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Full Length Research Paper

Overview of the methods of modeling and analyzing for the medical framework

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This article presents briefly the famous methods of modeling and analysis used for the medical framework. Some methods present hiatuses and they are neither precisely coherent nor complementary for modeling the functional system and decisional of an enterprise. Indeed, the use of these methods is an important step within the medical framework which is concerned with the quality assurance of the medical guidelines and protocols. In fact, quality assurance represents the programs of regular assessment of medical and nursing activities to evaluate the quality of medical care. Our contribution in this paper consists in presenting on the one hand the methods SADT (structured analysis design technique), OOPP (objective oriented project planning) and GRAI (graph with results and actions interrelated) and on the other hand, a review on the methods of analysis and modeling used for the medical framework. An example of the application of the SADT method showing how to improve protocols and implement them in medical guidelines is presented.

Key words: Medical framework, quality assurance, analysis, modeling.

INTRODUCTION

Quality assurance can be defined as all activities that contribute to defining, designing, assessing, monitoring and improving the quality of healthcare. In fact, there are many tools and methods based on quality management principles used in industry that have been developed and applied in the context of health systems (Verspoor et al., 2009). The modeling is the first stage of all survey centered on the engineering of a system. This stage is very important because the theoretical model permits to understand the working of the system and to determine a method of resolution according to the problem. In fact, it exists numerous methods of modeling dedicated to the origin in enterprises or industrial systems; the term "enterprise" must here be understood to the large sense, designing production systems, particularly hospitals (Staccini et al., 2005). The major part of the methods of conception and analysis used in the system reengineering domain rests on the same procedure: modeling of the present system permitting the realization of a diagnosis, then modeling of the system targets in order to offer objectives of the reorganization and to construct a plan of action (Lakhoua, 2010a). The modeling is an essential phase of the analysis procedure and an appropriated tool of modeling must be selected judiciously. The modeling permits the representation of the structure and processes of the studied system. This activity is essential to understand the working of the system, to facilitate the communication with actors, to isolate the applicable performance indicators and to proceed to the simulation (Benard et al., 2008). The main tools of modeling and analysis in enterprise in particular for the medical framework are presented.

We present in this paper three tools that have been already applied for the medical framework: SADT (structured analysis design technique), OOPP (objective oriented project planning) and GRAI (graph with results and actions interrelated). The main part of this paper gives an overview of the methods of modeling and analyzing particularly for the medical framework. The paper is organized as follows. Subsequently, we give a short presentation of the methods SADT, OOPP and

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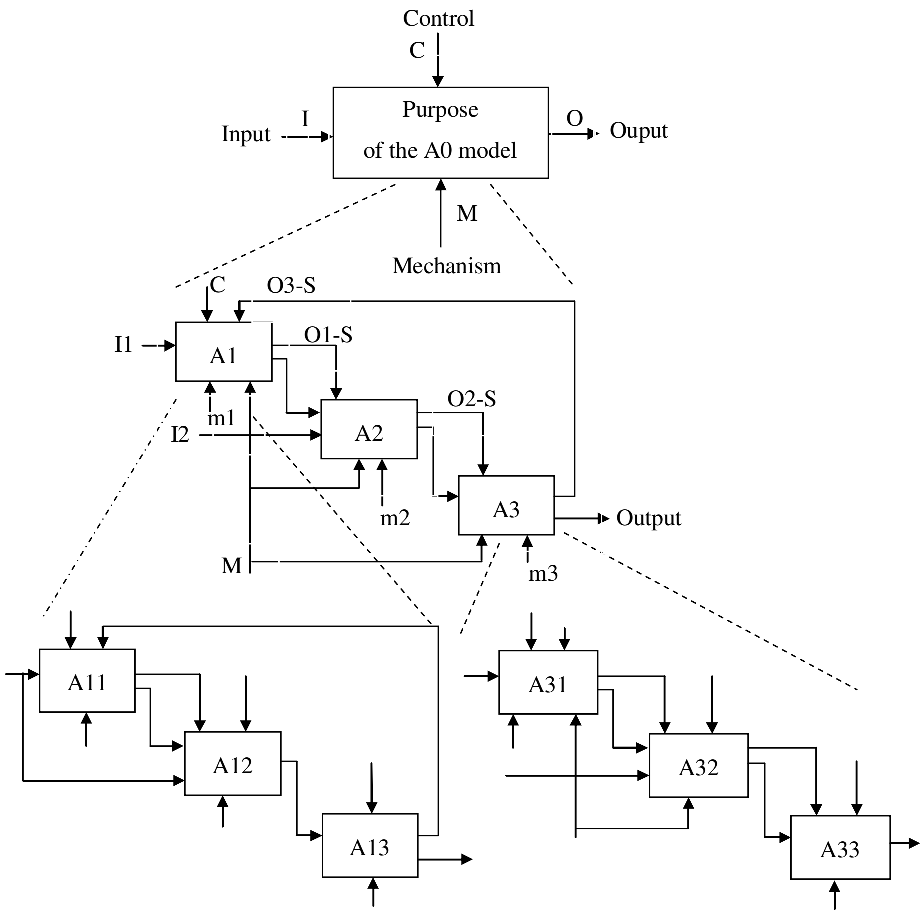

