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User Preferences for Adaptive User Interfaces in Health Information Systems

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Abstract

Purpose: An adaptive user interface requires identification of user requirements. Interface designers and engineers must understand end-user interaction with the system to improve user interface design.

Methods: A combination of interviews and observations are applied for user requirement analysis in health information systems (HIS). Then user preferences are categorized in this paper as either data entry, language and vocabulary, information presentation, or help, warning and feedback. The user preferences in these categories were evaluated using the focus group method.

Result: Focus group sessions with different types of HIS users comprising medical staff (with and without computer skills) and system administrators identified each user group's preferences for initial adaptation of the HIS user interface.

Conclusions: User needs and requirements must be identified to adapt the interface to users during data entry into the system. System designers must understand user interactions with the system to identify their needs and preferences. Without this, interface design cannot be adapted to users and users will not be comfortable using the system and eventually abandon its use.

Keywords: Adaptive user interface, Focus group, Health information systems, Usability, User preferences

1. INTRODUCTION

Information technology (IT) facilitates the recording, maintenance, retrieval and management of information. With the development of IT and the transition from traditional information systems to electronic ones, users are directed to utilize digital user interfaces (UIs). UIs are interfaces between the end user and the system and can be either static or dynamic. Static interface does not change and has the same look and feel for all users, while a dynamic interface changes in response to user behavior during his/her interaction with the system [1]. Dynamic interfaces can be categorized as adaptable, adaptive or a combination of the two. If adaptation of the interface is managed by the user, it is called an adaptable interface. Adaptive user interfaces (AUIs) automatically adjust their displays and actions to current user goals and abilities. AUIs assist users in accomplishing tasks in an application [1, 2].

The purpose of adaptation in UI is content, navigation and presentation adaptation [3, 4]. For content adaptation, the system adapts the content of a page to user characteristics. The system provides navigation adaptation by management of hyperlinks (hiding, sorting, annotating, removing, and adding) during a user navigation session. The goal of adaptive navigation is to help users find the path to accomplish a specific goal in the application. Adaptive presentation focuses on text positioning, graphics, multimedia inclusion/exclusion, background and GUI interfaces. The combination of

1
2 adaptable and adaptive interface can be adaptable
3 with system support or adaptive with user control.
4 All of these categories are different scales of
5 personalized user interfaces [5, 2].
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8 The accurate design of a user interface is an
9 essential part of application design process. A
10 software system can only deliver its full potential if
11 it is consistent with the skills, experiences and
12 expectations of its users [6]. Lack of good user
13 interface has been a major barrier to the acceptance
14 and routine use of HISs [7].
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18 Designing user interfaces that fit user preferences
19 and needs is a challenge of the design of HIS. The
20 existence of a well-designed and friendly usable user
21 interface in healthcare is so important that can have
22 a direct impact on patient health. A poorly-designed
23 user interface leads to incorrect usage of the system
24 or increased user error. As a consequence, the system
25 may be abandoned. Users with different abilities,
26 skills and needs use the system; therefore, it is
27 necessary to adapt the interface according to user
28 needs. For an adaptive user interface design in HIS,
29 the users and their needs must be known and
30 understood and to design the interface according to
31 user needs.
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37 There are various principles for the design of user
38 interfaces. Effective UIs should be easy to learn, easy
39 to remember, easy to use, have predictable behavior
40 and keep the user in control [8, 9]. User interface
41 design is derived from the principles of human-
42 computer interaction (HCI) [10-12]. Toolkits for
43 HCI research can be used to assess user needs in user
44 interface design. Some toolkits that can be used to
45 identify user needs in HIS are the think-aloud method
46 [7, 13, 14], ethnographic studies [15], cognitive task
47 analysis [16, 17], participatory design [18], heuristic
48 evaluation and usability testing [14, 19, 17, 20, 21].
49 Previous studies have addressed user interfaces for
50 healthcare environments [10, 22, 17], and evaluation
51 of health UIs [20]. Some research has focused on the
52 effect of user interface on doctor-patient
53 communication [23], while others study design
54 principles and compare alternative designs [24] and
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develop UIs [25-28]. Researchers have proposed a
variety of guidelines to improve UIs for HISs [29-31,
28, 32, 17].

These studies either consider design guidelines for
specific health applications [26-28] or design
guidelines for one specific group of users such as
general practitioners (GPs) [11] or nurses [25] or the
elderly [30]. One study proposed a framework to
redesign healthcare UIs [17], but differences
between HIS users were not considered. Because
users of HIS are diverse and have different needs and
requirements, there is a need for adaptive user
interfaces for different user groups.

