HEALTH CARE PROCESS BASED ON THE ABC MODEL THROUGH A META-STRUCTURED INFORMATION SYSTEM

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Keywords: Medical information system, UML packages, ABC method, care process

Abstract: We propose in this article to define a system which generates a generic care process based on the ABC method. For this purpose, we adapt dynamically the medical information system with UML packages in order to generate some semantic and syntactic links between the different packages that represent the "business objects" of a hospital. These packages contain all the information related to a specific problem for all the patients. So we are able to extract the particular data concerning a criteria (diagnosis, IP number, etc.) and a patient and, in that manner, to re-build the care process. The ABC method gives the skeleton of the care process and allows the definition of costs on a particular care process (e.g. the care process of the patient "John" concerning the disease "kidney failure" in the hospital H).

1 INTRODUCTION

A serious problem is always noticed in hospitals; the great difficulty to coordinate medical information systems and management ones. So the financial evaluation of a care process is really difficult to do. It implies the extraction of the good data in the different information systems, the ability to re-build the patient care process and to evaluate the cost of this process. The data used to create the care process exists but its semantic and syntactic concatenations are very hard to make. So to couple an information system with a method which is able to identify the costs objects can be interesting to 1) build a generic care process, 2) define a particular care process and 3) propose a result-cost for this care process. The Activity-Based Costing method allows us to have a better understanding of the organisation management

We propose in a first paragraph to briefly consider the related works. We will continue with our approach and finish with an experimental study.

2 RELATED WORKS

2.1 ABC in medical areas

The ABC method was recently developed, in France (less than ten years old). Generally, we attribute it to (Kaplan, 1984). The authors initiated the criticism of traditional cost accountancy and proposed the ABC method. This method has been developed by several authors (Cooper, 1990), (Turney, 1991) and (Brimson, 1991).

All these authors share the same observations: the structures of the organisations transform themselves, the concept of the product is significantly modified, the logics of management are no longer the same. They concluded that the system of costing is no longer relevant.

ABC appears to be more coherent. It is based on a detailed analysis of processes and permits a diagnosis of quality, delay and cost of the different activities and finally facilitates the identification of factors which hinder the performance of activities and therefore of the organisation.

The inherent logic of ABC can also be presented as follows: Activities identification, activities

Verdier C. and Cluze G. (2004).
HEALTH CARE PROCESS BASED ON THE ABC MODEL THROUGH A META-STRUCTURED INFORMATION SYSTEM.
In *Proceedings of the Sixth International Conference on Enterprise Information Systems*, pages 149-154
DOI: 10.5220/0002622301490154

analysis, process construction, cost identification, activities cost description, costs calculation.

This technique is rarely used in the service sector and practically never introduced into health care centres (the rare French attempts to introduce it concerned the industrial activities of hospitals). This confers an experimental character on our work.

ABC presents besides, characteristics which, for us, seem particularly well adapted to the specificity of the production of health care. And thus the absence of a production function, the difficulty seizing the nature of the product, the confusion between the customer and the patient, the non standardisation of the processes of health care, the development of care networks, the environmental complexity, etc. are features which seem, from our point of view, linked with the concepts of transverse process and flexibility which are the bases of ABC.

Added to that, the ABC method can be used both for the health costs management in hospitals and to help find a financial solution when the resources decrease. The first experience in hospital is quite new (Baker, 1998). It was followed by several ABC applications in different countries: Germany, Great Britain, Spain and Australia (Abernethy, 1995). In France, despite of an increasing interest in ABC applications in hospitals, there is no real application. In Strasbourg (Biron, 1998])an ABC experiment was created in hospital but only concerning the medico-technique activities.

2.2 Treatment chain

The enormous possibilities within diagnosis and therapy lead to an extreme specialization of medical tasks. So, it becomes difficult to identify the treatment chain within a same medical organization. The problem is increased when we consider several health places; in that case, the treatment chain evaluation requires a coordination of the different information systems, the management of missing data, the interoperability of the systems, etc.

But, the requirements of the justified medical costs lead the researchers and the practitioners to discard a unit-centered approach (to care and to evaluate) in aid of treatment chain value.

The successful projects match static and dynamic models (especially UML tools) with activity diagrams or workflow procedures. Two main difficulties have to be affronted beyond: the accurate aggregation of the patient medical data and the dynamic links between these data.

In (Ammenwerth, 2000), the authors consider 5 views of the treatment process (roles and activity profiles, documentation, business processes, communication and cooperation). They mix the different tools related to every view and propose a solution to catch the treatment process.