Figure 1. Top-down, modular and hierarchical decomposition of SADT method.

GRAI followed by a review of the application of these methods for the medical framework; lastly the study is concluded.

PRESENTATION OF THE METHODS

There are many methods that have been used for the medical framework. We review some of these methods here because we think them to be fairly representative of the general kinds of methods in use. The methods include SADT, OOPP and GRAI.

SADT methods

The SADT method (Marca and McGowan, 1988; Jaulent, 1992) represent attempts to apply the concept of focus groups specifically to information systems planning, eliciting data from groups of stakeholders or organizational teams. SADT is characterized by the use of predetermined roles for group/team members and the use of graphically structured diagrams (Figure 1). It enables capturing of proposed system's functions and data flows among the functions. SADT, which was designed by Ross in the 1970s, was originally destined for software engineering but rapidly, other areas of application were found such as aeronautic, production management, etc.

SADT is a standard tool used in designing computer integrated manufacturing systems, including flexible manufacturing systems (Schoman and Ross, 1977). Although SADT does not need any specific supporting tools, several computer programs implementing SADT methodology have been developed. One of them is design: IDEF, which implements IDEF0 method. SADT: IDEF0 represents activity oriented modelling approach. IDEF0 representation of a manufacturing system consists of an ordered set of boxes representing activities performed by the system. The activity may be a decision-making, information conversion or material conversion activity. The inputs are those items which are transformed by the activity; the output is the result of the activity. The conditions and rules describing the manner in which the activity is performed are represented by control arrows. The mechanism represents resources (machines, computers, operators, etc.) used when performing the activity (Piereval, 1990; Lakhoua, 2009). The boxes called ICOM's input-control-output-mechanisms are hierarchically decomposed. At the top of the hierarchy, the overall purpose of the system is shown which is then decomposed into components-subactivities.

The decomposition process continues until there is sufficient detail to serve the purpose of the model builder. SADT: IDEF0 models ensure consistency of the overall modelled system at each level of the decomposition. Unfortunately, they are static, that is they exclusively represent system activities and their interrelationships, but they do not show directly logical and time dependencies between them. SADT defines an activation as the way a function operates when it is 'triggered' by the arrival of some of its controls and inputs to generate some of its outputs. Thus, for

