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Investigating Determinants of Medical User Expectations from Hospital Information System

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***Abstract*—**User satisfaction is one of the most used success indicators in the research of information system (IS). Literature shows user expectations have great influence on user satisfaction. Both expectation and satisfaction of users are important for Hospital Information Systems (HIS). Education, IS experience, age, attitude towards change, business title, sex and working unit of the hospital, are examined as the potential determinant of the medical users' expectations. Data about medical user expectations are collected by the "Expectation Questionnaire" developed for this study. Expectation data are used for calculating the Expectation Meeting Ratio (EMR) with the evaluation framework also developed for this study. The internal consistencies of the answers to the questionnaire are measured by Cronbach´s Alpha coefficient. The multivariate analysis of medical user's EMRs of HIS is performed by forward stepwise binary logistic regression analysis. Education and business title is appeared to be the determinants of expectations from HIS.

***Keywords*—**Evaluation, Fuzzy Logic, Hospital Information System, User Expectation.

I. Introduction

WE all know that healthcare domain is a huge combination of problems. For a physician, deciding to what should be done in every case is difficult, because of the variable nature of disease and patient characteristics. The physician depends on his education, experience and mental capacity to make these decisions. Taking into account the number of decisions he is supposed to make and pace in patient, medical errors are inevitable. He needs some help for investigating the background of the patient, giving orders to his assistants, making decisions, etc. Not only the physicians, but also the other medical users need qualified help while doing their work. To help medical domain users tackle with this huge combination of problems, Hospital Information Systems (HIS) are employed. The purpose is giving them the help they need, by the facilities of computer and information system technologies. HIS' are of great interest to the literature and they are improving rapidly with the technological and academic advances.

HIS' have been largely discussed in the literature as a great research area. Although it is said they improved, there are still big problems to solve and under study. One of the issues under study is success and failure reasons. It is estimated that nearly 60-70% of software projects in healthcare fail [1]. Users' satisfaction have direct impact on system usage, meaning that if IS cannot satisfy its users, the users will not use the system effectively [2]. Unwilling users result in an unsuccessful system, independent of how technically successful the system is [3], [4]. If the users of the system think the information system (IS) they are using is "poor", then without any discussion we can name that IS as "poor" no matter what good virtues it has. Szanja and Scamell state that unmet expectations create psychological discomfort concluding with the unsatisfied users and unused system [5].

User expectations have great influence on user satisfaction with IS. Expectation can be defined as a belief about the possibilities related to the future state of issues [6]. In a survey of information systems, "user expectations" was ranked second in a list of 33 items affecting user satisfaction [7]. This is consistent with earlier research which found that user expectations have a strong effect on overall satisfaction with IS [8]. Additionally, three (system quality, system use, user satisfaction) of the six dimensions of DeLone and McLean's IS success model are directly related with the user expectations from an IS [9]. Mahmood *et al*. have analyzed 45 end-user satisfaction studies between 1986 -1998, by focusing on relationship between end-user satisfaction and nine variables, one of which is user expectations [10]. In this study findings show that end-user satisfaction is strongly affected by user expectations.

Norman *et al*. state that IS may have higher attributes than the user's expectation, but if these attributes do not meet the needs of the user they may result in unsatisfied users [11].

The expressions "meeting the expectations", "meeting the needs" raise one big question: How we measure these "meetings" of the IS? The answer is evaluation. Literature gives us many definitions of evaluation. Drawing from the literature, in this study, evaluation is defined as, measuring the extent of meeting the specified criteria of a system, in a specified context.

In Ryker's study [12] determinants of expectations are divided into 3 categories: sources internal to the organization, sources external to the organization, and past experience.

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External sources are given as; word-of-mouth friends outside the work, media commercials and vendor communication, academic schools and journals. Internal sources are given as word-of-mouth co-workers and staff communications.

Szanja and Scamell stated that the user whose expectations are set by the internal organization factors are more satisfied than the users whose expectations are set by the external organization factors [2].