An adaptive user interface improves user
interaction with systems by facilitating user
performance, minimizing user need to request
assistance, helping users deal with complex systems
and avoid cognitive overload [5]. Ramachandran [4]
explored two major techniques to create adaptive
interfaces: adaptive presentation and adaptive
navigation. He provided examples of each in
healthcare applications. Chen [33] used USHER's
predictive ability to design intelligent user interface
adaptations to improve data entry accuracy and
efficiency. He then evaluated these mechanisms with
professional data entry clerks working with real
patient data. The USHER model gives a subset of
answers for a form and accurately predicts values for
unanswered questions. The results show that these
adaptations have the potential to reduce error with
limited effect on entry time. Findlater and Grenere
[34] evaluated the impact of screen size on
performance, awareness, and user satisfaction with
adaptive graphical user interfaces. Additional
examples exist about adaptive user interfaces and
techniques for adaptation [2-4, 35-37]. Nguyen and
Sobecki constructed user profiles based on
consensus for adaptive development of user
interfaces in multimodal web-based systems [38].

To summarize the state of the art, while some
research projects studied user interface issues in
health care [7, 10, 11, 17- 20, 24-28, 30] and other
studies examined adaptive UIs [2-5, 35-37], few
studies have examined adaptive UI design issues,
especially for health settings [39], and none

1
2 considered different user groups in HIS. Shakshuki,
3 Reid and Sheltami [39] offered a multi-agent system
4 with learning techniques to construct adaptive UIs
5 for each patient. Other HIS users were not considered
6 in this study.

7
8 The contribution of the present study beyond the
9 state of the art is that it takes the first step in the
10 design of an adaptive user interface, which is
11 understanding and analyzing user needs when
12 interacting with HIS. It also presents adaptive
13 interface design requirements with a combinational
14 view to individual and group adaptation. To evaluate
15 the proposed requirements, the focus group method
16 [40] was applied as a qualitative evaluation method
17 along with a questionnaire. The focus group is a
18 valuable tool for understanding the needs and
19 concerns of users in human-computer interaction
20 studies. Meetings with different groups of HIS end
21 users were held to discuss their requirements. The
22 focus group discussions were then analyzed as
23 qualitative information. Participants also filled out a
24 questionnaire which was analyzed to gain
25 quantitative results for this study. To the best of the
26 authors' knowledge, the current paper is one of the
27 very few research studies that examine user
28 requirements to design user interfaces for HIS
29 especially tailored to different user groups in health
30 settings.

37 2. METHODOLOGICAL FRAMEWORK

38 2.1. Eliciting user requirements

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40 In any service adaptation including user interface
41 adaptation, there are two tasks to be carried out; one
42 is the adaptation of content or service, and the other
43 is knowing the user and identification of user needs
44 and preferences. Identifying the needs of users is like
45 exploring an ancient castle; the more we work, the
46 more we discover and the more we discover, the
47 more we realize that there remains a lot to explore
48 [41]. In addition to scientific literature, methods such
49 as interviews with users, ethnography and
50 observation of user interactions with the system were
51 applied. Dialogue with users, their behavior and
52 speech, and how they interact with the system during
53 interviews and observations were recorded and
54 employed. The main requirements for user interface
55 design were then identified. Some identified

requirements were the use of simple and quick data
entry devices for HIS [22], considering multiple
methods for data entry and search (e.g., text entry
fields, A-Z lists) [8, 31], using feedback requiring
minimal attention, such as light and sound [23, 22],
using general as well as specialized terminology for
different users, designing mobile devices with semi-
transparent screens, making pocket-sized devices
[23], removing or hiding unnecessary information
from the screen, showing confirmation to user for
recorded data [31], using understandable icons and
figures instead of just text in screen (form factor)
[18].

2.2. Requirement Classification

For a more detailed study of user preferences, it
was necessary to classify the requirements derived
from previous studies and observations. This allowed
classification of user preferences about HIS
interfaces into the categories of data entry devices,
system language and vocabulary, information
presentation and help, warning and feedback as
shown in Figure 1.

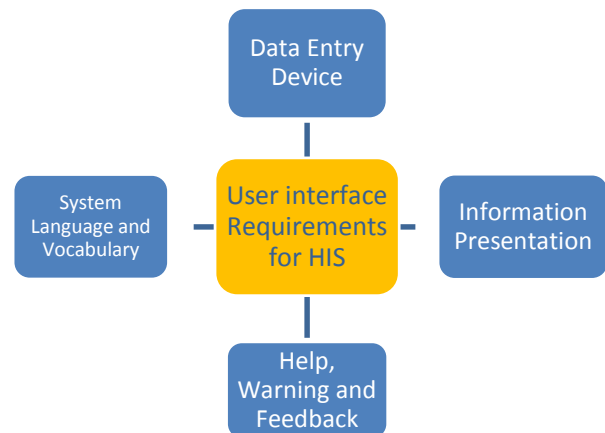


Figure 1. Proposed user interface requirements for HIS

2.3. User Classification

Age, sex, physical ability, education level,
computer skills, medical knowledge, goals and
motivations are the set of variables and aspects that
impact end-user preferences. Vasilyeva et al. [3]
pointed to “medical knowledge” as the main criterion
for grouping users for user interface adaptation.