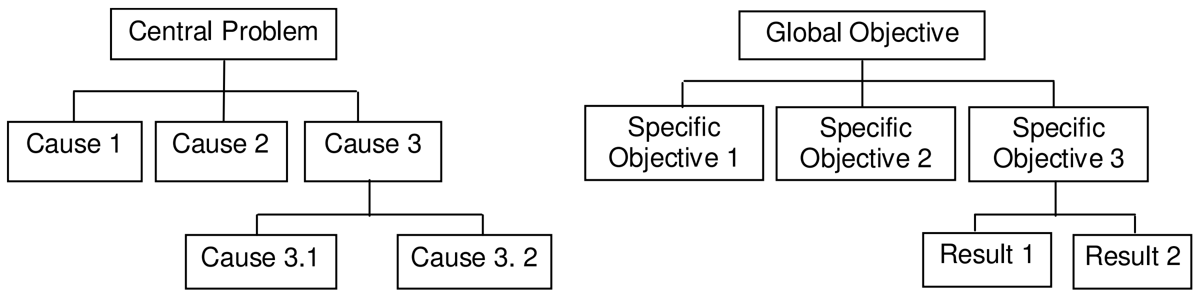

Figure 2. Problem tree and objective tree of the OOPP method.

any particular activation, not all possible controls and inputs are used and not all possible outputs are produced. Activation rules are made up of a box number, a unique activation identifier, preconditions and postconditions.

OOPP methods

The OOPP method also referred to as logical framework approach (LFA) (McLean, 1988; LFA, 1999) is a structured meeting process. This approach seeks to identify the major current problems using cause-effect analysis and search for the best strategy to alleviate those identified problems. OOPP method has become the standard for the International Development Project Design. Team technologies have continued to refine the approach into TeamUP (Killich, 2002; Lakhoua, 2010a). The design methodology of the OOPP method is a rigorous process, which if used as intended by the creators will impose a logical discipline on the project design team. If the process is used with integrity, the result will be a high quality project design. The method is not without its limitations, but most of these can be avoided with careful use of ancillary techniques. Many things can go wrong in the implementation phase of a project, but if the design is flawed, implementation starts with a severe handicap. The first few steps of the LFA are: situation analysis, stakeholder analysis, problems analysis (GTZ, 1991; Lakhoua, 2010b). In fact, the document of "situation analysis" describes the situation surrounding the problem. The source could be a feasibility study, a pre-appraisal report or be a compilation done specifically for the project design workshop. Typically, the document describes the problem situation in detail, identifies the stakeholders and describes the effects of the problems on them. The stage of "stakeholder or participation analysis" is an analysis of the people, groups or organizations that may influence or be influenced by the problem or a potential solution to the problem. This is the first step to understanding the problem. We might say, without people or interest groups there would be no problem. So to understand the problem we must first understand the stakeholders.

The objectives of this step are to reveal and discuss the interest and expectations of persons and groups that are important to the success of the project. If there is no agreement between participants on the statement of the problem, it is unlikely there will be agreement on the solution. This stage of "problem analysis" therefore seeks to get consensus on the detailed aspects of the problem. The first procedure in problem analysis is brainstorming. All participants are invited to write their problem ideas on small cards. The participants may write as many cards as they wish. The participants group the cards or look for cause-effect relationship between the themes on the cards by arranging the cards to form a problem tree (Figure 2). In the step of "objectives analysis", the problem statements are converted into objective statements and if possible into an objective tree (Figure 3). Just as the problem tree shows cause-effect relationships, the objective tree shows means-end relationships. The means-end relationships show the means by which the project can achieve the desired ends or future desirable conditions. Frequently there are many possible areas that could be the focus of an "intervention" or development project. The next step addresses those choices. The objective tree usually shows the large number of possible strategies or means-end links that could contribute to a solution to the problem (Lakhoua, 2011). Since there will be a limit to the resources that can be applied to the project, it is necessary for the participants to examine these alternatives and select the most promising strategy. This step is called "alternatives analysis". After selection of the decision criteria, these are applied in order to select one or more means-end chains to become the set of objectives that will form the project strategy.

After defining the objectives and specifying how they will be measured (OVIs) and where and how that information will be found (MOVs), we get to the detailed planning phase: "activities planning". We determine what activities are required to achieve each objective. It is tempting to say; always start at the situation analysis stage and from there determine who are the stakeholders.

