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Some of models in decision support systems on the example of a surgery unit.

Abstract

This paper present some of models for an intelligent Decision Support System for the surgery unit . The system is designed to support decisions in scheduling the surgery on surgery units. Based on historical data of the patients flow, the operations costs and the expected time of the surgery.

Keywords: knowledge engineering , decision support system, base model, planning of the hospital service, optimization

1. Introduction

In recent years, we have to deal with the dynamics of changes in various organizations and institutions, particularly in concerns. These changes mainly result from the development of the economy: increasing competition, which allows a whole new actions in the management and manufacturing. Requirements are placed on raising skills by employes at different levels of management. Teamwork is specialized to use modern technology for production of goods and services and introducing innovative techniques of services. The possibilities of computers and communication techniques are being used more wildly. Integration of technological and organizational processes takes place. Norm for many companies becomes a computer decision support as well in management and in manufacturing [1,2,3]. At all levels of management decision-making process can be supported by DSS systems.

In this work the possibility of using the system class DSS for the urban hospital is in hand. Hospitals organization as well as taking care of patients depends equally on the organization of the country, country's wealth and from general medical condition. That what requires hospitalization in Poland, does not require it in England. Taking into account the hospital as a business organization, we are dealing with different types of decisions at the management level. These decisions have an influence on the further work of the hospital [4].
Among the various hospital problems we can specify:

1. Signing contracts with NFZ (National Health Fund).
2. Reinforcement hospital unit in accordance with the results of the analysis of profit and loss account.
3. Specify the quantity of medicines that will be needed in the next period on the basis of statistics of use the medicines in the previous years.
4. The extension of medical services, which will bring benefits to the hospital, and discontinue those that cause large losses.

Typically, the surgery unit carries out two types of surgical operations: operations not scheduled, unless there is a risk of a patient's life, and operations planned, when the patient may wait for the treat.

Hospitals use different methods of signing for the surgery. One of them is when a patient goes to the registration with doctor’s referral, where will be reserved for him the first free term. In this case, several problems may arise. Among other things, there can be a problem of large losses due to high operation costs. There are few records of the operation of so-called "dirty" in a single day, which means that the operating rooms will be blocked for about 2 hours after the operation because of the disinfection. There are situations when a patient may be in a hospital for a few days waiting for the operations, which exposes the hospital to the loss because of the patient staying for the night. Consequently, in order to provide the necessary support in surgery planning process, the problem of creating supporting models should be resolved. This paper examines the problem of the modeling in support of surgery terms planning in such a way as to minimize the loss of the hospital.

2. Components of decision support system for the surgery unit

The paper [5] was presented a simplified model of the formal structure of the class DSS. Using this model we can provide decision support system components for the surgery unit in the hospital what is shown on figure 1. The hospital operates an information system that is used to settle with NFZ as UHC's information system - a system of settlement service providers, based on so-called Homogeneous Patient Groups . The system is going to get its own database and knowledge base. Acquisition of knowledge is the task of programming agents that will be built into the system in order to facilitate access to knowledge, and optimize system. Analysis Center is the most important unit in the system, its task is to process all the data that are needed for analysis. Using database and knowledge base system on a local level and from other online databases using the OLAP.

