OD RAZGOVORA DO KORISNIČKOG INTERFEJSA U RAZVOJU MEDICINSKOG INFORMACIONOG SISTEMA
FROM OPTIONAL TALK TO MEDICAL INFORMATION SYSTEM'S USER INTERFACE

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Sadržaj – *Medicinski informacioni sistemi (MIS) su postali bitan faktor svakog modernog društva. Njihova osnovna namena im je da ubrzaju proces sakupljanja i korišćenja informacija u medicinskim ustanovama. Međutim, postoje zabeleženi slučajevi kod kojih je MIS zapravo usporio proces rada korisnika zaposlenih u ovim ustanovama, kao što je u radu navedeno. Ovi slučajevi obično su povezani sa loše prilagođenim korisničkim okruženem u informacionom sistemu, i korisničko nezadovoljstvo i otpor naročito su izraženi u početnoj fazi korišćenja sistema. Naša istraživanja su pokazala da projektanti obično imaju potpuno različite poglede na sistem od kranjih korisnika, i da su njihovi napori obično usmereni ka prilagođavanju interfejsa više funkcionalnostima sistema, a manje ustaljenoj korisničkoj rutini. Radeći na našem projektu, mi smo pristup okrenuli, što je rezulitralo zadovoljstvom korisnika i manjim vremenom potrebnim za njihovu obuku.*

Abstract – *Medical Information Systems (MIS) are important factor for fast and reliable work of healthcare facilities. But there are some cases when MIS can downgrade business processes of these facilities. These cases are usually related to poorly understandable and confusing user interface. This is particularly emphasized in the MIS employment phase, when users are not used yet to the new applications. Our research has shown that MIS developers have completely different view to the system than the end users, and that they usually try to adjust interface to the system functionality rather than to the user's habits. Working on our project, we have tried one opposite approach, described in this paper, and managed to give some improvements in this area, that have already resulted with user's approval, and reduced time needed for their training.*

1. INTRODUCTION

At the beginning of the 21st century enormous efforts are done in the area of implementing and using modern information systems across the world. Medical Information Systems became a necessity of any modern society. In more developed countries this kind of science has reached more complicated researches, such are preoperative risk predictions [1], or biosignal-based systems for different kind of patient's monitoring [2], but we in Serbia are at the beginning of introducing and developing of Medical Information Systems yet. In our country, many healthcare facilities use only a part of MIS, which is related to recording given medical services and consumption of medical materials, and generating reports needed for Republican Institute of Health Insurance ("Republički zavod za zdravstveno osiguranje" in Serbian, or RZZO).

In our project (Improvement, integration and collaboration of information systems of medical institutions, TR13015), which is founded by Ministry of Science and Technological Development, we have tried to develop much wider and comprehensive approach. MIS we have developed is intended to record not only basic information about given medical services (who did it, what was done, and how much does it cost), but all relevant medical information about medical examinations, medical therapies, hospitalizations, complete medical history of the patient, or shortly, complete Electronic Health Record of the patient (EHR) [3]. Such information system in health care greatly accelerates the process of generating the voluminous documentation that follows the provision of health services, such as reports for other state institutions which are based on the provision of health services, and reports for the management of health institutions themselves; data access is facilitated and accelerated in the sense that they can be accessed from multiple locations simultaneously, and not for each episode of treatment to be performed a physical search of impressive archive of these institutions.

However, it was proven around the world that the introduction of wide software systems in health care has its negative side also [4]. MIS users, especially older ones, have deeply established routine in their daily work, and every novelty can be disruptive to them. They usually have to deal with several electronic systems during their work, which are often provided by different manufacturers [4]. In the period of introducing and implementing MIS to health care facilities especially, it can slow down their working process instead of speeding it up. When a problem occurs in using the software tools we as developers are often the easiest to blame the non-IT professional users, but is it only and real reason for such situations? Or maybe a different approach in the design and implementation of systems could contribute that such situations do not occur or be reduced to a minimum?

This paper deals with problems that MIS users have or can have with non user friendly interface. Section two briefly

describes these problems as we have tried to classify them. The rest of the paper is dedicated to our approach and our solution to this problem, which gained to results. As one set of problems cannot be bind only to users of MIS, but is universal, described solutions can be applied to arbitrary information systems, as well.

2. END USERS PROBLEMS WITH MIS

Users of information systems in health care, beside administration that can be met in every area of one society, are usually doctors and nurses. Administrative stuff use IS modules like evidence of employees, financial accounting, accounting earnings, material assets, end similar. EHR modules are used only by doctors and nurses, according to the low of patient's data privacy [5].

