

## AN APPROACH TO MODELING MEDICAL INFORMATION SYSTEMS

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**Summary:** Paper presents an approach to modeling medical information systems. Modeling is done using UML (Unified Modeling Language). The paper shows use case diagram, activity diagram and class diagram showing some basics functions of the system that needs to be created. The importance of modeling complex information systems was determined, and also some groundwork for next steps: designing, implementing and evaluating system. Future work relates to the creation of medical information system.

**Key words:** Medical information system, UML modelling.

## PRILOG MODELOVANJU MEDICINSKIH INFORMACIONIH SISTEMA

**Rezime:** Rad daje prilog modelovanju medicinskih informacionih sistema. Modelovanje je urađeno korišćenjem UML-a (Unified Modeling Language). U radu su prikazani dijagram slučajeve korišćenja, dijagram aktivnosti, kao i dijagram klasa preko kojih su prikazane neke od osnovnih funkcionalnosti sistema koji je neophodno kreirati. Dat je značaj modelovanja kompleksnih informacionih sistema, kao i podloga za sledeće korake: dizajn, implementaciju i evaluaciju sistema. Budući rad se odnosi na kreiranje medicinskog informacionog sistema.

**Ključne reči:** Medicinski informacioni sistemi, UML modelovanje.

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## 1. INTRODUCTION

In information society, as it is today, the application of modern information technologies is necessary in every domain in everyday life. Healthcare presents no exception. Beside medical staff, patients have expectations too. These expectations are related to more efficient functioning in this domain. The medical information system is used in order to increase quality of healthcare, reduce costs and scope of work [1].

Designing medical information system includes comprehensive analysis of all process that this system has to enable. Design process is followed by implementation and evaluation, after which necessary enhancements should be made. With constant increase of medical demands, the approach of modeling medical information system demands innovations. The increase of demands complexity leads to usage of object-oriented design and UML modeling. [2]. The Unified Modeling Language (UML) presents language for modeling not only application structure and architecture; bus also, business process and data structure [3].

As the modeling represent one of the mandatory processes during design of complex systems, universality of the model is very important. For this reason UML approach impose itself in modeling process.

This paper presents an approach of the modeling medical information system with UML design. The following diagrams are shown in the paper:

- use case diagram,
- activity diagram,
- class diagram.

## 2. RELATED WORK

The fact is that a hospital consists of the several organizational units with various information processing profiles for the different types of the healthcare using various computer-supported of the traditional information processing tools. The patient care process is mostly individual and therefore demands high interoperability among organizational units. Considering that the patient is not a merely customer but that his health depends on successful care, which depend strongly on availability of the information, leads to a high responsibility concerning information processing. [4].

Because of the mentioned reasons, heterogeneity that exists in hospitals has to be controlled by good information management. Over the years, there have been many attempts and approaches of modeling medical information systems and their architectures, as part of various projects such as [5,6,7,8].

At the very beginning of development there have been various obstacles, some of which were technical in nature while others were related to patient's privacy issues. [9] Some of the obstacles have been overcome in the coming years with the development of new technologies, while others remained to the present day.

During the last decade medical information systems have grown rapidly and became more difficult to develop due to its complex and decentralized nature. Some of the complexity was overcome with distributed e-healthcare system that uses the Service Oriented Architecture (SOA) as a basis for designing, implementing, deploying, invoking and

managing healthcare services [10]. However, SOA have some shortages in analyzing and modeling a complex healthcare system which involves multiple stakeholders with multiple concerns. To address this problem, a new Adaptive architecture was developed. This architecture enables the modification of the norms and ontological knowledge according to the changes of the society, organization and environment [11].

Independently of the approach and architecture that is used, every medical information system have to have a life cycle. Life cycle of the medical information system can be divided into 4 phases: analysis, design, implementation and evaluation. Analysis phase is the most critical because the information that analytics provide decides whether the information system is appropriate for user needs. One of the major problems in medical information systems is misunderstanding of the institutional and individual user demands and expectations [12]. Failure in understanding user needs as a result to have unsuccessful implementation and insufficient functioning of the system.