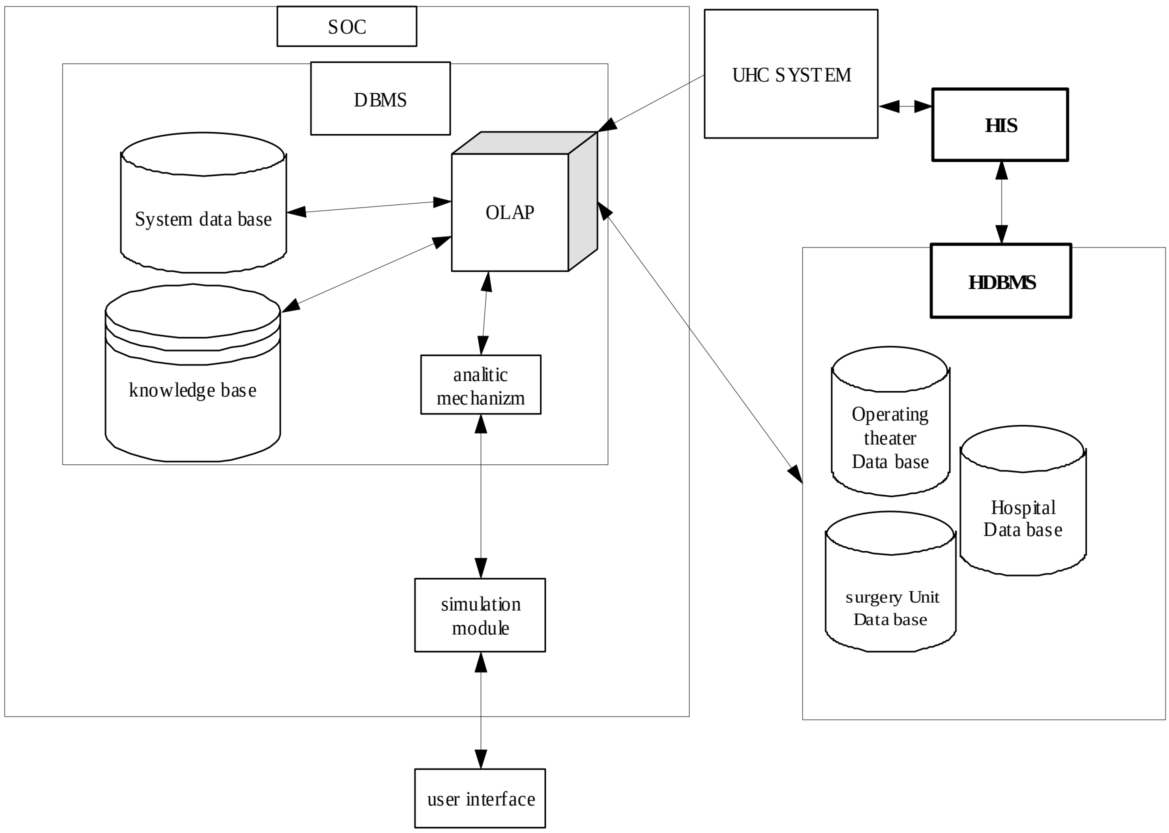

Figure 1. Components of decision support system for the surgery unit

Source: Own study.

3. The base model of decision support for hospital

In systems fully deserving the name "Intelligent Decision Support System" one of the most important role is played by the knowledge base [2,3,6,7]. Its major components are to perform the simulation models, the results of which will take the adequate decision. In Table 1 some of the models included in the decision support system for the hospital are presented.

Table 1. A list of some of the models included in the SWD- SOC
Source: Own study.

MODEL	Set	explanation
1.Surgery cost model [8]	KXi={Ki,W}	KXi – surgery cost, Ki – surgery cost elements, W – prices rate growth.
2.Operating room booking model	Ri={Xi,Ti,Bi,Ii}	Ri - booking operation room, Xi - the type of operation, Ti - the average duration of the operation, Bi - the type of operation in terms of purity, Ii - the tools needed to complete the

		operation.
3. Surgery duration model	Ti={Xi,Ci,Zi,Tpi}	Ti - the average duration of operation, Xi - the type of operation, Ci - joining complications Zi-the team performing the operations. Estimated time of operation can be defined using: Tpi = (Tmin +4 * (TSR) + Tmax) / 6 Where: Tpi - provided time of operation, Tmin - minimum time of operation, TSR - the average time of operation, Tmax - maximum duration of operations.
4.Surgery profit model	Zi={Xi, PXi, KXi}	Zi – profit , Xi - surgery, PXi - income, KXi - cost.
5. The health condition of the patient model	Sj={Wj,B1,B2,..,Bn}	Sj - the overall condition of the patient, Wj – patient age, B1...Bn - medical examination results
6.Operation rank model	Oij=(Xi, Ti, Zi, KXi, Chj, Sj ,Wj , Ri,Hj)	Oij – operation rank, Xi – operation type, Ti – the time need to make such operation Xi, Zi - profit, KXi – average cost, Ch - other diseases that cause the occurrence of complications, Sj - Patient's health status can , Wj – patient's age, Ri -the risk assessment is the occurrence of complications with such an operation, Hj – hospitalization in days .

3.1. The model of the surgery number planning for the next year

The model of the surgery number planning for the next year is one of the most important models in the system - he assisted in the construction of a surgery unit planning number of surgery to minimize losses caused by making not cost-effective surgery at the unit. The first question that must be given the answer is: how many and which surgery should be make to get the maximum profit.

