

## Usability Evaluation of Ulite Web-Based Picture Archiving and communication Systems Software in Shiraz University of Medical Science Hospitals

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### ABSTRACT

**Introduction:** Health information systems have the potential of improving the quality of healthcare and treatment procedures and supporting the physicians in their clinical diagnoses. Nowadays, evaluating the usability is widely accepted as a crucial factor in the acceptance and success of the interactive healthcare systems. The present study aimed to evaluate the usability of Ulite Software based on the ISO 9241 model.

**Method:** This analytical-empirical study was performed in 2014. The target population consisted of 50 Ulite Software users. The data were collected through a valid and reliable questionnaire containing questions from 10 valid and reliable questionnaires on the related field. The content validity of the questionnaire was evaluated and confirmed by the scholars and experts in Picture Archiving and Communication Systems (PACS) and the reliability was estimated through statistical procedures using Chronbach's alpha Test ( $\alpha=0.958$ ). Data were analyzed in SPSS 20 using descriptive statistics and Smart-PLS version 3, using Structural Equation Method and Partial Least Square Approach.

**Results:** The obtained results of the simultaneous analysis of all constructs regarding ISO 9241 model indicated a positive effect of "effectiveness" (P-value= 0.05) and "satisfaction" (P-value= 0.00) on the usability of web-based PACS, while the effect of "efficiency" (P-value= 0.68) was not confirmed.

**Conclusion:** Usability evaluation of Ulite software in the demo version was performed based on the ISO 9241 model. Based on the results, it seems that this software has the necessary effectiveness and user satisfaction has been somewhat successful, but since the evaluation in the demo version aimed to purchase the system and eliminate initial problems, we should focus on the deficiencies that decrease the efficiency of the system.

**Keywords:** Usability, Ulite, PACS, Evaluation, User, ISO 9241 model

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### Introduction

The World Wide Web has become very important in communication, sharing information, and presenting services during a few years (1). Using the Internet in order to consult and present health information is increased during the time. Increasing the number of costumers for receiving online health information (2), portals (3), and websites shows the tendency to apply online healthcare information and making decisions in the healthcare domain (4, 5).

The necessity of using portals has increased the users' needs in acquiring different skills for applying information technology in the noisy world of the Internet. User experience, ability to use, or usability of the new-fangled technology is of great importance in the success of each

technology. In other words, the usability of information systems is essential for their acceptance with final users and the spread of the use of these technologies (6). Thus, evaluating usability is known as an important factor in the success of interactive healthcare systems nowadays and the evaluation has been performed during the recent years. The benefits of high usability systems are increasing the efficiency, decreasing the errors, decreasing the educative needs of the users, helping and supporting the users, and improving the acceptance of these systems by the users (7).

Usability can be introduced as a potential of each system which lets the users do their tasks calmly, effectively, efficiently, and pleasantly (8, 9), while inappropriate usability can affect the users by the failures related to the installation and administration of an information system

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which points to the problems related to the designing process (10). It is mentioned in Agharezaei et al.'s (2012) study that despite the vast application, the design of many health information systems in Iran has usability problems, which can affect the quality of the users' interactions with the system, thus affecting the care outcomes (11).

Viitanen et al.'s (2011) study showed that usability problems prevent appropriate efficiency of the clinical systems based on information technology, communication, and performing daily medical tasks. Therefore, these systems do not have necessary features for supporting clinical tasks such as diagnosing and preventing medical faults (12). Improving the acceptance of a system by the users is indirectly the result of usable system design. Since a huge amount of money is allocated to design a system, if the system has no application, it may not be used, leading to buying and installing new information systems for the organizations (13, 14). Moreover, the studies have shown that if an information system does not meet the users' expectations, that system will not be used any more, even if the primary submissions are successful (15). Furthermore, the results of the study by Jorritsma et al. (2014) indicated that the differences between PACSs with the same abilities show that the functional requirements of the PACS cannot solely determine the total quality of the PACS information systems. Thus, in addition to prepare a list of functional requirements, there should be a usability evaluation in the selection of PACS to ensure that the hospital is buying a high quality PACS information system (16). Among different information systems in the healthcare domain, radiological information systems are of the most effective and practical information systems and the web-based version, named Ulite, is more appreciated by the specialists in the radiology domain.