GRAI methods

Developed by the laboratory for automation and production at the University of Bordeaux- France since 1970's (Roboam, 1993; Doumeingts, 1984). Before developing the GRAI method, some existing works had been reviewed, notably SADT method. It was found that the decisional aspects were not very well taken into account in these methods. So, it was important for the GRAI method particularly to deal with the decisional aspects of manufacturing systems. Based on the GRAI models, two formalisms were developed to model the macro decision structure and the micro decision center; the GRAI grid and the GRAI nets (Figure 3). A structured approach was defined to show how to apply the method. Another work performed at the GRAI laboratory was the extension of the GRAI method to GRAI-GIM (GRAI integrated methodology). GIM is composed of the following elements:

GRAI conceptual model

A representation of basic concepts of a manufacturing system decomposed into three sub-systems: physical system, decision and information system.

GIM modeling framework (RA) with three dimensions

Views, life cycle and abstraction level.

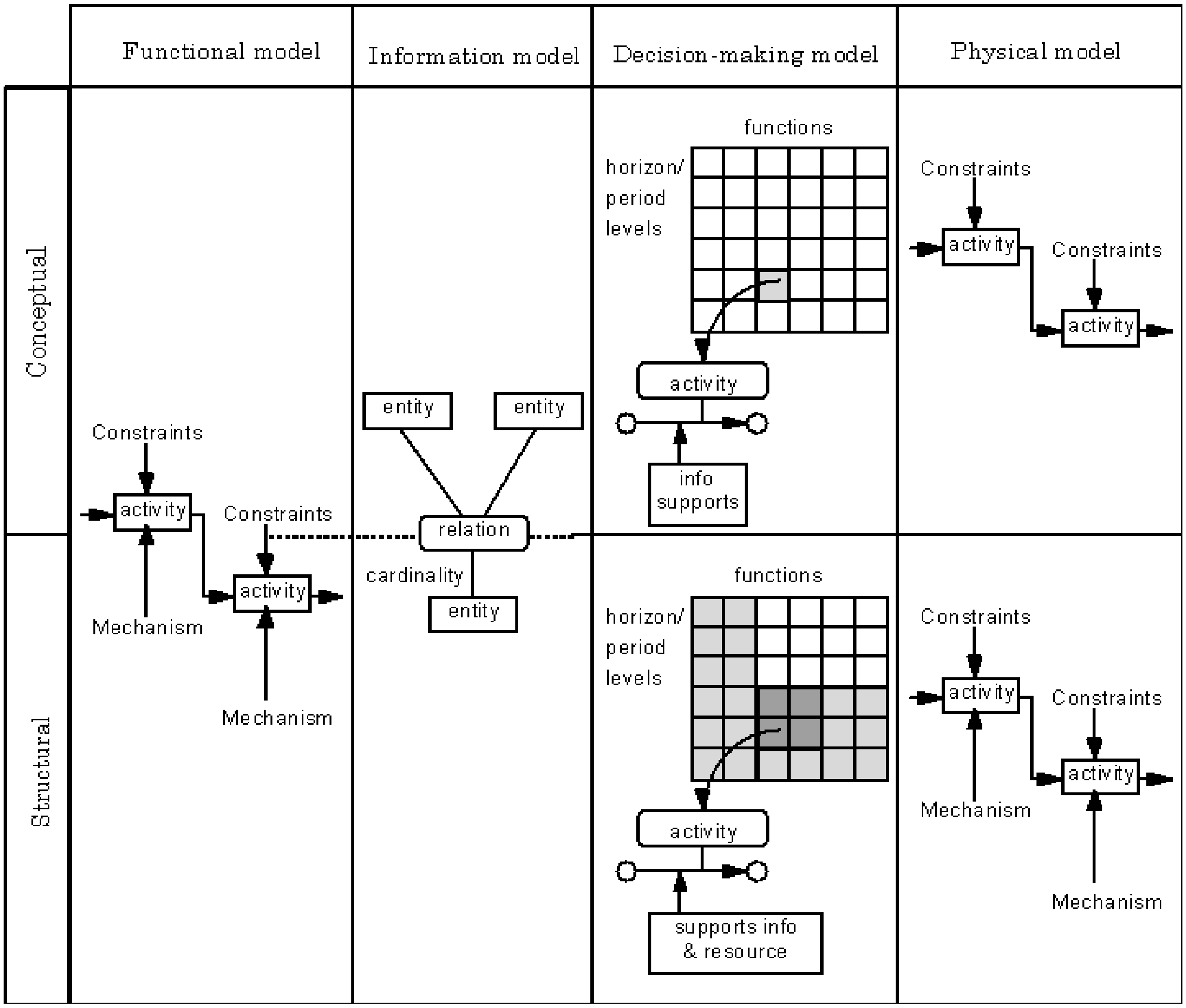

Figure 3. GIM modeling formalisms.

GIM structured approach

Guide to show how to perform analysis and design of the manufacturing system in three main phases: analysis, user-oriented design and technical-oriented design.

GIM modeling formalisms (languages)

GRAI grid and GRAI nets for decision system modeling, IDEF0 and stock/resource for physical system modeling, ER for information system modeling, IDEF0 for functional system modeling.

The GRAI model is a reference through which various elements of real world can be identified (Errasti, 2008). The macro conceptual model is used to express one's perception and ideas on the manufacturing system which is decomposed into a decision subsystem, an information subsystem and a physical subsystem. Particularly, within the decision subsystem, one finds a hierarchical decision structure composed of decision centers. Decision centers are connected by a decision frame (objectives, variables, constraints and criteria for decision making). The operating system is an interface between the decision system and the physical system. The micro conceptual model is used to represent the internal elements and structure of the decision center. GRAI-GIM contains a user-oriented method and a technically-oriented one. The user-oriented method transforms user requirements into user specification in terms of function, information, decisions and resources. The technically-oriented method transforms the user specification into technical