Although determinants of expectations and the methods to manage them discussed in the literature, there is no dedicated study for the expectation of medical users. We do not know what personal features; we name them as "assets" in this study, are the determinants of the medical domain users' expectations from HIS.

In this study, we have tried to analyze the determinants of medical user expectations from HIS. For this purpose a new evaluation framework is developed.

II. Materials and Methods

A. Framework

To measure medical users' expectation meeting ratio (EMR) of HIS, a new evaluation framework is developed. In this framework 17 user expectations (variables) from HIS are examined in four dimensions, given in Table I. Each evaluation variable is considered in expectation scope and represented in the evaluation result by the degree of its importance to end users.

The evaluation result is a numerical value (percentage) meaning the degree, to what extent user expectation is met. This numerical value can be calculated for the whole HIS as well as for each variable and for each end user asset.

Fuzzy logic methodologies are used in the proposed framework as a different approach in HIS evaluation. Fuzzy logic is used when the boundaries are not clear. In linguistic variables such as Likert scale ratings, the context is very suitable for fuzzy logic operations, because they have ambiguity and multiplicity in meaning. They are represented as a range of fuzzy numbers instead of crisp values because of this ambiguity and multiplicity. Fuzzy logic methodologies can be summarized as fuzzification (converting the linguistic variable or crisp number into fuzzy numbers), fuzzy operations (addition, division, multiplication, subtraction) and defuzzification (converting fuzzy numbers into crisp numbers). The details of the framework and the results of the case study in two hospitals about EMRs were given in our previous work [13].

TABLE I
Possible User Expectations from HIS

Usage Expectations	System and Data Expectations	Improvement Expectations	Managerial Expectations
Ease-of-use	Consistency	Improving Service Quality	Reporting Facilities
Need For Training	Privacy	Decreasing Work Load	Decision Support
Help Manuals	Security	Bringing Positive Change	Function Sufficiency
Speed	Availability	Research Facilities	
User Support	Interoperability		

B. Expectation Questionnaire

For evaluation, data are collected using the questionnaire method. The questionnaire, named as "Expectation Questionnaire", is formed and used for collecting medical user expectation data. For each expectation variable, an importance question is asked to capture the importance (weight) of that variable to the user, some questions are asked to capture the expectation meeting of that variable again. Medical users are asked to express their importance weights using 5-point Likert scale (very important, important, average important, not so important, not important), and expectation rating using 5-point Likert scale (strongly agree, moderately agree, not sure, moderately disagree, strongly disagree). Volunteered HIS end users participated in the study.

C. User Assets

In this study seven user assets are examined that may affect HIS medical user expectations, *Education, IS Experience, Age, Attitude towards change (ATC), Business title, Sex, Working Unit (WU).* User asset variables, their values and types of variables are given in Table II.

D. Computation of EMRs

Expectation ratings and importance weights of the users, collected by means of the Expectation Questionnaire, are converted into fuzzy triangular numbers (fuzzified). A fuzzy number F on K is represented as $F = (l, m, u)$ where l = lower value, m = mean value and u = upper value of the fuzzy number F. Fuzzy number F is defined to be a fuzzy triangular number if its membership function $\mu_f : K \rightarrow [0,1]$ is equal to [14] *:*

TABLE II
Variable Types and their Values

User Asset Variables	Values	Types
Education	Primary, Secondary, University graduate	Ordinal
Sex	Male, Female	Nominal
IS Experience	None, Inadequate, Average, Good and Advanced.	Ordinal
Age		Numerical
Attitude Towards Change	Conservative, Open to Change, Open Depending on the Change	Nominal
Business Title	Office workers, Nurse, Physician, Biologist, Laboratory Technician, Other	Nominal
Working Unit	Administrative Unit, Surgical Medicine, Internal Medicine, Basic Medicine	Nominal

$$\mu_{\tilde{f}} = (1/(m-l))\ \chi-(l/(m-l))\ \chi \in [l,m]$$
$$\mu_{\tilde{f}} = (1/(m-u))\ \chi-(l/(m-u))\ \chi \in [m,u] \quad (1)$$
$$l \le m \le u$$

the data gathered by Expectation Questionnaire contain a weight (importance degree) and expectations ratings for each variable, for a user.