Nowadays, presenting medical images related to medical imaging such as CT scan, MRI, radiology, etc. in the hospitals affiliated to Shiraz University of Medical Sciences is performed via PACS system, and access to these systems and images is only available for the physicians working in these hospitals. Ulite version of PACS information system is a web-based portal which presents services related to archive, communicates medical images, and makes online access via the Internet possible for all medical workers such as physicians, radiologists, general practitioners, specialists, private physicians, physicians in different clinics, radiology technologists, and other people. This software is installed for the first time in hospitals of Shiraz, Iran. Due to the administration of this software, as a primary pattern and demo version, only a few physicians were permitted to access this software while gradually and after administering the final version, a wider range of users can experience the capabilities of this system. This portal has to serve abilities to support health services with high quality and meet people's needs about each specific service (17, 18). One of these abilities is usability, which results from considering the users' needs at the time of designing, applying proved methods for designing the system, and performing usability tests while developing the system. Systems with these features are able to help the users to accomplish necessary tasks easily and quickly and with the minimum mental effort (19).

Generally, it is crucial in software industry to realize the fact that it is necessary to perform continuous evaluations in the development of a system, from primary design to summative assessments, in order to make sure that the final product meets the designers', users', and organizations' expectations (20, 21). Effective evaluation of the healthcare information systems in order to investigate that the system sufficiently matches the conditions and needs of the users and healthcare organizations in processing the information seems vital (22). Therefore, by reviewing the history of usability (ability to use or users' experience) and presented models, ISO 9241 model was selected as a model for evaluating the usability of Ulite software in the present study. This study aimed to evaluate the usability of Ulite software in hospitals of Shiraz University of Medical Sciences in order to measure the effectiveness, efficiency and user satisfaction was based on the ISO 9241 model.

### Methods

Usability models are conceptual points that not only introduce the usability features, but also explain the appropriateness of these features (23). International Organization for Standardization (ISO) has presented and developed different standards in usability and Human-Computer Interaction (HCI) in the previous years. ISO standards (24) were not approved for users' interface such as icons, controlling the cursor, and so on, because industrial standards such as IBM, Macintosh, or windows were more successful in this domain. ISO standards were widely approved for ergonomic needs such as Visual Display Terminal (VDT) workstations, hardwares, and industrial occupational environments instead. These standards lead to preparation of guidelines for software users' interface and related interactions based on the investigations of Maclead and Bevan (25, 26).

ISO 9241 presents a definition of usability which is mostly used in ergonomic standards as: "The effectiveness, efficiency and satisfaction with which specified users achieve specified goals in particular environments (27).

**Effectiveness:** The accuracy and completeness with which specified users can achieve specified goals in particular environments.

**Efficiency:** The resources expended in relation to the accuracy and completeness of the goals achieved.

**Satisfaction:** The comfort and acceptability of the work system to its users and other people affected by its use.

This is a descriptive cross-sectional study conducted in 2014. The research field of the study was teaching hospitals affiliated to Shiraz University of Medical Science. The target population was all of 50 radiologists and radiology technologist of these hospitals who worked with Ulite software. Data were analyzed by PLS technique.

The questionnaire of the study consisted of two parts: demographic questions and research construct questions. Demographic questions included age, sex, marital status, and education. In the present study, the constructs of the model were effectiveness, efficiency, and satisfaction, and each construct was evaluated via indices or questions, as presented in Table 1.