specifications in terms of information and manufacturing technology components and the organization. The technical specification must allow the implementor to choose (buy, commission or develop) all the components needed to implement the system. A computerized support tool knows as CAGIM (computer aided GIM) is being developed at the GRAI Laboratory within the framework of the IMPACS project on Unix systems with X-Windows to support the GRAI-GIM method.

Review on the methods of analysis and modeling

In this part, we present a state of the art of the application of the methods of modeling and analyzing in enterprise particularly for the medical framework. Fagan (2003) has presented the practice of modern medicine and biomedical research which requires sophisticated information technologies with which to manage patient information, plan diagnostic procedures, interpret laboratory results and carry out investigations. In fact, the medical informatics provides both a conceptual framework and a practical inspiration for this swiftly emerging scientific discipline at the intersection of computer science, decision science, information science, cognitive science and biomedicine. Lohr and Brook (1984) have described the current quality assurance efforts in the health care field. They have defined the concepts of quality of care and quality assurance and recounted the history of the quality assurance movement. It then describes three initiatives in quality assurance sponsored by the federal government: 'experimental medical care review organizations', 'professional standards review organizations', 'utilization and quality control peer review organizations'. The authors conclude that quality assurance is unlikely to grow in prominence or funding, but that the legacy of the federal programs is very positive. Methods for providing quality assurance as well as for evaluating quality assurance organizations showed progress in an environment almost wholly concentrated on controlling the costs of medical care. Staccini et al. (2005) have used a modeling technique designed for manufacturing processes (IDEF0/SADT). They enhanced the basic model of an activity with descriptors extracted from the Ishikawa cause-and-effect diagram (methods, men, materials, machines and environment). They proposed an object data model of a process and its components, and programmed a web-based tool in an object-oriented environment. This tool makes it possible to extract the data dictionary of a given process from the description of its elements and to locate documents (procedures, recommendations, instructions) according to each activity or role.

