ANALYSIS OF THE LEVEL OF USE AND ACCEPTANCE OF THE MEDICAL INFORMATION SYSTEM IN PRIMARY HEALTH CARE

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This paper presents the analysis of use and acceptance of the medical information system (MIS) within the primary healthcare. Analysis is mostly based on data from the Health Care Center Niš, although the conclusion was made on data from a dozen health care centers which use the medical information system MEDIS.NET developed within the Laboratory for Medical Informatics at the Faculty of Electronic Engineering in Niš. Analysis of the use of MIS is based on calculating the percentage of successfully entered records of visits, provided medical services, recipes, referral letters and physical examinations. In the context of the analysis of the use of MIS, successfully entered medical service is actually the service that was not changed or deleted later. Results of this analysis are significant for further technical development of the medical information system, and support the identification of these functionalities that are hardly accepted by the end-users and should be further developed. The acceptance of MIS is analyzed in the light of the technology acceptance model. Registration of provided services and keeping the record of physical examinations are taken as representative functionalities. Registration of provided services has been observed as a functionality that is accepted by the users due to simplicity of use (perceived ease of use), while the registration of physical examinations is observed as functionality is presumed to be accepted by the users as useful (perceived usefulness). For the functionalities with the expected acceptance based on the simplicity of use, the rate of correct data input is over 90% in each of the category. However, the rate of correct data inputs for visits and provided services is more than 99%. This is very significant having in mind the fact that these functionalities are often used and the high rate of incorrect inputs would slow down the work of doctors. On the other hand, the percentage of use of special functionalities for input of physical examinations varies considerably. Specially designed functionality for the most common physical examinations of children is used in more than two thirds of cases (sometimes more than 97%), while for the registration of adult's physical examinations the percentage is lower than 20%. Since the users could input data on physical examinations using the form for visit input, as well as with special form, they will probably use the other option only when the frequency of use is high enough or when the improved functionality of the specialized form provides improved system performances. Under users of MIS we consider the medical staff which uses MIS functionalities in accordance with their duties and privileges (doctors, nurses, medical technicians, etc.).
Acta Medica Medianae 2018;57(4):122-136.

Key words: *medical information system, technology acceptance model (TAM), assumed functionality usefulness, assumed simplicity of system use*

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Introduction

Medical Information Systems (MIS) are designed in order to improve the work of healthcare institutions, enable better resources management and be a good basis for generating various types of reports (1). Even though they are developing during the last half century, their acceptance from the potential users did not always go smoothly (2). Globally, the trend of acceptance of medical information systems and their efficient use starts mid nineties (3), while the final expansion was actually during the first decade of the 21st century (4). Massive use of the medical information systems within the primary healthcare of the Republic of Serbia starts from 2010-2011 with the great support of the Ministry of Health. Health Care Center in Niš, as the leading regional health center, started the implementation of the medical information system as the pilot project with the Faculty of Electronic Engineering in Niš (5,

6). Information system, named MEDIS.NET had been in full use since January 2012, and after that was installed in twenty more healthcare centers in South and East Serbia.

After a four-year period, and active use of MEDIS.NET, it is possible, from the point of technology acceptance model, to analyse the effects of use of MIS. Our goal was to assess the level of acceptance of medical information system in general through the analysis of collected data, as well as to assess its individual parts that were given special attention during the development phase. Our basis for analysis was technology acceptance model (8) which considers the system acceptance through two categories of functionality – the ones presumed to be easy to use and the ones that enhance the efficiency of the healthcare institution.

There are a large number of papers dealing with the analysis of the MIS functionality acceptance. Within this research, the particular importance was given to the part (9) on detailed analysis of the use of medical records in primary health care. Beside this, the authors presented the overview of great number of positive and negative aspects of introducing the medical information systems as the collection of implementation strategies that contribute to system acceptance from end users.

In general, the usefulness of the system is commmonly marked as the key element of system acceptance (10). For users, a well designed software system that does not follow their working processes and needs is less significant. During the system development and in communication with potential users it was very important to mark the most useful things (11) and to develop the system in this direction. After the development phase is finished, and starts the system use phase, it is necessary to monitor the users' behaviour and make adaptations of critical parts.

This paper is the result of such monitoring and the results will be the basis for improvement of the most important parts of the MIS. As mentioned in (12) and (13), the acceptance of medical information systems is not a linear process and after initial analysis it is necessary to monitor users' behaviour and react to their changes, suggestions and recommendations.

Potential users could have different opinions on certain parts of the system, and the promptness of functionalities that are not considered as basic could vary a lot (14, 15). Although it is nowadays considered that the medical workers are determined to accept information technologies in their everyday work, a various operative inefficiencies of realized softwares could result with complete rejection of some initially good functionalities. On the other hand, some simple functionality could be identified by users as extremely important and generally could be very quickly accepted.