In this current research, Structural Equation Modeling

(SEM) by Partial Least Squares (PLS) approach was applied. PLS is an attitude based on variance, which needs fewer conditions in comparison with other similar SEM techniques such as Lisrel or AMOS (28). For example, unlike Lisrel, PLS modeling is more appropriate for factual applications, especially when the models are more complicated or the data are normally distributed (29). However, the most important privilege of PLS modeling in comparison with Lisrel is that it needs fewer samples (30).

model can be determined by  $R^2$ .

The general model consists of two models: measurement and structural, and by approving them, evaluating the goodness of the model would be completed. In the PLS software, the goodness of the model is from the formula of Tenenhaus et al.; the index of the goodness should be over 0.36.

$$GOF = \sqrt{\text{Communalities} * \bar{R}^2}$$

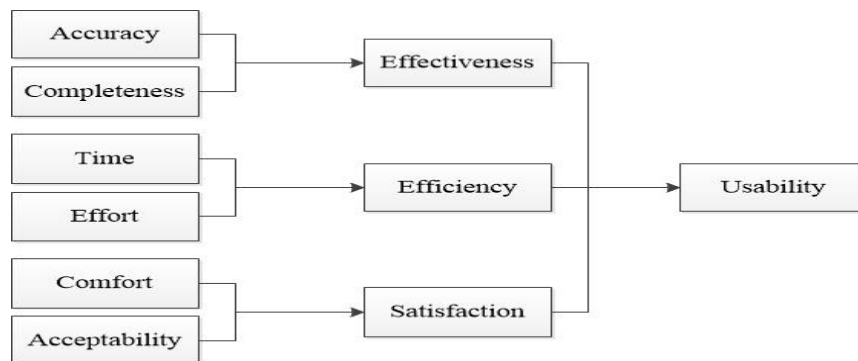


Figure 1. ISO 9241 model(27)

For evaluating the validity of the PLS model, three stages should be concisely considered:

1. Evaluating measurement models (relationships between the components of each construct with that construct) through three tests: reliability index, convergent validity, and discriminant validity.

2. Evaluation structural models (relationships between the constructs) through four test: t-values coefficient,  $R^2$  criterion,  $f^2$  effect size, and  $Q^2$  criterion

3. Total evaluation of the model (measurement and structural) through Goodness For Fit (GOF)

For investigating the reliability of the constructs in the model, Chronbach's alpha test and composite reliability were applied. The desirable amount of Chronbach's alpha to assume homogenous and unidimensional was considered over 0.7, and for composite reliability we considered over 0.8 (31).

The validity of the constructs was evaluated through convergent and discriminant methods. In the convergent method, Average Variance Extracted (AVE) is used for which the desirable range is over 0.5 for each variable. The discriminant validity is a supplementary concept and two criteria were mentioned for that: Fornell-Larcker method and transverse load test.

After investigating the validity and reliability of the measurement model, the resulting structural model was investigated through the relationships between the Maknoon's variables. Then, path coefficient,  $R^2$ , and endogenous variables were investigated. Higher amounts of  $R^2$  related to endogenous variables show higher goodness of the model. Chin (1998) introduced three amounts (0.19, 0.33, and 0.67) as the criteria for weak, moderate, and strong  $R^2$ . Therefore, the level of the structural part of the

(Communalities) shows the shared value of each construct and ( $\bar{R}^2$ ) is the average of  $R^2$  of the endogenous variables. The hypotheses were tested regarding the results, and the findings are shown in Table 1 (31).

The present study applied a quantitative methodology and a questionnaire as an instrument and the questions are related to the measurement criteria introduced in ISO 9241 model. In order to determine the users' opinions about each construct, some questions were asked. There were 4 questions for effectiveness, 5 questions for usability, 4 questions for efficiency, and 6 questions for satisfaction. The questionnaire was designed based on the 5-point Likert scale, from strongly agree (score 5) to strongly disagree (score 1). The score of each question was considered from one to five.