Analysis and design phase are followed by evaluation phase. During the evaluation of the object-oriented approach, many different methods can be used. The problem may occur because although most methods have similar characteristics there are some differences that lead to problems in communication between users and designers, as well as designers themselves. UML presents attempt to overcome this problem, by involving both designer and user in establishing a document of the model of the information system from the user's perspective.

### **3. AIMS AND TASKS**

Having in mind complexity of the medical information system that needs to be created, aim of this paper is focus on UML modeling basic process in system through mentioned diagrams.

Tasks:

- Establishing user demands for information system, and
- Modeling of the system with UML diagrams.

### **4. RESULTS**

#### **4.1 Use case diagram**

One of the strategies for modeling the function of the system begins with identifying the actors. Actors can be objects or persons outside the system that interact with it and initiate imputes to the system. Also, actors can be users or some other systems or subsystems. For this strategy case diagram is applied. Another strategy is applying scenario taken from usual business processes that can be decomposed into logical functional areas where each one presents one use case diagram [13]. In order to properly identify the actors, the following questions are asked:

- Who is interested in certain request within the medical information system?
- Which are the fields where medical information system will be used?
- Who will benefit from medical information system?
- Who will supply system with informations and use that informations and remove it?
- Who will give support to the system?

- Does this system use external resources?
- Does one person have several different roles? Do several persons have the same role?
- Does the system establish interaction whis previous system?

User’s functions represent functionality that system provides. The following questions can be used to help identify user’s functions:

- What’s the task of every participant in medical information system?
- Which user’s function will create, store, update, remove or read information in medical information system?
- Will some participant have to inform system about unexpected external changes?
- Is there a need for some participant to be informed about certain events in the system?
- Which user function will support and maintain the system?

The Use Case diagram is created basing on the answers to the asked questions. The Use Case diagram is shown in the Figure 1.

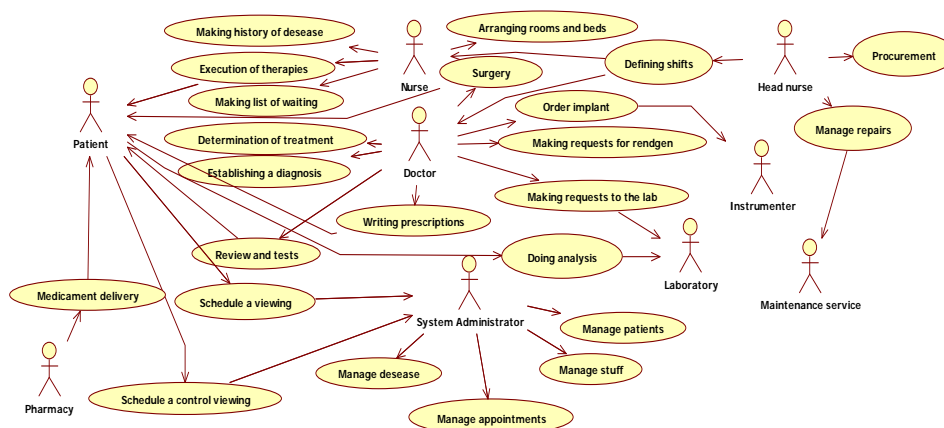


Figure 1: Use case diagram of the medical information system

#### 4.2 Activity diagram

Activity diagram represents system dynamics. They are workflow diagrams that are used to depict work process in the system. They present control flow from activity to activity in the system, which activity can be parallel, and also any alternate flow. At this point of life cycle, activity diagrams can be made to represent every user functions flow, or to present flow under some user function. In later life cycle, activity diagrams can be made to show process in some operation. Figure 2 shows activity diagram for all participants in the Use case diagram.