Material and methods

From the technical point of view, it was of great interest to analyse the system use by medical workers, and in accordance with this to define the guidelines for further development and adaptation of the existing functionalities, as well as forming internal recommendations for more efficient realization of new MIS segments. In order to get objective results, we followed the analysis of collected data for the period from 01/01/2012 to 31/12/2015. Results were processed through the prism of technology acceptance model (TAM). Figure 1 presents block scheme of TAM. Previous experience, domain knowledge and social context could be defined as so called external variable that affects the acceptance of a system. Accordingly, users will accept different system functionalities either because they perceive them as ease of use (Perceived Ease of Use - PEOU), or because they find them useful (Perceived Usefulness – PU). From the point of view of these two categories, the reaction of users considering the functionality will affect the level of functionality acceptance. Another measure for the level of acceptance is the number of mistakes, or corrected records. Ideally, the percentage of corrected records should be the lowest as possible and with the entities that are more frequently created should be lower.
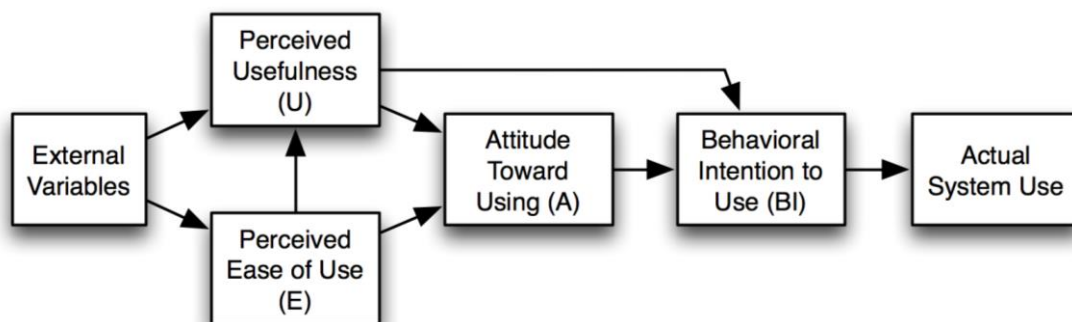

Figure 1. Block scheme of the Technology Acceptance Model (TAM) (8)

In this paper, the primary focus was given to three, from our point of view, the most significant set of entities processed by the medical information system, and these are provided services, referral letters and recipes. The most important entity defined at the level of MIS is provided service that presents the record on provided medical services to patients. They present the basis for all further actions, such as creation of report or invoicing of provided medical services. Also, they present the parent entity for all medical documents such as referral letters and recipes. Provided medical services are modeled in a way that every change upon them is recorded and kept in database as provided service. Once the provided service is changed, the previous version stays recorded as non-valid provided service and could be seen only through the process of revision and generating the report. Secondarily, we have analysed the use of specially defined forms for physical examinations, as specific categories that have specially defined forms for registration and data view. Basic part of the physical examinations is recorded as the entity of provided service, while the specially defined fields that are specific for physical examinations are kept separately.

For both focus points of our paper, the elements of MIS were mainly developed in such a way as to provide full support of established practice and to make it possible for the users to transfer from paper to electronic form of record keeping. Through PEOU approach, our idea was to enable users to initially accept MIS functionalities with simple and easy training, and later with system finishing, to focus on PU in order to increase the work efficiency and recognize the advantages of MIS use.

Results

First important thing that we have analysed is the percentage of successfully entered records for entities that describe provided services. Since MIS users in primary healthcare mainly have large number of patients, it is very important for system to be designed in such a way that users change or delete records as less as possible. Each of these actions is unnecessary waste of time and the general goal is to have less of these actions. For entities such as provided services that percentage should be less than 5%. The level of 95% of valid records means that users had to change or delete on average one out of twenty provided services. Having in mind that data from our MIS could not be deleted, but marked as non-valid in case of deletion or update, absolutely all created records are available from the database special reports or revision.

At the end of period of our research, in the fourth quarter of 2015, the percentage of valid provided services was 99.23 % (Table 1), the best quarterly result since the beginning in 2012. Initially, the percentage of valid provided services reached the level of 95% already in the second quarter of 2012.

Table 1. Percentage of valid provided services: A) quarter, B) year, C) number of registered provided services, D) number of valid provided services, E) percentage of valid services, F) number of active departments, G) number of active users, H) number of users who had non-valid services, I) percentage of users with non-valid services.

A	B	C	D	E	F	G	H	I
1	2012	50475	46870	92.86	16	136	95	69.85
2	2012	708596	678567	95.76	30	342	261	76.32
3	2012	679229	668100	98.36	31	339	232	68.44
4	2012	1234478	1218322	98.69	31	344	262	76.16
1	2013	1269571	1253785	98.76	31	342	253	73.98
2	2013	1212871	1190815	98.18	31	336	249	74.11
3	2013	1091818	1074589	98.42	31	338	238	70.41
4	2013	1389613	1368269	98.46	31	344	239	69.48
1	2014	1387759	1372180	98.88	32	319	229	71.79
2	2014	1263009	1251536	99.09	32	310	220	70.97
3	2014	1150759	1140641	99.12	32	305	203	66.56
4	2014	1464404	1451603	99.13	32	303	209	68.98
1	2015	1379097	1368216	99.21	32	303	213	70.30
2	2015	1321209	1310318	99.18	32	298	188	63.09
3	2015	1157166	1148156	99.22	33	296	195	65.88
4	2015	1486557	1475066	99.23	34	298	202	67.79

Initially, this percentage was 92.86% which was satisfactory. It is important to mention that during the first quarter of 2012, the system was used by 136 users who worked in 16 organizational units. At the same time, the training was provided for new users and many initially noticed disadvantages were corrected.