In general, in relation to the use of application modules, we can define two main groups of users:

1. Users that most of their work spend using only software tools;
2. Users who are dedicated to clients or some other electronic systems, and only part of their work spend using software.

Doctors and nurses belong to the other group of users. Their daily work must be dedicated more to the patient's treatment and less to the information system. Let us consider the fact that they are confronted with several different electronic systems, usually provided by different manufacturers, and in our country entirely unconnected to the information system. Additional difficulty is that they are strongly used to paper evidence in Serbia. Working on the MIS development, on the basis of multiple interviewing medical staff employed at the Health Center of Nis, and the clinic in Nis, (Department of Child Neurology and Internal Clinic), we have attempted to categorize their current problems and issues that they could have in working with parts of the medical information system:

- Windows or web forms for inserting and editing data are endless.
- They find themselves "lost in application". When the functionality of the medical process is such that it demands entry (or choice) of a large amount of data, and more than one windows form is opened, and more than one "save" action is necessary, users after a while don't know where they are, or what they have recorded yet.
- "They lose a patient." If system demands moving patient from one list to another many times during the examination, one wrong mouse click and patient is completely lost in the system.
- The layout of tabs on the form is inadequate in terms of monitoring the natural process of entering data in a commonly used scenario.
- Search for right value is slow and endless. Combo boxes contain hundreds or thousands of values, too much of the working time is lost for searching.
- Some data is entered more than one time in the system.
- Too many rows lost because application did not ask the user: "Are you sure…", and the wrong click was fatal.
- Repeating of the same or similar actions several times in the working time. There are situations when user acts the same many times a day (like injections to the patients) and yet, he or she need to enter the same information every time again, just for different patient, because system demands, and many many other.

Problems like described are detected not only in Serbia, but in the west Europe countries, as well. According to the researchers of the *Smart Transplantation Project* in *German Research Center for Artificial Intelligence (DFKI),* like it can be found in [4]: "More than 30 staff members of the Department of Hematology and Oncology at the Heidelberg University Clinic participated in an online survey which asked about various areas of application of Information and Communications technologies (ICT) within the hospital. 94% of those asked responded that IT applications are critical to the daily routine at the clinic and 90% said more than 50% of their work involves the use of computers; 58% even reported more than 75%. Important criteria for the respondents was not only a timely system response but also that the system be efficient and user friendly. The responses were ambivalent concerning the current state of integration of the IT applications in the daily work routines." Information as listed are not flattered for designers and information system developers at all.

3. STEPS TOWARDS SOLVING THE PROBLEM

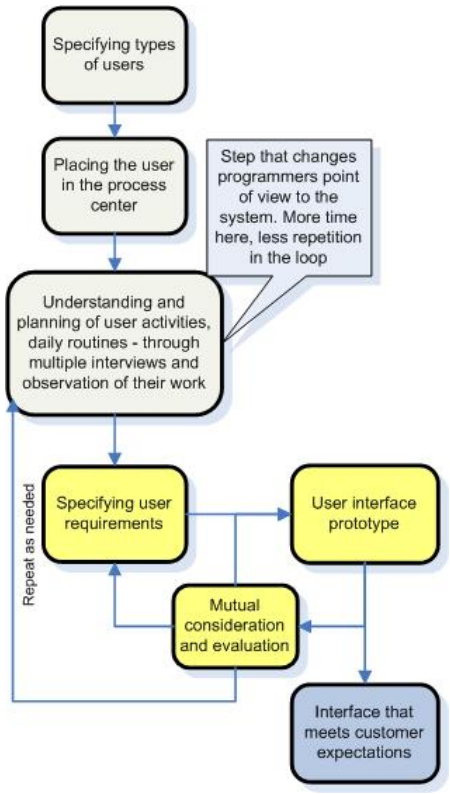

Figure 1. The interdependence of human-centered user interface activities

Without the strong cooperation of the development team and future users of software systems it is difficult to expect that the project will result in a satisfactory user interface. Our research project and development in this direction gave some results as this paper presents. The concept "From the conversation to the user interface" in the steps shown in Figure 1, resulted in mutual satisfaction of us and our users,

both. The third step asks for attention, because it is the step that can save a lot of time to developers in the further designing.