After identifying, based on Use Case diagram, objects are organized and relations among them are established. At this point class diagrams are used. During the analysis phase class diagram does not describe methods. It is done in design phase.

Class diagram contains all identified classes in the system and relations among them. The figure 3 shows class diagram form of medical information system.

## 5. CONCLUSION

The functions of medical information system are modeled by identifying the participants or by breaking down scenarios from usual business processes into use cases. Description of the use cases and activity diagrams further clarify interaction between user and the system. Use cases diagram also identify the objects in the information system. Class diagrams graphically depict these objects, their attributes and relations among them.

Having in mind all presented diagrams (Use Case, Activity and Class diagram) the conclusion can be made about basic needs during creation process of the medical information system. This approach indicates importance of the modeling complex systems, and UML has proven as very flexible and universal. Future work relates to the creation of the medical information system in accordance with conducted modeling.

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## REFERENCE

- [1] Janković D., Rajković P., “Medicinski informacioni sistemi – značaj i struktura”, XXXI Simpozijum o operacionim istraživanjima, Iriški venac, Fruška Gora, 14-17.09.2004, 173-176.
- [2] Chen, Z.C., Chen, J., Ming Yu, Y. “The Analysis and Design of Hospital Information System Based on UML Model” Retrieved January 28, 2012. from: <http://www.scientific.net/AMR.121-122.441>
- [3] UML Resource Page, [www.uml.org](http://www.uml.org), Last access, 8.1.2012.
- [4] Winter, A., Brigl, B., Wendt, T., “A UML-based Ontology for Describing Hospital Information System Architectures” MEDINFO 2001 V. Patel et al. (Eds) Amsterdam: IOS Press © 2001 IMIA
- [5] The European ISHTAR Project, Retrieved November 4, 2001, from [http://www.ehto.org/ht\\_projects/initial\\_project\\_description/ishtar.html](http://www.ehto.org/ht_projects/initial_project_description/ishtar.html)
- [6] Blobel, B., The European TrustHealth Project experiences with implementing a security infrastructure. Int. J. Med. Inf. 60:193–201, 2000.
- [7] The European TrustHealth Project, Retrieved November 4, 2001, from [http://www.ehto.org/ht\\_projects/html/dynamic/130.html](http://www.ehto.org/ht_projects/html/dynamic/130.html)
- [8] The New Zealand Electronic Medical Record Standard, Electronic Medical Records Standards Subcommittee, February 25, 1998, Retrieved October 1, 2001, from <http://www.nzhis.govt.nz/infostandards/emr/SC606.html>
- [9] Yu-Chuan Li, Hsu-Sung Kuo, Wen-Shan Jian, Dah-Dian Tang, Chien-Tsai Liu, Li Liu, Chien-Yeh Hsu, Yong-Kok Tan, Chung-Hong Hu “Building a generic architecture for medical information exchange among healthcare providers” International Journal of Medical Informatics 61 (2001) 241–246

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- [10] Firat Kart, Gengxin Miao, L. E. Moser, P. M. Melliar-Smith “A Distributed e-Healthcare System Based on the Service Oriented Architecture” 2007 IEEE International Conference on Services Computing (SCC 2007) 0-7695-2925-9/07
  - [11] HongqiaoYang, KechengLiu, Renchu Gan “An Adaptive Architecture for Healthcare Systems” ISBN 978-952-5726-00-8 (Print), 978-952-5726-01-5 (CD-ROM) Proceedings of the 2009 International Symposium on Web Information Systems and Applications (WISA’09) Nanchang, P. R. China, May 22-24, 2009, pp. 250-253
  - [12] Sittig, D. F., Stead, W. W., “Computer-based physician order entry: The state of the art”, J. Am. Med. Inf. Assoc. 1(2):108–123, 1994.
  - [13] Aggarwal, V. ”The Application of the Unified Modeling Language in Object-Oriented Analysis of Healthcare” Information Systems, Journal of Medical Systems, Vol. 26, No. 5, October 2002