Already in second quarter of 2012, the number of users went up to 342, while the number of active departments went up to 30. Over time, the percentage of successfully recorded services had the mild uptrend, which could be explained by the fact that the medical staff was getting more and more secure and more easily accepted the provided technology. During the third quarter of 2012, the percentage of successfully recorded services went up to 98%, and in the second quarter of 2014 went over 99%.

With the percentage of correctly entered provided services, important factor is their total number, as well as the moment of increase of these recorded data. At the beginning (January – March 2012), the number of recorded visits was around a couple of tens of thousands a month. In the first quarter of 2012, over 50 thousand provided services were recorded. But, in the second quarter of 2012, a significant increase of registered visits arose and went over 700 thousand. In the third quarter of 2012 this number went down a bit, while in the fourth quarter, there were over a million registered records.

Also, each of these great lumps in number of registered services included a great lump in the number of users, as well as in number of departments that use MIS. For example, in April 2012 not only the number of services went up from 45 to 170 thousand, but the number of departments that use the system went up from 14 to 29, and the number of active users from 225 to 376. The biggest number of users in one month was 377, and it was registered in July 2013. After this we had the trend of decrease of users. In July 2014 the number of users went down to around 300 and stayed there until the end of 2015. The percentage of users who registered non-valid visits was around 70%. Although, a great number of users, from time to time, made mistakes during the recording of provided services, the general trend was positive.

On the other hand, the trend for referrals and recipes was a bit different. Table 2 presents general statistics related to referral letters. Having in mind the total number of created referrals, the trend was going up. The biggest number of registered referrals was recorded in the last quarter of 2015. Also, the number of valid referrals was bigger, but their percentage went down ovrt time. During the system development, the number of supported types of referrals was increased from initial 9 to current 13. Table 3 presents distribution of referral letters by type. Even though the number of created referrals was different from type to type, the highest percentage of non-valid was among the categories that were least used, while within the categories that cover the highest percentage of crated entities the percentage of non-valid was 10%. Similar trend could be recognized for recipes.

Table 2. Statistics related to the referral letters

Month	Year	Referral letters	Valid	Valid %	Type of referral letters	Urgent	Out of institution	Out of institution (%)
1	2012	3700	3481	94.08	9			
2	2012	47551	46838	98.50	10	16	7266	15.51
3	2012	59007	57443	97.35	10	26	27087	47.15
4	2012	70116	67739	96.61	11	79	32548	48.05
1	2013	67906	64941	95.63	11	72	30045	46.27
2	2013	55133	52392	95.03	11	71	23917	45.65
3	2013	59553	56250	94.45	11	76	26092	46.39
4	2013	69085	64425	93.25	11	91	28649	44.47
1	2014	68246	63619	93.22	11	100	28092	44.16
2	2014	61439	56839	92.51	11	133	26790	47.13
3	2014	61399	56336	91.75	12	78	26591	47.20
4	2014	79029	71709	90.74	12	97	33172	46.26
1	2015	81259	73057	89.91	12	70	33344	45.64
2	2015	78473	69892	89.07	12	66	32630	46.69
3	2015	73881	65183	88.23	12	59	30942	47.47
4	2015	92811	81930	88.28	12	86	38348	46.81

Table 3. Distribution of referral letters according to the type

Name	No. of referral letters	No. of non-valid	% of non-valid
Medical specialist report	717	65	9.07
Referral for intervention	5617	245	4.36
Referral for transport	665	35	5.26
General laboratory referral	112836	8750	7.75
Certificate on travel need for healthcare purposes	1107	49	4.43
Registration of disease	82	9	10.98
Registration of infectious disease	1515	58	3.83
Transfer referral - laboratory	82	13	15.85
Referral to specialist	595694	56628	9.51
Referral to medical commission	10368	372	3.59
Laboratory referral	137267	3046	2.22
Radiology referral	33752	3076	9.11
Stationary treatment referral	57637	4974	8.63

Table 4. Recipes: A) month, B) year, C) total number of recipes, D) number of valid recipes,
E) percentage of valid recipes, F) number of patients, G) number of users,
H) number of different prescribed medications, I) number of different diagnosis,
J) number of recipes marked as the recipes of specific importance,
K) percentage of recipes of special importance

A	B	C	D	E	F	G	H	I	J	K
1	2012	9092	8742	96.15	2889	80	603	362	634	7.25
2	2012	232432	222887	95.89	36838	148	923	1138	5532	2.48
3	2012	288942	267636	92.63	34441	142	885	1117	4557	1.70
4	2012	384943	352155	91.48	41254	145	893	1164	9476	2.69
1	2013	371961	342602	92.11	42504	147	930	1114	9943	2.90
2	2013	354373	325683	91.90	39755	146	1002	1111	7800	2.39
3	2013	361392	328673	90.95	40096	158	1045	1145	6666	2.03
4	2013	433702	395611	91.22	47068	161	1080	1218	7506	1.90
1	2014	422912	389569	92.12	46144	157	1059	1235	6685	1.72
2	2014	422006	386098	91.49	41994	156	1037	1227	6231	1.61
3	2014	402450	368834	91.65	44341	150	1042	1223	5918	1.60
4	2014	483711	442390	91.46	49933	154	1053	1320	6818	1.54
1	2015	448923	408087	90.90	49661	150	1068	1293	6394	1.57
2	2015	455558	412450	90.54	43728	150	1101	1274	6555	1.59
3	2015	422875	382723	90.50	42552	148	1096	1291	6381	1.67
4	2015	504459	456506	90.49	50705	152	1125	1331	7335	1.61

Table 4 presents general statistics for recipes. As the number of recipes went up, the percentage of non-valid was also increasing, similar like referrals.