## Result

According to the results from SPSS Software, 40 users (83.3%) were radiologists, 25 users (52.1%) were males, 27 users (56.3%) were married, and the most frequent age group was 31 to 35. In the present study, the constructs of the model were effectiveness, efficiency, and satisfaction, and each construct was evaluated via indices or questions, which are presented in Table 1.

According to the results of Chronbach's alpha and mixed reliability, as shown in Table 1, all the constructs under the study have desirable internal consistency reliability. Also, all the variables have desirable convergent validity. After estimating the validity and reliability of the model, the determined structural model was evaluated by Maknoon's variables.  $R^2$  was estimated 0.578 which shows that this model could measure the usability by this level. Therefore,

model appropriateness is desirable.

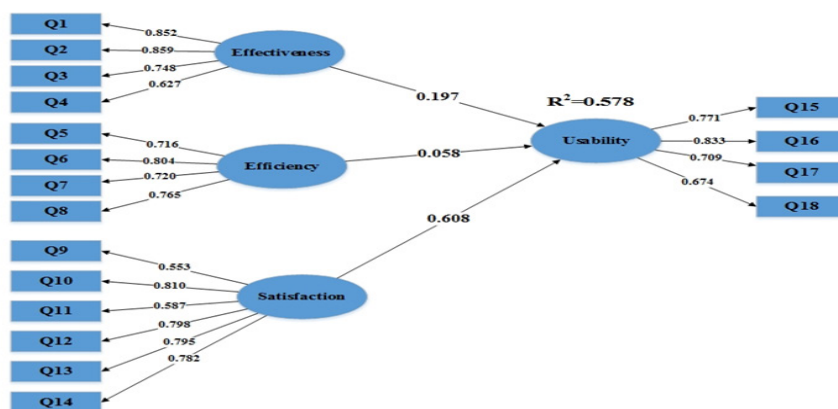
Analyzed model along with the value of path coefficient and R2 is shown in Figure2.

Also, the appropriateness index for GOF model was 0.482 which confirms the appropriateness of the general model. According to the results, the research hypotheses were tested and the results are shown in Table 2 (31).

effectiveness criterion with accuracy and completeness indices had a positive and statistically significant relationship with the usability, which corresponds to the investigation of Mohammad Saeed et al.'s (2009) study that mentions most users agreed with the completeness and effectiveness of the Landstinget Portal, considering

**Table 1.** Evaluation of different indices of the usability constructs

Fornell-Larcker method	Average variance extracted	Composite reliability	Chronbach's alpha	Number of items	Indices	Constructs
0.778	0.605	0.858	0.787	2	Accuracy	Effectiveness
					Completeness	
0.752	0.565	0.838	0.745	2	Time	Efficiency
					Effort	
0.729	0.531	0.869	0.817	2	Comfort	Satisfaction
					Acceptability	
0.748	0.560	0.835	0.737	2	-----	Useability



**Figure 2.** Analysis model

**Table 2.** Hypotheses and results

Hypothesis		Path coefficient	P-value	Result
H1	The effectiveness of the web-based Picture Archiving and Communication System Software has a statistically significant and positive relationship with the usability	0.197	0.050	Confirmed
H2	The efficiency of the web-based Picture Archiving and Communication System Software has a statistically significant and positive relationship with the usability	0.580	0.687	Denied
H3	The users' satisfaction from the web-based Picture Archiving and Communication System Software has a statistically significant and positive relationship with the usability	0.608	p<0.001	Confirmed

**Discussion**

The present study is an effort to investigate the effects of ISO 9241 criteria on the usability of Ulite web-based information system which was conducted on the radiologic users. After designing ESM and selecting appropriate measurements, the designed constructs were tested and after approving the appropriateness of the model, the hypotheses were evaluated. The findings showed that the

different aspects as searching the necessary electronic health services, medical advice, and introducing near clinics and physicians (32). Another study by Soohyung (2011) indicated the relationship between effectiveness and Usability while evaluating academic library websites which revealed that the users positively evaluated the website as an effective tool to complete their tasks (33).

