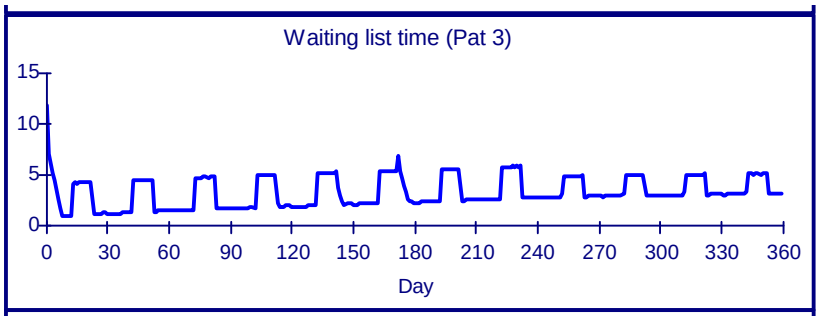

Figure 12 – Waiting list time for Pathology 3 with the solution *Complex but cheap*

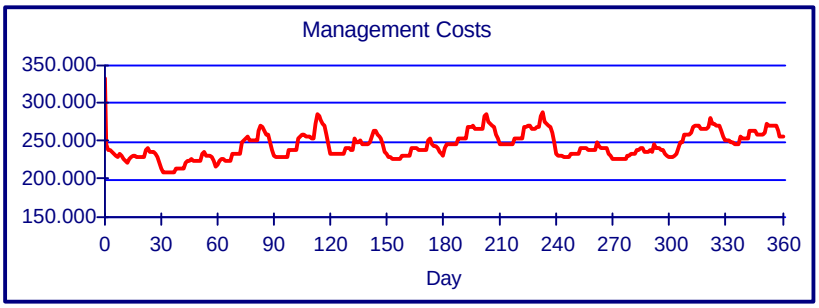

Figure 13 – Management cost with the solution *Complex but cheap*

5 Conclusions

In figure 14 the base (regime) management cost of the health department (curve marked with 1) is compared to the two above (curves marked with 2= first solution and 3=second solution) solutions management cost .

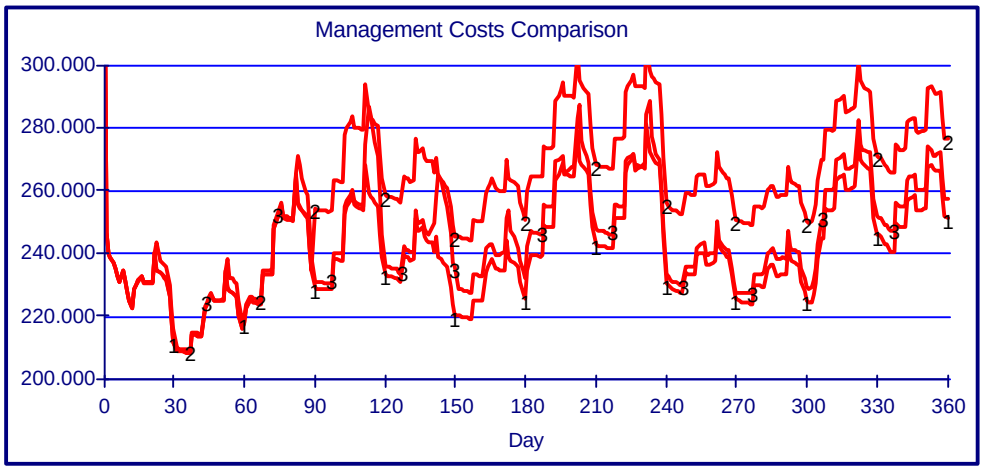

Figure 14 – Management cost comparison

While the accumulated year cost in the second solution is very near to the base simulation, the first solution total management cost is more than 10% of the department total base cost.

This means that being able to evaluate in advance some accurate decisions can help to make adequate actions together with possible save money decisions.

With this result the development and use of the model have convinced the health department manager to adapt the HDS as a support of his decision process.

In addition the HDS project development has changed the way of working of department manager, mainly through the following points:

- acting with a systemic approach rather than pure experience i.e. simply planning to increase the number of bed-rooms to resolve the periodic excessive waiting list time,
- being aware of different scenarios and in addition to evaluate these alternatives in advance with different economic solutions,
- better understanding of the whole process with the knowledge of principle system levers, through managing of which, different problems can be evaluated.