Further, forms for physical examinations were addressed in this analysis as an addition to the sys-tem developed on the request of users in order to support one specific category of entity. Physical exa-minations could generally consist of few provided services. Table 5 presents data related to services that are usually registered through the form of phy-

sical examinations. It is important to mention that it is possible for users to register any kind of service, even the physical examination, through the standard form for registration of provided services. The level of acceptance is the best with the physical examinations for school children. The lowest percentage is with adults, where the most various services were registered with the form of physical examinations.

Table 5. Overview of using the forms for physical examinations:
A) number of recorded examinations through specific form, B) total number of recorded examinations,
C) percentage of examinations recorded through specific form

Type of examination	A	B	C
Infants (37 different services)			
Preventive examination of newborns and infants during the first year of life	23028	35967	64.03
Physical examination of newborns and infants until the first year of life	5697	10359	55.00
Physical examination of small children from age one to six years	865	11129	7.77
Preventive examination of children from age one to school age	1234	17746	6.95
Others	863		
Pre-school children (29 different services)			
Preventive examination of children from age one to school age	15299	17746	86.21
Physical examination of small children from age one to six years	3973	11129	35.70
Control examination of children, school children and youth	8406	32853	25.59
Preventive examination of newborns and infants during the first year of life	4711	46326	10.17
Control examination of children, school children and youth (regular, in case of monitoring of disabilities)	2918	32626	8.94
Preventive examination before referring to residential institution for children, school children and youth	1134	49263	2.30
Medical examination before referring to residential institution (kindergarten, summer school)	167	11208	1.49
Others	1787		
School children (24 different services)			
Preventive examination of school children and youth	38875	39727	97.86
Physical examination of school children and youth	8303	10142	81.87
Physical examination of children age from one to six years	1235	11129	11.10
Preventive examination of children age from one year to enrolment in school	715	17746	4.03
Others	520		
Adults (42 different services)			
Preventive examination of adults	7095	41089	17.27
Physcial examination of adults	1367	13088	10.44
Others	161		

Analysis and discussion

In the light of the TAM, registration of visits has been treated as PEOU. Users should find easy to use the forms for entity registration which they already are familiar with – in this case visits and provided services (Figure 2). As already mentioned, the percent-age of successfully created provided services is over 99%.

The difference in percentage of non-valid provided medical services (changed and deleted) is significant if we look at the departments which have

medical records and the ones that do not have (Table 6 and Table 7). In Primary Health Center Niš, a total of 7 departments have registration of services through medical records, while 33 departments do not have separate medical record. Also, within the 7 departments that have medical records, certain number of medical services is registered as direct medical services. Medical recording, from the point of view of

TAM, could be identified as a significant external variable. Medical recording requires larger number of administrative operations than simple registration of provided medical services to patients. Users, who have the obligation to lead electronic medical record within MIS, have more contacts with the system and due to large scope of work they accept the MIS functionalities more quickly.

Figure 2. Example of entering the provided medical service using the form for entering the new visit from the electronic health record of the patient

In December 2015, 122 users recorded services that were registered using electronic medical record of the patient, while 298 registered services directly. Users that record services through electronic medical record of patient added on average 3264.71 services during December 2015, with an average of 6.61 non-valid records. This made 0.2% of changed or deleted services. Considering the services recorded out of patients' record, for the same month, average number of recorded services was 1275.84 where 13.02 were non-valid and that was 1.02%. At the beginning of MIS use, in January 2012, this percentage was 15.48% within the departments that had electronic medical records and 48.5% within the departments that did not have this type of recording. After three months this percentage went down below 5% within both categories.

Considering the recipes and referrals, the percentage of unchanged records is lower and it goes around 90%. Furthermore, after the initial percentage of valid records of over 95%, the increase of records, as well as the number of users that create these entities has lead to decrease of successfulness. Here, however, the records that are marked as invalid, and that could be excluded from the analysis (so called false positives) must be taken into account. We can divide them into following categories:
- Recipes and referrals that belong to deleted provided services and visits,
- Recipes and referrals created by coping the existing ones,
- Non-copied recipes and referrals deleted during the forming of provided service or visit.

Table 6. Statistics for departments that have medical records:
A) month, B) year, C) total number of registered visits, D) number of valid visits,
E) number of departments that have medical records, F) number of various registred services,
G) number of patients, H) number of MIS users, I) number of users with non-valid visits,
J) number of registered services by user, K) average number of non-valid services by user,
L) relative percentage of non-valid services.