In (Dadam, 2000), the authors develop a workflow tool called Adept which considers in conjunction all the aspects of the workflow process : robustness, security and flexibility.

In (Yousfi, 1996) and (Bricon-Souf, 1998), the authors develop a computer-based system supporting cooperative planning in critical care environment called Placo. They particularly develop structured and unstructured messages that are generated firstly by the system and secondly by the users.

Some researches work upstream in order to offer gathered data, explored in syntactic and semantic ways. We can cite works concerning visual approach for browsing huge amount of data (Tanin, 2000). Some other researches concern the design of specific interface in order to display all the dispatched data (wherever their health places creation). We can cite for example (Ouziri, 2002).

These approaches essentially deal with a real and complex problem that is the capture and retrieval of the right information in the right place in order to improve the medical follow-up of the patient.

3 OUR APPROACH

Our approach is a bit different. We propose a system that couple together evaluation techniques (ABC method) and information systems.

The main question is how to reconcile the necessity to have a justified medical health cost of patient cares and the difficulty to semantically and syntactically gather distributed medical data. Our system proposes to create a generic care process that can be instantiated according to every patient or every criteria from the existing information systems. Then we build an ABC system. The system model is a necessary stage, the theory is useless in practise without the system. The ABC system permits the application of the model into the health care sector. The system is enriched by successive experiments of the ABC, the progress of the research and our experiment in practice. After the organisation analysis, we conceived the idea of the « flow of patients » and the cost of this flow. We linked the concept of the « flow of patients » with the concept of procedures : we think that this idea is completely original in the domain of management and economics in France. To create that system, we propose three steps.

Three main parts can be identified :

The meta-structuring of the medical business-object

The definition of the generic care process

The instantiation of a patient care process with a concrete example.

3.1 Meta-structuring of the medical business-objects

To represent the whole activities of a hospital, we use the UML package notation to factorize homogeneous parts of models (that is to say elements of model getting the same « semantics » according to one criterion). A package can be defined as the following: a package is a grouping of model elements or packages. Packages themselves may be nested within other packages. All kinds of UML model elements and diagrams can be organized into packages. Packages own model elements and model fragments and are the basis for configuration control, storage and access control (UML, 1997). That definition supposes that (1) a package is homogeneous according to a criterion, (2) that it can be derived according to the goals and tools of the organization and (3) that the links structuring itself can be defined as needed.

3.1.1 Description of the business objects package

The packages in our approach are declined according to the criterion business-objects that are, specifically in our study, the only way to catch all the « businesses » of a hospital.

The different « business-objects » of the hospital are the following : to welcome (the patient in the hospital or in a particular service area), to diagnose (diagnostic procedures that help to know the patient's disease), to care (therapeutic procedure that helps to increase the health of the patient), to operate on (techniques and resources used to operate on a patient), to control (medical control procedures), to train (traditional training or continuing education), to feed (the patient during his stay), to clean (cleaning of the surgical/medical instruments and premises), to transport (outside or inside the hospital), to manage (resources allocation to succeed in the care process), and to accomodate (beds management). The different packages corresponding to each business-object of the hospital are described in figure 1.

NB : The packages contain some activities that can be divided into tasks.

3.1.2 Contents of the packages

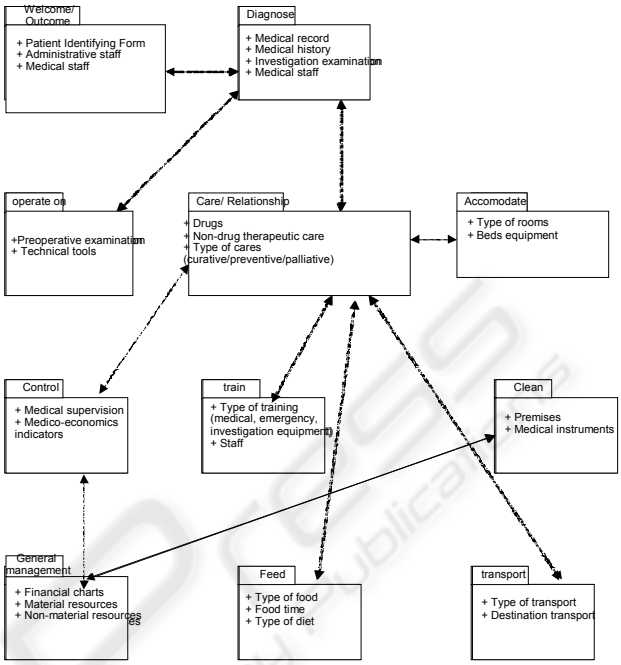

Figure 1: Description of the hospital activities with UML-packages

Every package is independent from the others. It implies that the information system can focus on one part or another. The content of a package can be declined as wished. More precisely, all the types of models can be described in every package. In order to design the static part of the information system, we can use a class diagram. Every part of a conceptual model (grouped into a package) corresponds to a distinct part of the activities but it can be linked to the rest of the model if needed. For instance, we can show the description of the class diagram of two packages: « welcome » and « diagnose » (figure 2).