By aggregating the expectation rating answers given by the user, the final rating, R_i of the expectation variable *i* for that user is calculated by the formula

$$R_i = 1/n \sum_{k=1}^{n} R_k \quad (2)$$

where n is the number of ratings for variable i,

The EMR is obtained by the weighted average formula

$$EMR = \sum_{k=1}^{n} W_k R_k / \sum_{k=1}^{n} W_k \quad (3)$$

where *n* is the number of variables and *W* is the weight and R is the final rating of the variable *k* .

In all equations, operations are fuzzy operations, so resulting EMR is also a fuzzy triangular number. A crisp number is needed to make a conclusion because fuzzy numbers do not have usable meaning in real world. That means EMR needs to be defuzzified. Centre of Area (COA) defuzzifier is used to convert fuzzy numbers into crisp.

EMR is defuzzified by using Best Non-fuzzy Performance, BNP [15] based on the COA method. Let EMR be (*l*,*m*,*u*), then BNP can be calculated by;

$$BNP = l + \left[(u-l)+(m-l)\right]/3 \quad (4)$$

BNP takes values between -0.83 and 0.83. The final EMR is found by converting BNP into percentage (where -0.83 is zero and 0.83 is 100). A higher EMR means, higher user expectation meeting degree by HIS.

Statistical Package for Social Sciences 19.0 (SPSS, SPSS Inc, Chicago, Illinois, USA) is used for statistical analysis. The internal consistencies of the answers to the "Expectation Questionnaire" are measured by Cronbach´s Alpha coefficient. Cronbach´s Alpha greater than 0.70 is considered reliable. The multivariate analysis of medical user's EMRs was performed by forward stepwise binary logistic regression analysis.

III. Results

The Cronbach's alpha value for the importance weights is 0.871, for the expectation ratings is 0.966. All the Cronbach's alpha values are apparently high and greater than 0.7, showing that the answers to the questions are internally consistent.

504 out of 660 questionnaires are returned by the users (response rate is 76.4%). Of them, 442 questionnaires having no missing data have been included in analysis. The distribution of medical users participating in the study according to the assets under investigation is given in Table III. The selected descriptive of user subgroups are given in Table IV-VI. Mean for age is 33.9 and standard deviation is 6.4.

TABLE III
DISTRIBUTION OF MEDICAL USERS ACCORDING TO THE ASSETS UNDER STUDY

Asset		n	%	Asset		n	%
Education	Primary	-	-	Attitude Towards Change	conservative	8	1.81
	Secondary	20	4.52		open to change	276	62.44
	University	422	95.48		depends	158	35.75
IS Experience	No experience	-	-	Business Title	Office worker	46	10.41
	inadequate	19	4.30		Lab. tech.	33	7.47
	average	178	40.27		Biologist	13	2.94
	good	219	49.55		Nurse	159	35.97
	advanced	26	5.88		Physician	166	37.56
					Other	25	5.66
Working Unit	Basic Medicine	57	12.90	Sex	Men	210	47.51
	Surgical Medicine	154	34.84		Women	232	52.49
	Internal Medicine	199	45.02				
	Administrative Unit	32	7.24				

TABLE IV
DESCRIPTIVE OF THE USER ASSET GROUPS FOR IMPROVEMENT EXPECTATIONS EMRS

Asset		*Median*	*25th-75th percentile*	*Asset*		*Median*	*25th-75th percentile*
Education	Secondary	41.78	53.03-65.92	Sex	Male	28.24	40.39-50.29
	University	30.69	41.39-48.66		Female	33.57	42.84-48.66
IS Experience	Inadequate	41.20	45.19-51.89	Working Unit	Basic	32.27	41.17-53.11
	Average	32.19	42.55-49.54		Surgical	28.66	40.39-47.17
	Good	30.42	41.22-49.19		Internal	30.63	42.10-49.41
	Advanced	22.74	35.47-48.97		Admin.	37.26	44.09-57.53
Business Title	Office worker	38.77	46.16-57.75	Attitude Towards Change	Conservative	42.09	47.21-71.38
	Laboratory Technician	39.77	46.54-61.67		Open to change	30.63	40.61-49.66
	Physician	27.50	35.47-46.62		Depends	31.90	42.93-48.83
	Nurse	32.12	43.36-47.32				
	Biologist	28.99	41.59-43.36				
	Other	35.95	44.75-56.42				