A	B	C	D	E	F	G	H	I	J	K	L
1	2012	1374	1335	4	13	708	170	20	12.59	1.95	15.48
2	2012	2941	2854	6	34	2062	83	15	40.58	5.80	14.29
3	2012	7970	6781	5	42	5087	128	30	351.30	39.63	11.28
4	2012	29563	25366	5	72	17829	159	93	1077.47	45.13	4.19
5	2012	79105	70001	6	85	47645	170	146	1659.90	62.36	3.76
6	2012	80366	74987	7	75	50776	154	143	1656.46	37.62	2.27
7	2012	66563	64939	6	84	44766	145	130	1514.77	12.49	0.82
8	2012	52737	51607	6	74	36711	142	127	1548.35	8.90	0.57
9	2012	78407	76957	7	82	51312	145	136	1653.26	10.66	0.64
10	2012	101447	99146	7	93	61950	151	138	2990.11	16.67	0.56
11	2012	91998	89719	6	95	57594	148	143	2758.57	15.94	0.58
12	2012	87347	84903	5	94	55373	146	135	2566.46	18.10	0.71
1	2013	86529	84513	6	95	54670	148	140	2499.09	14.40	0.58
2	2013	97700	94616	7	139	60254	151	142	2818.68	21.72	0.77
3	2013	98966	96127	7	100	61102	154	144	3078.48	19.72	0.64
4	2013	95616	93318	5	98	59972	153	143	3071.34	16.07	0.52
5	2013	77343	75556	5	92	52798	150	141	2556.03	12.67	0.50
6	2013	76194	74620	5	84	50101	147	131	2445.93	12.02	0.49
7	2013	79197	77322	5	85	50477	147	130	2507.99	14.42	0.58
8	2013	75809	74360	6	101	50307	160	149	2117.28	9.72	0.46
9	2013	95000	92947	7	203	59880	166	158	2315.54	12.99	0.56
10	2013	115525	112259	6	118	66961	169	165	2902.99	19.79	0.68
11	2013	103787	101356	6	117	63037	167	163	2642.60	14.91	0.56
12	2013	111131	108123	7	117	65767	170	163	2692.31	18.45	0.69
1	2014	97017	95498	7	108	59893	165	155	2495.44	9.80	0.39
2	2014	109740	108530	7	114	66497	167	147	2783.47	8.23	0.30
3	2014	112076	110810	7	113	67589	166	147	3079.35	8.61	0.28
4	2014	101036	100012	7	111	64371	165	144	2635.93	7.11	0.27
5	2014	96364	95385	7	106	62577	164	141	2583.94	6.94	0.27
6	2014	93753	92922	6	106	59391	157	129	2575.25	6.44	0.25
7	2014	86060	85390	7	105	54774	157	129	2398.20	5.19	0.22
8	2014	84468	83741	7	104	53751	155	125	2250.10	5.82	0.26
9	2014	103496	102672	6	108	62846	153	123	2780.89	6.70	0.24
10	2014	124118	123154	7	114	71195	156	135	3333.49	7.14	0.21
11	2014	105864	104990	6	112	63841	161	148	2860.75	5.91	0.21
12	2014	119290	118384	7	119	69084	158	135	3062.01	6.71	0.22
1	2015	94558	93780	7	105	58907	154	134	2615.43	5.81	0.22
2	2015	101716	100943	7	111	63037	154	131	2862.98	5.90	0.21
3	2015	122722	121870	7	113	71275	155	138	3454.34	6.17	0.18

4	2015	105166	104372	7	117	64113	154	136	2914.14	5.84	0.20
5	2015	102323	101492	7	109	63359	152	130	2902.74	6.39	0.22
6	2015	100566	99667	7	107	61409	149	125	2894.06	7.19	0.25
7	2015	89848	89143	7	109	55785	149	129	2516.68	5.47	0.22
8	2015	85574	84895	7	112	54645	148	120	2383.06	5.66	0.24
9	2015	102971	102236	7	116	62752	152	130	2825.58	5.65	0.20
10	2015	120037	119078	7	116	69796	154	141	3270.90	6.80	0.21
11	2015	110859	109646	7	122	65989	155	140	3097.24	8.66	0.28
12	2015	122567	121635	7	122	70053	154	141	3264.71	6.61	0.20

Table 7. Statistics for departments that do not have medical records or have visit records out of the medical records.
A) month, B) year, C) total number of registered visits, D) number of valid visits,
E) number of departments that do not have medical records, F) number of various registered services,
G) number of patients, H) number of MIS users,
I) number of users with non-valid visits, J) number of registered services by user,
K) average number of non-valid services by user, L) relative percentage of non-valid services