The class diagram of the package « welcome » contains three classes: the patient identifying form, the hospital staff and the administrative staff. The class administrative staff inherits (like the class medical staff in the package « diagnose ») from the class « hospital staff ». The only difference between them is the nature of the occupation, so it is better to factorize properties and methods in the class « hospital staff ».

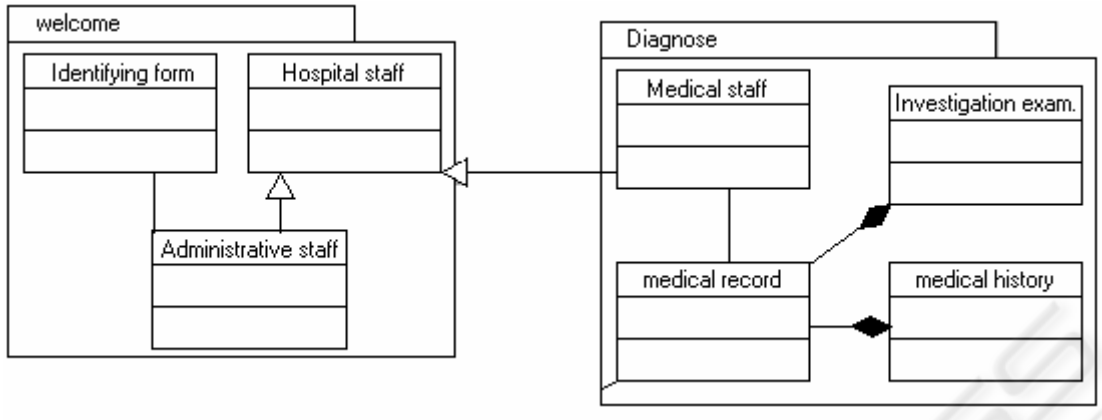

Figure 2: Class diagram in two packages

In the other package, four classes are present: the medical staff linked throughout the package to the class hospital staff, the medical record which is composed of the class Investigation examination and Medical history. Every package has to be filled like the two others and the association links between them must be created. We precise that the description of the class diagram in the different packages consists in the static design of the whole information system. One of the advantage is that the design of the IS is totally modular and every part can be created after each other without disrupting the existing running. Another advantage consists in the ability for the organization to reuse the part of existing applications with the restriction of the linkage between them and the IS.

3.2 The generic care process

The package representation of the medical information system makes easier the extraction of the generic care process.

Every activity is linked to the other by a syntactic link which role is to coordinate the data through a criteria: the IPP number, the disease, etc.

To realise our objective, we cross examine the ABC accountancy and the "package" information system. Resources are attributed directly to business-objects of the organisation. The activities are regrouped into macro-activities which are shared between cost items according to cost drivers. Doing that, we notice that analytical accountancy centred on activities induces a different view of information systems.

This new approach requires to have a particular information system, able to supply a multi-views of the whole hospitals information systems.