4. DESIGN OF INTERFACE

Addressing the second and third activity of the activities shown in Figure 1, we have noticed that the medical staff deals with enormous paperwork. However, they are very used to it, and they know in advance what paper form to fill and how to fill it, like they could do it with their eyes closed. In this paper we are not dealing with reading or medical data reporting, because in that area the information system certainly provides a significant improvement compared to the paperwork. But in the area of recording information, users (slow-typers usually) can be slowed with MIS compared to dealing with paperwork only. So we came up with the idea that the patient's electronic health record should look the same or very similar to paper, or the parts that cannot be fully copied should at least have the same layout of fields as in the paper. Instead of adjusting the form interface to the functionality, we have scanned papers, and planted them to the windows forms everywhere we could. One example, where it was possible to adjust interface in a great deal to paper, is shown in Figure 2. Figure 2a represents paper patient record that health workers operate dozens of years with. Similarity to the electronic form of the main page of patient record, which is shown in 2b, is obvious.

Figure 2a. The first page of patient's paper record, for preschool children

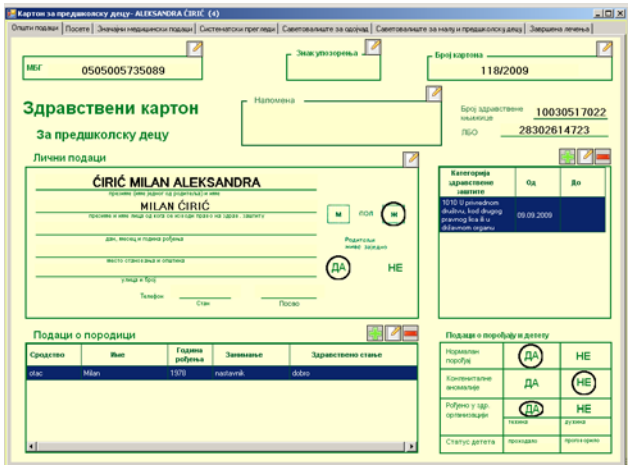

Figure 2b. The first page of EHR for preschool children

Tabs shown in the top have exactly the same sequence as the sequence of papers inside patient record is. In the cases when it was not possible to provide exactly the same design in the electronic forms, we have tried to contain the layout of fields, like shown in Figure 3a and 3b.

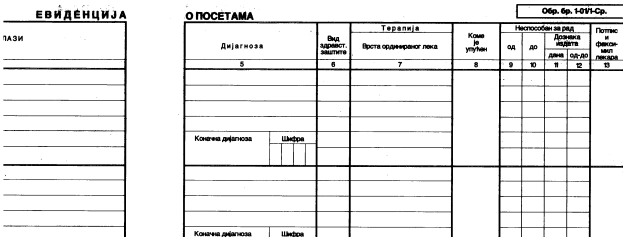

Figure 3a. The inner part of paper record, for recording diagnoses, therapies, dates, etc. during the visit

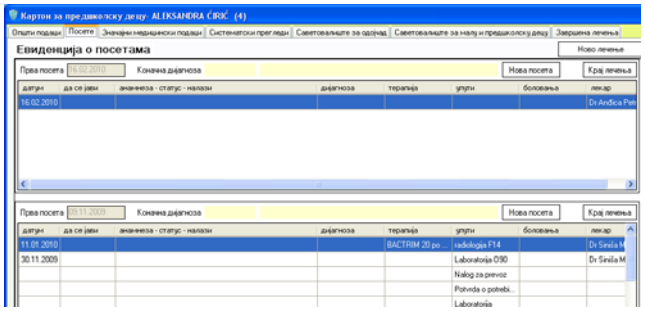

Figure 3b. Tab for visits. Double click on every cell opens modal form for recording proper medical data

The result of this approach to designing the user interface was more than satisfactory. User's resistance to the new software was minimal, and they needed no explanation of windows forms for EHR.

Another important moment in understanding user activities was a job routine. Routine work with software is gained easier if it is similar in different functionality. For this reason we decided to follow the one and the same standard for every man-computer interaction. Unique ways for search data is used everywhere, to enter, read and delete data, etc [6]. After each action the recording of data in the database is provided, according to the research that showed that users often lose control of where they are in the application. Deleting is not permitted to all users, but is in accordance with privileges. The time (on server) when the item is added is examined whenever someone tries to delete it. Time after which the removal is still allowed on the server is adjustable [5]. Upon expiration of the time (the time seen as a time in which they can correct random errors) all changes are recorded (the old value, new value, who made changes and when). So the possibility for user to accidentally delete item is minimal.