A	B	C	D	E	F	G	H	I	J	K	L
1	2012	767	663	14	144	216	93	26	8.25	4.00	48.50
2	2012	427	359	16	131	147	53	24	8.06	2.83	35.17
3	2012	36996	34878	14	189	10267	136	95	272.03	22.29	8.20
4	2012	141755	138475	29	523	35470	344	232	412.08	14.14	3.43
5	2012	203078	199351	30	548	53442	352	268	576.93	13.91	2.41
6	2012	174729	170387	30	543	45453	342	261	510.90	16.64	3.26
7	2012	153078	151157	30	523	38752	331	182	462.47	10.55	2.28
8	2012	167128	164430	29	515	46395	337	228	495.93	11.83	2.39
9	2012	161316	159010	31	575	41738	339	232	475.86	9.94	2.09
10	2012	350059	346599	31	622	55188	351	266	997.32	13.01	1.30
11	2012	316271	313036	31	632	52444	350	274	903.63	11.81	1.31
12	2012	287356	284919	31	619	47973	344	262	835.34	9.30	1.11
1	2013	283336	280672	31	597	45159	339	242	835.80	11.01	1.32
2	2013	327920	325468	31	667	52341	338	245	970.18	10.01	1.03
3	2013	375120	372389	31	623	58251	342	253	1096.84	10.79	0.98
4	2013	374299	369126	31	620	57122	346	265	1081.79	19.52	1.80
5	2013	306061	300343	31	613	50048	340	257	900.18	22.25	2.47
6	2013	283358	277852	31	604	43637	336	249	843.33	22.11	2.62
7	2013	289478	285340	31	589	42519	376	242	769.89	17.10	2.22
8	2013	262955	258938	31	585	39775	375	228	701.21	17.62	2.51
9	2013	289379	285682	31	970	42725	338	238	856.15	15.53	1.81
10	2013	375081	370163	31	624	53166	336	270	1116.31	18.21	1.63
11	2013	337527	333430	31	617	48892	343	270	984.04	15.17	1.54
12	2013	346562	342938	31	614	48261	344	239	1007.45	15.16	1.51
1	2014	314730	311670	32	583	42449	331	227	950.85	13.48	1.42
2	2014	355100	350282	32	583	47309	323	252	1099.38	19.12	1.74
3	2014	399096	395390	32	588	51886	319	229	1251.08	16.18	1.29
4	2014	333893	330863	32	594	45898	331	235	1008.74	12.89	1.28

5	2014	327402	324810	32	587	45142	323	230	1013.63	11.27	1.11
6	2014	310561	307544	32	565	41115	310	220	1001.81	13.71	1.37
7	2014	290458	287773	32	559	38540	305	218	952.32	12.32	1.29
8	2014	264297	261945	32	560	34517	300	180	880.99	13.07	1.48
9	2014	321980	319120	32	576	42079	305	203	1055.67	14.09	1.33
10	2014	395907	392559	32	595	50869	306	226	1293.81	14.81	1.14
11	2014	354717	351297	32	580	43623	307	218	1155.43	15.69	1.36
12	2014	364508	361219	32	592	44911	303	209	1203.00	15.74	1.31
1	2015	308218	305898	32	588	38866	304	193	1013.88	12.02	1.19
2	2015	339183	336484	32	606	43312	303	205	1119.42	13.17	1.18
3	2015	412700	409241	32	601	50712	303	213	1362.05	16.24	1.19
4	2015	343611	340561	32	609	44465	302	212	1137.78	14.39	1.26
5	2015	338894	336191	31	605	43635	299	208	1133.42	13.00	1.15
6	2015	330649	328035	32	615	41488	298	188	1109.56	13.90	1.25
7	2015	285137	282989	33	607	35958	293	195	973.16	11.02	1.13
8	2015	267119	265167	32	604	34501	291	171	917.93	11.42	1.24
9	2015	326517	323726	32	619	40176	296	195	1103.10	14.31	1.30
10	2015	383682	380671	32	617	46632	304	221	1262.11	13.62	1.08
11	2015	369213	366467	32	612	44449	300	209	1230.71	13.14	1.07
12	2015	380199	377569	33	631	45384	298	202	1275.84	13.02	1.02

When provided service or visit is deleted, that action necessarily leads to deletion of all related documents. In this way all related referrals and recipes will be marked as deleted, even though they were not directly deleted. Having in mind the fact that the number of this kind of services and visits is very low, the percentage of recipes deleted in this way is around 3.65% (total number is 18575, and the number of non-valid recipes is over 509 thousand, Table 8).

Copying of existing referrals and recipes into the new visit or provided service is the functionality created to accelerate the work of system users. The main purpose is to enable the prescription of the chronic therapy to the patient (prescription of recipes for continuation of existing therapy) or the creation of another referral for patients who suffer from chronic disease, in cases where it is necessary (Figure 3). The basic mode for use is that the user should choose one of the existing recipes or referrals from the list and copy it within the existing visit. If in this case the user decides to change some of the parameters after the copying, one non-valid entity will be created. This category gives around 10% of the total number of non-valid recipes.

Also, since the data are not physically erased from the database during the work in MIS, prescribed recipes and referrals, either they were erased or updated during the creation of new visit or provided service, will be registered as non-valid. These entities do not get valid protocol numbers until the moment when the complete visit is not saved, so we can ignore them from the total number of non-valid entities. This is the largest group of non-valid recipes and it actually presents one third of the total number of non-valid ones.

When we eject the above mentioned recipes from the total number of recipes, the result is that the percentage of invalid recipes goes within the acceptable 5%. During a couple of quarters, the number of changed and deleted recipes goes over 5% and it is not significant (Table 8). From the point of accepting technology, these are expected results since all the above mentioned categories are entities created within the well known processes and there was no need to explain to users any additional elements. Therefore all the observed functionalities that are classified into PEOU category are accepted in satisfying way.

As the representative of PU category we have chosen the overview of the physical examinations. During the system development and considering the demands of users, they were mainly focused on specific design of input forms and comparative view of values (Figure 4). The whole functionality was developed with the aim to be used instead of standard function for data input on visits for physical examinations recording. Generally, a user can input data on physical examination both through specific and standard functionality. Specific functionality was supposed to be the first choice in most of the cases in order to justify its PU nature.