The function is a linear function:

$$\sum_{i=1}^{n} CiXi \rightarrow MAX$$

$C1X1 + C2X2 + \ldots. CnXn \rightarrow max$

where: Ci is the number of procedures performed type Xi.

Restriction:

$X1, X2, X3, \ldots Xn \geq 1;$

$$\sum_{i=1}^{n} ZiXi > 0$$

amount of profits is limited by the number of points in the contract with the NFZ.

$PX1 + PX2 + .. PXn = QR$

where: Pi - points for surgery Xi, QR - the sum of contact points. Another limitation is the restriction of working time.

$T1X1 + + T2X2 \ldots. TnXn \geq ER$

Ti - the average duration of treatment Xi, ER - the sum of hours of work during a year.

To reduce the number of surgery that can be grouped - approximate sets are used here [9] since we combine the operations with similar characteristics. In Table 2 characteristics of the surgery, which are joining in our system, are presented. We will combine surgery with similar characteristics,

$$Gi = (Xi, Zi, Ti),$$

where Gi is a subgroup Xi operation with a similar time Ti and similar profit Zi.

It follows from this new feature to record:

$C1G1 + C2G2 + \ldots + CnGn \rightarrow MAX$

With our restrictions we gained smaller number of variables improves the search for optimal solutions.

Table 2. The characteristics of the operations performed on the branch of surgery

Source: Own study.

Surgery	Cost	Profit	Hospitalization	Time
X1	KX1	Z1	H1	T1
X2	KX2	Z2	H2	T2
…………….	………….	…………..	…….	………
Xn	KXn	Zn	Hn	Tn

3.2 The estimates model of the surgery cost

The database storing the characteristics of all available strategies is used to evaluate each strategy with respect to the criteria described in the previous section (i.e., feasibility, surgery time, hospitalization time and cost).We propose a fuzzy model, which evaluates the operations and provides them with the ranking. Rating "review" has a strong influence on the decision of the date of the surgery. With the expert medical knowledge base can be designed in such a way as to show the relationship between the facts. In some cases, it is significant. For example, the time of hospitalization may be extended due to patient other diseases and his condition, which causes an increase in the cost of surgery. Complications caused by the surgery can influence the opinion about the risk postoperative, which can cause a risk that the patient will have to return to the operating room, and this generates additional costs for the unit. On the other hand, the rules may dependent more of the accuracy of the division. Oij=(Xi, Ti, Zi, KXi ,Chj, Sj ,Wj , Ri,Hj) [table 1]

IF Ti is.. AND Zi is… AND KXi is… AND CH is… AND Sj is… AND Wj is… AND Rj is… AND Hj is… THEN Oij=… ?

Where:

Ti={VS,S,M,L,VL} Surgery duration in minutes, it can be: very short [0-40]min - VS, short - S [30-50]min, medium [45-110]min - M, long [100-240]min - L, very long – VL[200-1000]min;

Zi={BL,SL,NZ,Z,S,M,B} The profit from the operation in PLN: [-10000 - -2000] BN big loss, [-3000 - -100] SN small loss, [-200 - 200] NZ near zero, [100 – 1000] S small, [800-3000] M medium, [2000- 10000] B big;

KXi={VS,S,M,B,VB} Operations costs in PLN:[0-100]VS very small, [80-800] S small, [700-4000] M medium, [3000-15000] B big, [10000-100000] VB very big;

Ch={YES,NO} Are there any diseases that cause the occurrence of complications;

Sj={B,A,N,G} Patient's health status can be: [0-2] B-bad, [1-4] A-admissible, [3-6] N-normal, [5-10] G-good;

Wj={VY,Y,M,O,VO} Patient’s age: very young, young, medium, old, very old;

Ri={ VS,S,M,H,VH } The risk assessment is the occurrence of complications with such operation may be 0 to 10: VS[0-1], S[0,5-2,5], M[2-4], H[3,5-7], VB[6-10];

Hj={VS,S,M,L,VL} The hospitalization time: VS very short [0,2], S short [1,3], M medium [2,6], B big [5,10], VB [8-20] very big.