Our basic approach in EHR projecting phase was not to let user enter arbitrary data, but to choose between offered values. Classical windows search through controls like combo or list box is exactly what our research showed that users complained to. For example, last catalog of diagnoses (standard MKB10) contains exactly 14193 different diagnoses. General practitioner (GP) has to have all diagnoses available for choosing. Can you imagine popup of

14193 items for choosing the right one? This subject has different approaches among designers worldwide. Some of them use the concept of giving only few dozens of most used diagnoses in the late period [7]. This approach, however, can signal to the doctor what diagnoses or therapy to determine, or what facility for hospitalization to recommend. To avoid that, and to let doctors rely on their own knowledge, but to provide them quick choice of items like diagnoses, drugs, facilities, medical materials, we have developed our own *Search component*.

Starting with a fact that all catalogues are similar as entities, that they usually have the name and some kind of code for every item, we have made searching through 3 attributes (which are configurable). Every catalogue is modeled with a database table. *Search component* is independent and it links to a table. It addresses database after the third typed character, and gather appropriate dataset, which is usually consisted of few dozens or only few items. Filtered items are shown under edit boxes, and user can easily, using mouse or keyboard arrows, choose proper value, or he can keep typing and narrow the selection to one or two items. The examples of searching values through our component are shown in Figures 4a and 4b.

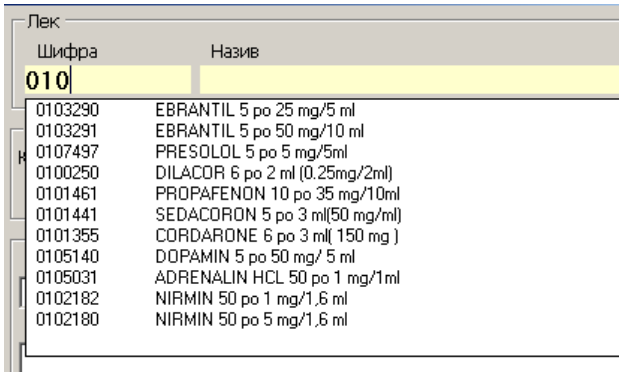

Figure 4a. User typed three characters of the medication code and 11 corensponding medications have appeared for choice

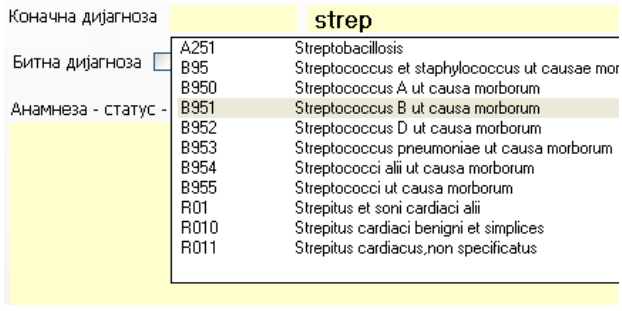

Figure 4b. Choosing diagnoses in exactly the same way, only by typing the beggining of its name instead of code

Performing the same search process for every catalogue in all modules, we provided a kind of introduction of user applications in the daily routine and getting used to working with the system quickly.

Another important item that we have avoided by this approach, and concerns the efficiency of the system, is the congestion that can occur when hundreds of concurrent users search through the same catalog in the database. Because the filtering is done after the third key typed, dataset that server returns to the client is consisted of ten or twenty records, the traffic in the network is greatly reduced compared to constant loading of entire catalogs.

In the choosing doctor module (in Serbia in the last few years, each patient selects his own doctor and make a contract with him), this component is used for the selection of doctors for whom the patient wants to make a statement. Since this function at the Health Center in Nis is made by nurses, they have to perform a search among the hundreds of physicians of this institution. However, with our module and described way of search through catalogs, their work in the recording patient statements proved to be easy and fast, without errors, and what is most important - do not create waiting lines at offices.

According to the our research that users complain in the sense of repeating the same actions more time in a day, and having to enter the same data for insurers again, we have provided them *Copying of done actions* through user interface. Figure 5 shows Copy button for recording of given medical service, which is on our country an obligation of every health care facility.