Table 8. Potential false positives for non-valid recipes: A) quarter, B) year, C) total number of non-valid,
D) non-valid from erased services and visits, E) non-valid from copied entities,
F) non-valid generated during the creation of provided service or visit,
G) number of non-valid after taking out potential false positives,
H) percentage of non-valid after deletion of false positives records.

A	B	C	D	E	F	G	H
1	2012	350	44	139	142	25	0.27
2	2012	9545	906	2281	3453	2905	1.25
3	2012	21306	300	3254	7926	9826	3.40
4	2012	32788	1197	3729	10060	17802	4.62
1	2013	29359	1172	3508	11044	13635	3.67
2	2013	28690	1090	3124	9669	14807	4.18
3	2013	32719	1257	2670	10103	18689	5.17
4	2013	38091	1863	3293	10872	22063	5.09
1	2014	33343	1759	3036	10143	18405	4.35
2	2014	35908	1544	3003	13065	18296	4.34
3	2014	33616	1157	3443	10989	18027	4.48
4	2014	41321	1327	3056	12488	24450	5.05
1	2015	40836	1190	3790	13324	22532	5.02
2	2015	43108	1304	3787	15395	22622	4.97
3	2015	40152	1088	4390	14370	20304	4.80
4	2015	47953	1377	4464	18615	23497	4.66

Figure 3. Copying the existing diagnosis, referral letters and recipes into the new visit/provided service

Параметар	Нема упут	Нема упут	Нема упут	Не постоји	Не постоји	Не постоји
datum	14.04.2014.	03.09.2014.	03.04.2015.			
starost godina	2	2	3			
težina	8.7	10	11.5			
visina	77	83	85			
BMI	14.67	14.52	15.92			
uhranjenost	E (eutrofija)	E (eutrofija)	E (eutrofija)			
dat savet o pravilnoj ish...	Da	Da	Da			
koža	Nalaz uredan	Nalaz uredan	Nalaz uredan			
deformacija grudnog koša	Nema	Nema	Nema			
deformacija kičme	Nema	Nema	Nema			
deformacija stopala	Nema	Nema	Nema			
tonzile i limfne žlezde	Nalaz uredan	Nalaz uredan	Nalaz uredan			
stanje zuba	Stomatologu	Stomatologu	Stomatologu			
čula sluh	Nalaz uredan	Nalaz uredan	Nalaz uredan			
čula vid	Nalaz uredan	Nalaz uredan	Nalaz uredan			
pluća	Nalaz uredan	Nalaz uredan	Nalaz uredan			
srce	Nalaz uredan	Nalaz uredan	Nalaz uredan			
jetra i slezina	Nalaz uredan	Nalaz uredan	Nalaz uredan			
kongen anomalije kostura	Nema	Nema	Nema			
kongen anomalije srca	Nema	Nema	Nema			
kongen anomalije polni...	Nema	Nema	Nema			
kongen anomalije ostalo	Nema	Nema	Nema			
govorne mane	Nema	Nema	Nema			
hgb		132				
er		5,21				
hct		4,01				
mcv		79				
anemija	Ne	Ne	Ne			

Figure 4. Comparative review of data obtained after the physical examinations.

Usage results may vary from department to department, as well as from the type of physical examination. The best percentage of acceptability is within physical examinations (81.87%) and preventive (97.86%) examinations of school children (Table 5). Within the physical examinations of school children there were totally 24 various services registered, at it is important to mention the examinations related to school enrolment. Their percentage is lower 11.1% and 4.03% while the percentage of use with all other registered services is insignificant. From the remaining 20 services there are 520 records that are made.

Considering the physical examination of pre-school children, the best indicator of acceptance is within the preventive examinations of children – 86.21%. None of the remaining services does have the usage percentage more than 50%, and only 7 of them is on the level of 1% and higher. Considering the examinations of infants, percentage of usage for PU functionalities is 64% for preventive and 55% for physical examinations. Here we can notice great number of various services for which the functionality has been used, but with the small percentage.

For preventive and physical examinations of adults, the percentage of acceptance for PU functionality is the lowest – 17.27%, or 10.44%. For physical examinations of adults there are totally 42 different services registered, but similar like with infants it has low percentage, less than 1%.

It is important to point out that these services are registered through various types of physical examinations; therefore in the overview given by the categories they have lower percentage of use for PU based functionality. For example, these services are *Preventive examination of children from age 1 to school age* and *Physical examination of children from age 1 to 6 years*. These services are registered through physical examinations of infants and pre-school and school children. There are totally 17746 registered preventive examinations, of which 15229 physical examination of pres-school children, 715 examinations of school children and 1234 infant examinations. It is totally 17248 from 17746 examinations. It represents more than 97% of all registered ones. For physical examinations the total percentage of registered ones is 55% (6023 out of 11129).

For registration of physical examinations through specific PU functionalities it can be concluded that the functionality itself has been used for large number of various services through each of offered forms, but only for couple of characteristic ones the percentage of use was significant. Users are usually using the above mentioned functionality for preventive and physical examinations of children, since they are carried out according to a predefined model and there is a detailed record about it. Unfortunately, there is no large number of registered physical examinations of adults, so the percentage of use for PU functionality is on the lower level than expected.