TABLE V
DESCRIPTIVE OF THE USER ASSET GROUPS FOR MANAGERIAL EXPECTATIONS EMRS

Asset		*Median*	*25th-75th percentile*	*Asset*		*Median*	*25th-75th percentile*
Education	Secondary	46.82	56.49-67.90	Sex	Male	41.36	47.71-59.22
	University	41.96	47.73-58.72		Female	42.82	48.05-59.22
IS Experience	Inadequate	44.98	49.35-53.36	Working Unit	Basic	41.60	48.29-63.11
	Average	44.02	49.11-60.30		Surgical	44.04	47.73-58.56
	Good	41.36	47.62-58.21		Internal	41.37	48.12-59.42
	Advanced	35.49	45.83-64.60		Admin.	39.35	48.88-56.15
Business Title	Office worker	41.65	49.34-57.26	Attitude Towards Change	Conservative	41.84	46.63-57.38
	Laboratory Technician	43.89	53.16-63.59		Open to change	41.36	47.62-57.38
	Physician	40.65	47.62-59.22		Depends	44.39	49.30-62.90
	Nurse	44.04	47.88-56.92				
	Biologist	39.11	44.14-64.15				
	Other	43.21	47.70-61.51				

The binary logistic regression results are given in Table VII. In Usage Expectations and System and Data Expectations there is no statistically significant difference. Education appears to be statistically significant for Improvement Expectations and Managerial Expectations. That is, Secondary schools graduate users' EMRs are higher than those of university graduate users'. Business title is another statistically significant user asset for Improvement Expectations. For this dimension, office workers appear to have higher EMRs than that of nurses. As to general EMRs, business title is significant, but in category comparison, no significant difference is found. Physicians are nearest to significant (p=0.070), their EMRs are lower than office workers.

TABLE VI
DESCRIPTIVE OF THE USER ASSET GROUPS FOR GENERAL EXPECTATIONS EMRS

Asset		*Median*	*25th-75th percentile*	*Asset*		*Median*	*25th-75th percentile*
Education	Secondary	42.75	50.50-54.00	Sex	Male	36.00	44.00-51.00
	University	39.00	46.00-51.00		Female	41.00	47.00-51.00
IS Experience	Inadequate	43.00	48.00-52.00	Working Unit	Basic	40.50	48.00-55.50
	Average	40.00	47.00-53.00		Surgical	40.00	45.50-49.25
	Good	39.00	45.00-51.00		Internal	39.00	45.00-51.00
	Advanced	35.00	43.00-49.00		Admin.	40.00	49.00-53.00
Business Title	Office worker	40.00	48.00-54.00	Attitude Towards Change	Conservative	43.75	47.50-68.00
	Laboratory Technician	43.50	49.00-58.00		Open to change	39.00	45.50-51.00
	Physician	35.00	43.00-49.00		Depends	40.75	46.00-50.25
	Nurse	41.00	46.00-50.00				
	Biologist	39.50	46.00-55.50				
	Other	43.50	49.00-53.50				

TABLE VII
SIGNIFICANT VARIABLES IN BINARY LOGISTIC REGRESSION FOR EXPECTATION DIMENSIONS' AND GENERAL EXPECTATION EMRS (N=442)