Aimed at structuring needs and storing information provided by directly involved teams regarding the workings of an institution (or at least part of it), the process-mapping approach has an important contribution to make in the analysis of clinical information systems. Bursztyn and Ribeiro (2005) have presented a model for participatory evaluation of the Adolescent Health Program (PROSAD) in Brazil. The study focuses on the concept of participation, with a review of internationally validated planning methodologies (RAP, logFRAME, ZOPP, PCM) and the programmatic characteristics of PROSAD. The proposed model comprises 4 steps involving the constitution of the analytical matrix, a self-evaluation workshop, a summary of results and graphic representation. The model promotes participatory practice in health program management by using techniques that allow a workshop to be held in 70 min (mean time), producing results that are recognized and easily grasped by the local team. Hill (2000) has questions the appropriateness of highly structured strategic planning approaches in situations of complexity and change using the Cambodian German Health Project as a case study. Based on participant observation and organisational analysis in the Cambodian public health sector, the authors examines the rhetoric of values, objectives and strategies outlined in the original project documents and their assumptions and implications, and the responses to the changing political situation. Project planning had included an intensive goal oriented planning process (ZOPP) undertaken in collaboration with counterparts from the Ministry of Health, Provincial Health Departments and other bilateral, international and non-government stakeholders. Following the military action, the project was initially suspended, then substantially re-drafted within a new framework of assistance and eventually re-established after an interval of eight months. Glaa et al. (2006) have introduced the longitudinal organization of the patient handling called "emergency path" and it discusses the application of the company modelling methods especially the GRAI methodology in the emergency department. In fact, the emergency department in a hospital as its name implies is a facility to be utilized by those who require emergency medical care. The goal is to optimize these paths and to improve the quality of the patient handling while mastering the costs.

The development of this model was based on the ED and three geriatrics, neurology and traumatology services. Simulation was used in this work to assess the effects of some changes at the ED of the Medical Center of Valenciennes in France. The survey is integrated into the regional project whose theme are the emergency paths that have just been created at the ED of Valenciennes Hospital center and will contribute to the ED service project achievement.

Example of health's enterprise

In this example of health's enterprise, we can validate the functional model which describes the interactions between the different functions and using the resources in the health's company (HC). This representation is based on the decomposition of the global function "to manage a health's company" (Figure 4). In fact, the modeling oriented functions consist in describing processes of the enterprise. They must be capable to show interactions between these processes and to proceed to a decomposition of functions or activities. Recall that the techniques such as SADT are semi-formal. By consequence, for the same subject, different correct models can be built without having to know with certitude which model is the good or, at least, the best. In fact, this kind of model allows lets users sufficient freedom in its construction and so the subjective factor introduces a supplementary dimension for its validation. That is why the validation step on the whole necessitates the confrontation of different points of views. As to the SADT technique, users can follow rules or recommendations to the level of the coherency of the model such as distinction between the different types of interfaces, numeration of boxes and diagrams, minimal and maximal numbers of boxes by diagram, etc. One intends, by coherency application of the heritage rule that is when data are placed at an N decomposition level, it is explicitly or implicitly present at the inferior levels. However, a complementary mean to check coherency of actigrams is a confrontation between actigrams and datagrams, which is not possible in our case. For the SADT box, there is the function (verb to infinitive) and around this box, the associated data are specified of which the nature (input, output, control or mechanism) appears directly.