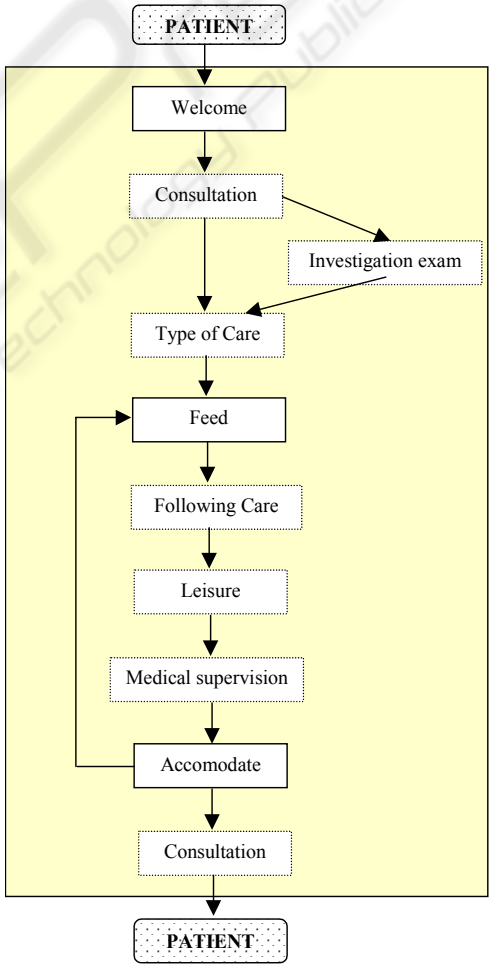

Figure 3: Process Patient-Medicine Trajectory

4 A FIRST EXPERIMENTAL STUDY

4.1 Generic care process design

The experimentation lead in the Château de Vernhes, a French private hospital, specialized in obesity care. Like most hospitals (Saulquin 1995], the accountancy is quite restricted and does not permit to obtain a real image of the care process cost. The experimentation was realized in a medical unit, the medicine department. This department contains 15 beds: this particularity is interesting to get a better image of the cost reality. The process used is the process medicine and the care process is called patient-medicine trajectory.

The medical business-objects defined in the packages represent the basis of the activities defined. The activities can be retrieve from the packages, some others can be added.

The care process is represented by the figure 3.

The activities, tasks and business-objects are retrieved from the packages of the information system. We said that the packages can be filled in as wished. The parts (elements of models) of the existing information systems are put together to be

Main activities	Reference package	activities drivers	number of activities drivers in a year
MA 1: Welcome	Welcome	Number of entrance	470
MA 2: Expertise	Diagnose	Number of patients	470
MA 3: Care	Care	Number of days	5394
MA 4:Catering	Feed	Number of days	5394
MA 5: Relationship	Care	Number of patients	470
MA 6: Accomodate	Put up	Number of nights	5394
MA 7: Management	General management	Number of days	5394
MA 8: Building management	General management	m²	5130
MA 9: Leaving	Welcome	Number of leavings	470

Figure 4: Activities Drivers

used in a strategic way. In our application, some activities or business-objects are used to define the process described above. The dotted rectangle concern the activities and the others, the business-objects. Some activities are still in the package model. Some other are not considered. The selection

	Global cost (€)	Nb of drivers	Unit cost (€)
MA 1	17486	470	37,2
MA 2	31434,9	470	66,88
MA 3	133072,7	5394	24,67
MA 4	83069,4	5394	15,4
MA 5	17455,4	470	37,14
MA 6	16403,5	5394	3,04
MA 7	114428,2	5394	21,2
MA 8	209861,3	5130	40,9
MA 9	16601,6	470	35,32

Figure 5: Cost Drivers

of the activities concerning a generic process represents the first step of the update of the dynamic package creation. The modelling elements contained in the packages necessary to catch the generic process are gathered and processed as needed before the step of process creation.

4.2 Representation of the activities drivers

To calculate the costs, we use the following steps :

- step 1 : research the procedures and activities (identification of the key factors, the process, the activities, the cost drivers).
- step 2: linking costs to activities

The activities drivers are used to find a link between ressources consumption and the real production. The activities drivers have been defined for each activity and for a reference year.

The activities drivers are represented in the figure 4.

Every resource has been linked to the main activities and permit to determine the cost drivers (the costs of the activities drivers). The cost drivers are represented in the figure 5.

Then, the resources are allocated in proportion of the consumption.

The final cost of the process patient-medicine trajectory is obtained by adding the resources directly attributed to the cost object to the indirect resources consumed by the activities used by the cost object (here, the object cost is a particular patient).

For a particular patient, the ABC cost is shown in the figure 6. The patient stayed 7 days. The additional costs were : 155,49 € for external lab examinations and 148 € for blood products.

The global cost is so identified according to the global care process (see figure 6) and is really equal

to the real costs engaged for the treatment of this patient.

Resources consumed	Quantity	Unit cost (€)	Total amount (€)
Direct expenditure			
Blood products			148
Lab exam			155,49
Indirect expenditure			
MA 1	1	37,2	37,2
MA 2	1	66,88	66,88
MA 3	7	24,67	172,69
MA 4	7	15,4	107,8
MA 5	7	37,14	259,98
MA 6	7	3,04	21,28
MA 7	7	21,2	148,4
MA 8	0,82	40,9	3,53
MA 9	1	35,32	35,32
Total amount			1156,57

Figure 6 : Global costs

5 CONCLUSION

We try to show in this paper that we can couple the economic and medical information in order to measure a real cost of the care process. For that, we build a re-organisation of the different information systems with the packages and we adapt the ABC method to generate the generic care process and calculate the costs induced by a specific patient care process.

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