EMR types	*Variable*	*B*[*]	*p*	*Odds*	*95% CI*[**]
Improvement Expectations	Office workers		0.025		
	Lab technician	-0.075	0.880	0.928	0.350-2.455
	Biologist	0.175	0.791	1.191	0.325-4.365
	Nurse	-0.971	0.013	0.379	0.176-0.816
	Physician	-0.757	0.051	0.469	0.219-1.003
	Others	0.024	0.965	1.024	0.360-2.911
	Education	-1.086	0.032	0.338	0.125-0.911
Managerial Expectations	Education	-1.323	0.008	0.266	0.100-0.707
General Expectation	Office workers		0.018		
	Lab technician	0.446	0.339	1.562	0.626-3.902
	Biologist	0.159	0.807	1.172	0.329-4.179
	Nurse	-0.600	0.098	0.549	0.269-1.118
	Physician	-0.655	0.070	0.519	0.255-1.056
	Others	0.023	0.663	1.250	0.458-3.412

[*]Estimated Coefficient [**]Confidence Interval

IV. CONCLUSION

The results of tests show that the framework has a high reliability with 0.89-0.97 Cronbach´s Alpha coefficients, which is commonly used as a measure of the internal consistency or reliability. Using the newly developed framework in this study, we have tried to analyze the determinants of medical user expectations from HIS. By using the elasticity of the framework, beginning with the general EMR, the study is detailed by deepening into the user expectation dimensions. The results may also be detailed into the each expectation variable if needed. To be clearer, the framework can give detail into the each variable level.

Results show us that education, and business title is the determinant of user expectations from HIS. Education is found statistically different in two of the expectation dimension EMRs (Improvement and Managerial) whereas business title is found statistically different in one of the four expectation dimension EMRs (Improvement). In business title, especially other group has differences over nurses and physicians. Of the six user groups in title, nurses (p=0.013) and physicians (near to significant difference by p=0.051), have lower EMRs when compared to office workers in Improvement Expectations.

Nurses and physicians are in the center of the health service and they need more qualified help when compared to the other groups. The results are compatible with this need as they expect HIS to make improvement in the hospital. They may

have lower expectation meeting level related to improvement aspect of HIS. They want HIS to be more helpful for them while doing their work. Some functions maybe sufficient and suitable for many users, but it seems it is not for Nurses and Physicians. They expect more virtues from HIS. If HIS is expected to help users (especially nurses and physicians) with doing their work, it must make improvements.

Similarly university graduate users have lower expectation meeting level related to improvement aspect of HIS. The results tell us the university graduate users expectations are poorly met when compared to secondary school graduate users. As the graduate level increases, the users expect more from HIS in the improvement scope. Low graduate level users think just doing their work with the facilities provided by HIS, but higher graduate level users questions the facilities provided by HIS.

These results can be used both for improvement of the HIS evaluated as well as designing and implementing the new HIS' by taking into consideration the lessons learned from different HIS evaluations. The weak sides, the variables that have the lower/lowest EMRs, can be taken care of more carefully not to give users these handicaps again. By examining the causes that make the user groups having lower EMRs can be eliminated by the help of taking true actions. Because the results of the study are just a snapshot of the current situation; a deeper analysis of these findings must be done for further information about the causes of these results.

By examining the results discreetly, the assets that give way to low expectations can be treated more carefully. The factors that cause this situation can be studied more deeply. This can be both a new area of academic research and organizational target. The virtues and functions of the HIS which address these user groups can be improved to make the EMRs higher. These kinds of efforts and measures also will affect the overall EMR.

Since the late 1980s, user expectations are one of the big problems IS managers have been being faced [16], [17]. Similarly, Staples *et al*. state that for implementing a new information system, managing expectations is an important issue [18]. Their study showed the adverse effects of issue [18]. Their study showed the adverse effects of unrealistically high expectations on success of the implementation of a new system. They recommend that managements develop strategies to keep the expectations in a realistic level. Ginzberg's findings also support the Staples' results by stating unrealistically high expectations led to lower levels of satisfaction [19].

Nevo and Chan claim that managers are able to generate realistic expectations [20]. If these groups' expectations from HIS are considered to be unrealistic (very relative issue, so the management must be very careful to make this decision), as the Ryker *et al*. put forth the management can organize some committees and arrange interviews with these users to set realistic expectations [12].

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