CONCLUSION

The structured gathering of information relative to users' needs and system requirements is fundamental when installing clinical and hospital information systems. This stage takes time and is generally misconstrued by caregivers and is of limited efficacy to analysts. In this paper, we presented an overview of the methods of analysis and modeling used for the medical framework. These methods include SADT, OOPP and GRAI. In fact, the use of these methods is an important step within the medical framework which is concerned with the quality

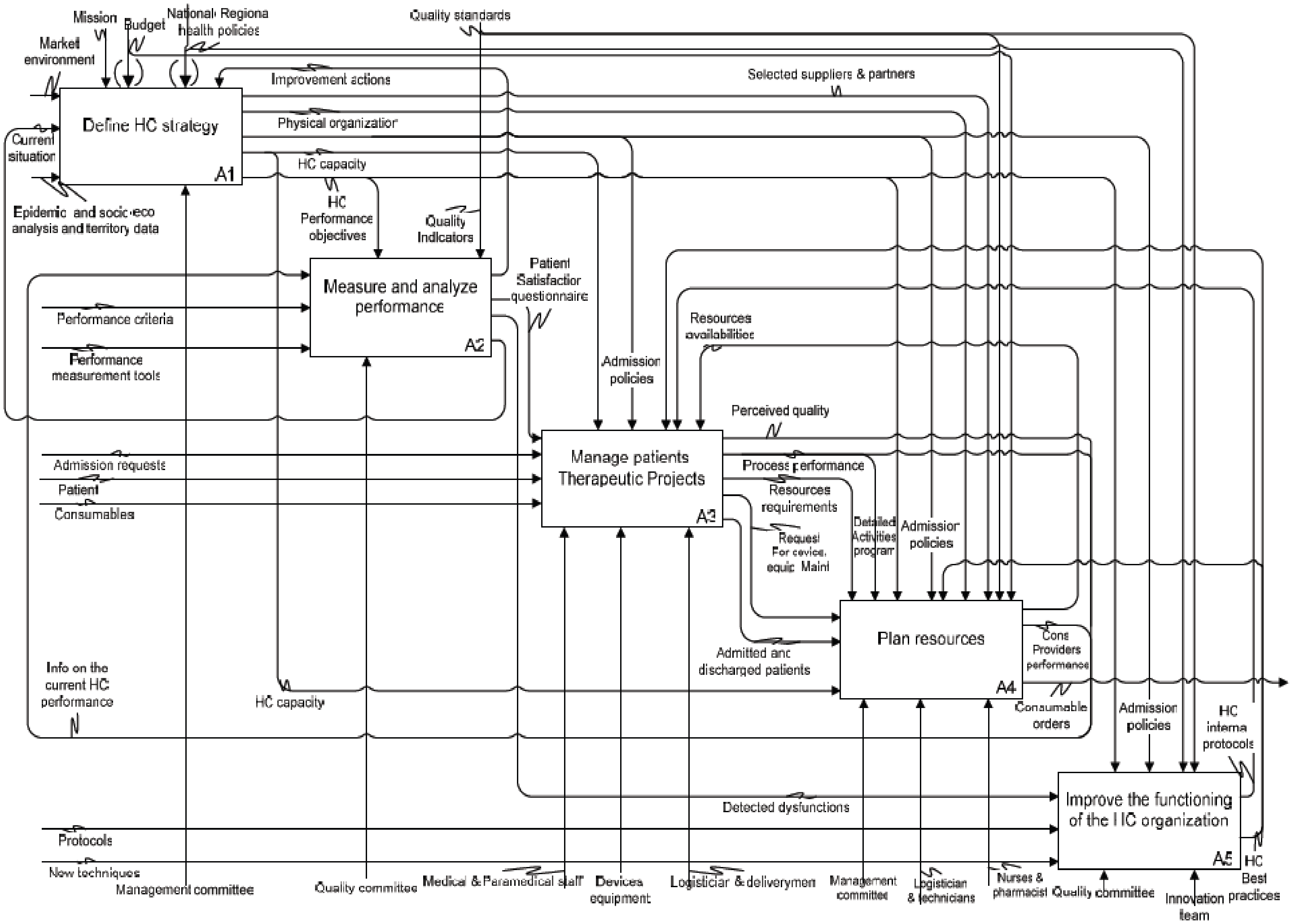

Figure 4. Example of the functional model of the health's enterprise.

assurance of medical guidelines and protocols. An example of the application of the SADT method on health's enterprise was presented. This example shows how to improve protocols and implement them in medical guidelines.

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