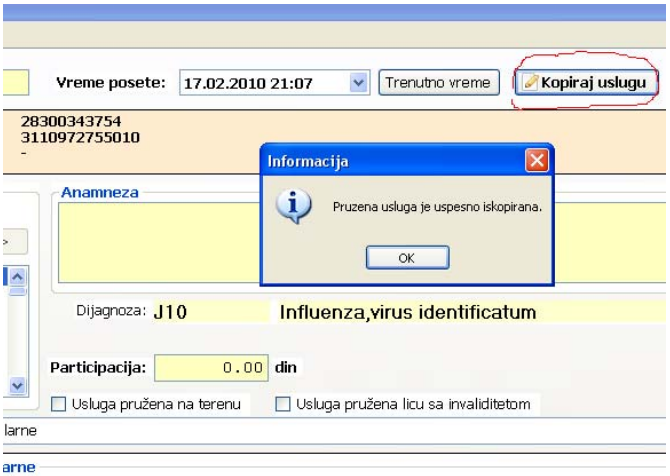

Figure 5. The possibility of copying data for given service together with medical material, for giving injections

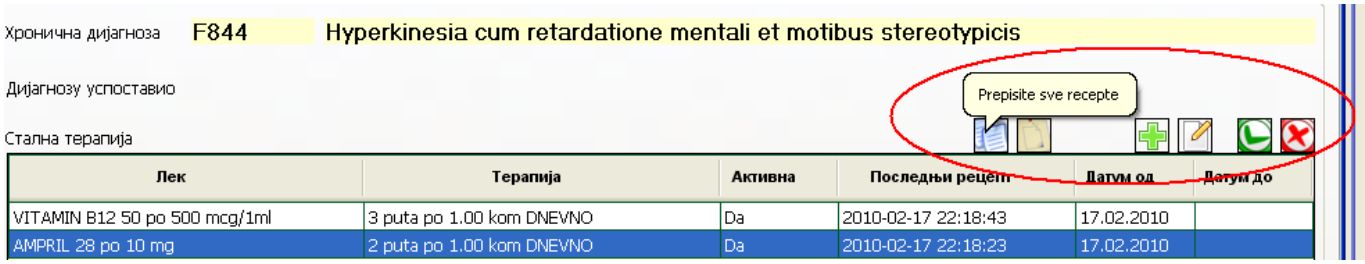

Figure 6. Accelerated prescription of recipes for chronic patient

Another good example of copying actions is related to the chronic patients. They (especially older ones) come again and again to get the same or similar therapies from general practitioners. So we have provided our users (in this example only if they are GP) with a possibility to copy prescriptions, if the patient was marked as chronic one. With one mouse click through user interface, therapy is shown in the EHR, and doctor further has 6 different possibilities, provided through 6 buttons in user interface, described as follows from left to right (Figure 6): copy all medications, copy only selected one, add some therapy, change selected item, activate or deactivate selected therapy. Therapy is defined as permanent in the system, and it can be consisted of many medications (Figure 6 shows permanent therapy with two different medications).

5. CONCLUSION

In most cases medical information systems are charged with a large number of users, hundreds or even thousands of them. It is almost impossible to satisfy the great population like that with user interface in any kind of area. However, health care as a very important feature of a modern society requires fast and reliable systems, considering the fact that one side of systems are live people, with limited response waiting time (babies, old ill people, etc). Sometimes that time is critical, as when it comes to emergency situations. MIS instead of paperwork is a huge change, especially for medical stuff with 20 or more years of working experience. It can seriously reduce their working performance, and produce long lines of patients in the waiting rooms, in the beginning phase of using it.

Without cooperation with future users we cannot even imagine a good MIS as a result, since the views are always different from the designers and user's points of view. Brokers in the development of the IS can play a key role in the whole process, if there are some. However, our project has shown so far that much can be done, and designers could easily become agents to themselves, if they strongly respect process of designing user interface as is shown in Figure 1 of this paper. Interaction with future users should not be a waste of time to the designer in any case. On the contrary, the more time spent in the phase 3 of mentioned process will reduce with the less time spent looping, and users will be more satisfied, and give less resistance to introducing new software.

Three things have proved to be important for designers of medical information systems in our project in the system-user interaction: neutralize the fear of introducing innovation in the work process with having these innovations presented in the user-close way; keep the user in the process of the similar daily routine work that was before the introduction of new system; and enable quick and easy way of using system functions without suggesting the user what is his future step or choice in working with the system. Consistency in the interface of the module and all forms is necessarily implied. In order to reduce errors it is necessary to reduce the entrance of free text to the minimum, and wherever there is a predefined catalog, user should be given the choice of appropriate values. The less values for choosing user get, the quicker choice he will make, and the less errors in choosing will be made. Appropriate search component can be a solution to that, like we have shown in previous chapter. The order of fields in the form should follow the established working process, and the design of the form should always have at least one thing that user will recognize at the first human-system contact.

Beside MIS, these recommendations could be applied in any kind of information system designing, with some sort of modifications.

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