Assuming that only a moderate number of fuzzy sets is used for each input this would result in a combinatorial explosion in the number of fuzzy rules, that is a total of more than 60000 possible rules would be required [10,11,12]. The design of such a huge fuzzy inference system would be extremely tedious and the extreme partition of the knowledge space into hundreds of thousands of rules (most of them being of insignificant value or even impossible to occur in reality) would no longer directly reflect the experts' knowledge about the system. Moreover, such a system would be slow in execution speed and requiring a very large storage space. In order to overcome these difficulties, the proposed fuzzy block was hierarchically decomposed into the interconnected fuzzy subblocks KB1–KB6 shown in figure 2,3.

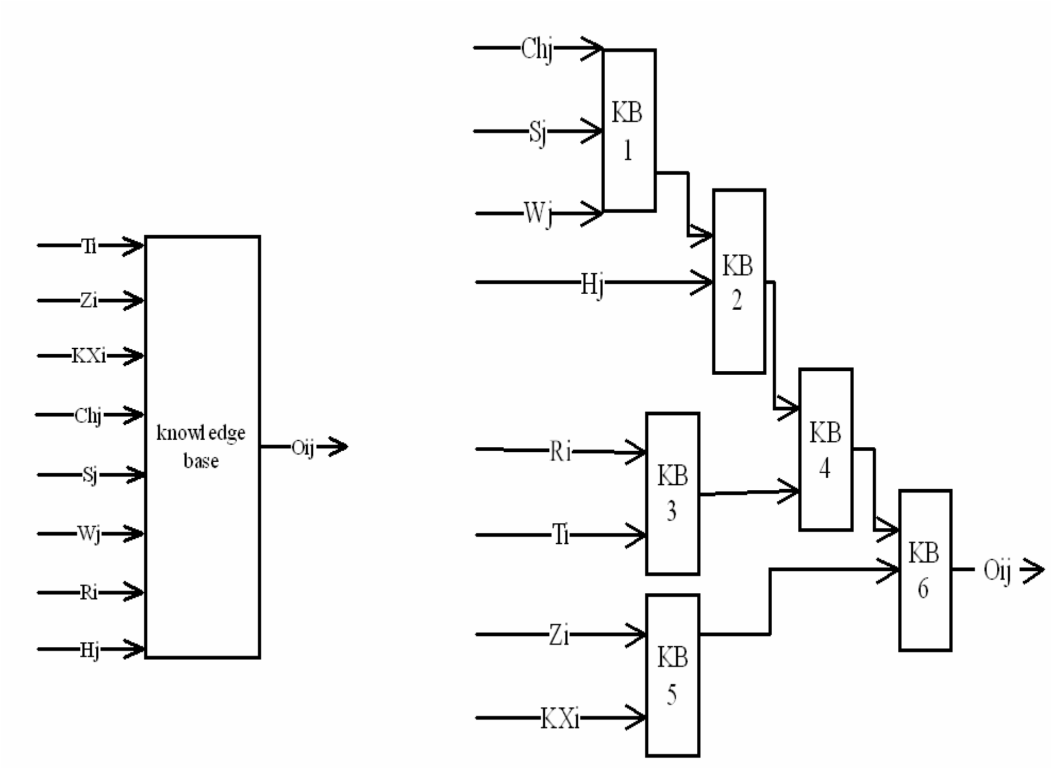

Figure 2. Hierarchically decomposed into the interconnected fuzzy subblocks.
Source: Own study.

Conclusions

Scheduling the operations mechanism starts when we give the registration system the patient's data. The first condition is whether the patient situation is a life-threatening condition. If it is addressed to the agent system who is responsible for booking the operating room and the resources to perform medical services. Otherwise the data is taken to the calculating process to set the weight of his surgery what is based on the model presented in section 3.2.

The next step is to compare the weight with the standard norm, which is defined in the system. This norm is adopted, according to the selection operation by the hospital experts. There are two cases:

1 - the weight is bigger or equal to the norm that is acceptable to the operation and unconditionally passed on to the next stage of the surgery's verification, where the weight is calculated for the second time. If the weight will be about 10 the patient will be adopted as soon as possible, if not the operation is posted to the agent's planning procedures;
2 - the weight is less than the standard operation – it is sent to verify whether there is a limit to the exercise of that type of operation. If so, the operation is posted to the agent's planning of operations, and if not the operation will be scheduled at a later date.

The system components are presented to encourage the process of planning operations on the surgery unit and the hospital, section of the algorithm is an example of registration operations per patient. A model to assist planning of the operation amounts to the construction of a branch surgery strategy, aimed at minimizing losses and models for knowledge acquisition. The model also estimates the cost of the patient operation, which helps to confer the rank.

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