The aim of the information systems installed in the hospitals is to manage the information which the healthcare

personnel need to improve effectiveness, efficiency, and accomplishing their tasks. This system should have the abilities to support presentation of high quality health services and meet different people's needs. One of these abilities is systems' usability which is obtained through realizing the users' needs while designing and applying proved methods for designing a system, and performing practical tests while improving the system.

However, the efficiency had no effect on usability and it does not correspond to some previous studies, such as Noori et al. (2009), Agharezaee et al. (2013), and Te'eni et al. (2005) (11, 34, 35), which shows a strange and notable result, because in addition to the studies mentioned in the present study, other studies have clearly shown that the efficiency affects usability, but the results of data analysis of the web-based PACS rejected these results and indicated that the users did not consider the efficiency as an effective factor on usability. However, it could be due to the fact that this software is imported and administered as a demo for the first time in Iran, in hospitals affiliated to Shiraz University of Medical Sciences. Thus, for the Iranian users' application, more prerequisites are needed and it can be the most important reason of rejecting this hypothesis.

Moreover, the findings of the present study indicated that satisfaction criterion by comfort and acceptability components have a positive relationship with usability; this result corresponds to the findings of the studies of Farahi and Sadooghi (2012), Marty and Twidale (2005), Kial (2014) and Khajouei (2014). In the study of Marty and Twidale, the direct relationship between usability and clinical efficiency, level of error, users' tiredness, and users' satisfaction were more emphasized (36). In another study by Farahi and Sadooghi, it was revealed that most of the users were satisfied with the above-mentioned hospital information system and the system met the expectations of 59.8% of the users. The usability of the system from the users' point of view shows the success of the hospital information system which indicates a strong relationship between the system and the user (19). A number of investigations were run in the recent years to investigate the importance of the usability evaluation of the clinical information systems. All studies showed that little attention is paid to the usability of the information systems. All of them suggest the evaluation of the usefulness and usability from the users' point of view. It is not possible to evaluate an information system without analyzing the users' perceptions. Users' satisfaction guarantees the administration of an information system and it points to the positive attitudes of people. It is necessary to apply the opinions of the users, such as nurses, physicians, and other healthcare personnel who spend a lot of time work time with these systems each day. Unfortunately, hospital information systems used in different hospitals of Iran could not satisfy all the users. It is not possible to improve the information systems without considering the causes of these dissatisfactions. Therefore, it is vital to have a comprehensive evaluation about these systems from the users' point of view.

At the end, it is worth mentioning that huge amounts of

money are investigated to install and administer hospital information systems which increase the importance of evaluating these systems. Managers in the healthcare domain have to perform a deep analysis based on the users' needs and their present activities, and then they try to choose a system. Evaluating the system is performed in each stage of the operation and development of the system seems crucial. In all stages of designing an information system, the usability needs (efficiency and satisfaction) and the method of evaluation by the user should be noticed. Moreover, the primary administration should be investigated from the users' point of view before the final administration. Therefore, more evaluations with different criteria are suggested.

#### **Limitations of study**

Software evaluation in the demo or prototype version, the limited number of available access for software testing, considering only the opinions of radiologists and radiologytechnologist as research population, and ignoring the opinions of other physicians and professionals and users are the constraints of the implementation of the this research.

#### **Suggestions for future research**

- Studies on usability of all the processes of design and development of information systems to ensure adaptation of these systems with the needs of users
- Education desirable standards for computer system design to system designers before any actionis designed to enhance usability of these systems
- Usability evaluation of clinical information systems such as pharmacy information system, laboratory systems, radiology systems,etc with using heuristic, cognitive walk through and other methods of evaluation
- Provision of new models to better usability clinical information systems

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