Conclusion

During the exploitation phase of the medical information system, very important activity is constant system improvement in order to achieve higher level of the efficiency and satisfaction of users. In order to improve MIS, it is necessary to conduct the data analysis on how the system is used after the appropriate period of exploitation. This paper shows the results of this analysis and adequate conclusions.

Considering the number of users and number of generated records we could be satisfied with the scope of system acceptance. The percentage of valid records is on the extremely high level considering the provided services (more than 99%), while the referrals and recipes are on satisfying 90%, or 95% when we drop out the records marked as false positives. It is confirmed that users do accept much easier and on a larger scale these functionalities which are considered easy to use, especially if they follow in detail the existing working processes. What we did not cover with this analysis is the quality of collected medical data. The validity of records has been measured only through users' actions aimed at their creation, deletion and updating.

Considering the acceptance of additional functionalities that are expected to provide additional sy-stem quality, on the example of physical examinations we have received high level of acceptance for those examinations which are more frequent and in larger number. The level of acceptance for physical and preventive examinations is much higher with physical examinations of children than with adults. Unfortunately, even the number of provided physical examinations of adults is lower due to the fact that there are many various examinations (our users have registered even 42 types of different physical examinations) and does not create the sense of need for use of special functionalities.

As already mentioned in (14), when accepting the new technology, the level of functionality acceptance, if presented through the acceptance model as simple, is very high. This is also significant because these functionalities are the ones that are often used and the high level of bad records would significantly slow down the work of doctors. In cases where users have the choice between basic and improved functionalities that presumably could contribute with their usefulness, the users will choose the other one only when the usage frequency is high enough or the improved functionality offers the obvious improvement of system performances.

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OSVRT NA KORIŠĆENJE I PRIHVATANJE MEDICINSKOG INFORMACIONOG SISTEMA U PRIMARNOM ZDRAVSTVU REPUBLIKE SRBIJE

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U ovom radu prikazana je analiza korišćenja i prihvatanja medicinskog informacionog sistema (MIS) u Domu zdravlja Niš. Analizirani su podaci prikupljeni u periodu od 1. januara 2012. do 31. decembra 2015. godine. Analiza uspešnosti korišćenja sistema bazirana je na računanju procenta uspešno unetih zapisa o posetama, pruženim medicinskim uslugama (datim uslugama), receptima, uputima i sistematskim pregledima. U kontekstu analize korišćenja sistema, uspešno uneta medicinska usluga je usluga koja kasnije nije menjana ili brisana. Kako se tokom rada iz MIS-a zapravo ne brišu zapisi, već se samo označavaju kao promenjeni ili obrisani, može se tačno odrediti broj i procenat zapisa koji nisu menjani nakon svog prvog snimanja. Rezultati ove analize su od značaja za dalji tehnički razvoj medicinskog informacionog sistema i pomažu u identifikaciji onih funkcionalnosti koje krajnji korisnici teže prihvataju i koje je potrebno dalje usavršavati. Samo prihvatanje MIS-a je analizirano u svetlu modela prihvatanja tehnologije (technology acceptance model). Kao reprezentativne funkcionalnosti uzete su registracija datih usluga i vođenje evidencije o sistematskim pregledima. Registrovanje datih usluga je posmatrano kao funkcionalnost koju korisnici prihvataju zbog jednostavnosti korišćenja (perceived ease of use), dok je registrovanje sistematskih pregleda posmatrano kao funkcionalnost za koju se pretpostavlja da će biti ocenjena od strane korisnika kao korisna (percieved usefulness). Za funkcionalnosti kod kojih se očekuje prihvatanje na osnovu jednostavnosti korišćenja, stopa ispravnih unosa podataka je preko 90% u svakoj od kategorija. Šta više, stopa ispravnih unosa podataka kod poseta i datih usluga je više od 99%. Ovo je značajno zato što su te funkcionalnosti najčešće korišćene i visok stepen loših unosa bi u mnogome usporio rad lekara. Sa druge strane, procenat korišćenja posebne funkcionalnosti za unos sistematskih pregleda znatno varira. Dok se za najčešće sistematske preglede kod dece posebno dizajnirana funkcionalnost koristi u preko dve trećine slučaja (kod pojedinih i više od 97%), kod registrovanja sistematskih pregleda odraslih bolesnika taj procenat je niži od 20%. Kako korisnici mogu da unesu podatke o sistematskom pregledu i pomoću forme za unos posete, kao i pomoću posebne specijalizovane forme, korisnici će se opredeliti za korišćenje druge, tek onda kada je frekvencija korišćenja dovoljno velika ili kada unapređena funkcionalnost specijalizovane forme pruža očito poboljšanje performansi sistema. Pod korisnicima MIS-a smatraćemo medicinsko osoblje koje u skladu sa zaduženjima i privilegijama koje ima koristi funkcionalnosti MIS-a (lekari, medicinski tehničari,...).

Acta Medica Medianae 2018;57(4):122-136.

Ključne reči: *medicinski informacioni sistem, model prihvatanja tehnologije (TAM), pretpostavljena korisnost funkcionalnosti, pretpostavljena jednostavnost korišćenja sistema*