1
2 Ramachandran [4] found that healthcare users range
3 from having little computer knowledge to having
4 expert computer knowledge. The observation of
5 users interacting with HIS in the current study
6 indicates that these two factors clearly influence user
7 needs and preferences and how users interact with
8 the system. It can be concluded both from literature
9 and observation of HIS usage in clinics that there are
10 two important aspects that distinguish end users,
11 computer literacy and medical knowledge. Based on
12 these two criteria, end users can be clustered in four
13 groups: medical staff with computer skills (MSCS),
14 medical staff without computer skills (MS), system
15 administrators (SA) and clerks who are employed to
16 work with HIS. The fourth user group comprises
17 users without computer literacy and medical
18 knowledge. Because this last group of users is very
19 rare in clinical settings, they have not been included
20 in this study. MS and MSCS groups can interact with
21 information systems directly at the patient's bedside
22 to view, record and search information related to the
23 patient. The SA group transfers information from
24 paper chart to electronic information systems.

3. EVALUATION METHOD

37 User requirements extracted from the first stage of
38 research were evaluated using a qualitative method
39 (focus group) and a quantitative method
40 (questionnaire); hence, both qualitative and
41 quantitative results were obtained.

3.1. Qualitative Analysis by Focus Group

47 Three focus group sessions were held with end
48 users of HIS at three hospitals in Tehran, Iran.
49 Sixteen persons from the different hospitals were
50 invited to attend. The first meeting was held with
51 eight users from the SA group. Four persons from the
52 MS group attended the second session and four
53 physicians from the MSCS group were invited to the
54 third session. The mean age of participants was 33.7
55 years and the average work experience was on
56 average 7 years. The educational level of the
57 participants comprised 12% associate degrees, 50%

undergraduates, 31.25% general physicians and
12.5% specialist physicians.

User requirements were identified for initial
adaptation of the user interface. To achieve this,
unstructured and semi-structured questions were
developed based on the requirements (section 3.2).
Discussions in each session began with opening and
introductory questions so that participants could gain
insight into the topic and express their opinions. The
agenda was the same for all three focus groups. All
sessions lasted for approximately two hours. During
each session, topics were accompanied by a visual
display in Microsoft PowerPoint. Each session was
recorded for later transcription and analysis. In
addition, all statements, comments and gestures of
the participants were recorded by an assistant. The
researcher noted the key points as the meeting
facilitator.

3.2. Quantitative Analysis by Questionnaire

Two questionnaires were developed. The first
questionnaire was given to participants at the
beginning of the session and covered areas such as
demographic data, work experience and consent to
participate in the session. The second questionnaire
contained structured questions about the main topics
of research. It was validated by 10 experts in user
interfaces design and HCI. Experts commented on
the relevancy, simplicity, clarity and necessity of
items in accordance with the recommended range.
The final questionnaire with 42 questions was
designed using a five-point Likert scale. This
questionnaire was completed by participants and
delivered to the meeting facilitator at the end of the
focus groups session.

4. RESULTS

The results of the focus groups and questionnaires
were made available for qualitative and quantitative
analysis, respectively, for each group of
requirements discussed below. Comments from
participants are shown in italics.

4.1. Data Entry Device

Data entry device selection was one of the topics discussed with end users. The keyboard, mouse, barcode reader, digital pen, touch technology, voice and radio frequency identification (RFID) are data entry types used for HIS that were introduced to the users. The SA group suggested different criteria for selecting the type of data entry device, because they worked in different parts of the hospitals. For example, reception and operation ward users considered use of the barcode reader to facilitate data entry to be suitable; however, a user with many years of work experience stated that a mouse and keyboard are the best devices for data entry. Clinic secretaries prefer touch technology for recording patient visits because it is less tiring compared to long hours of working with a keyboard and mouse.

One physician in the MS group remarked that the keyboard is the hardest data entry device. On the other hand, the best tool for data entry, according to the physicians, are voice and digital pens. Physicians in the MSCS group considered RFID as a necessary and appropriate technology at bedside to automate and facilitate the process of entering patient records. One participant stated that input through voice, especially in large patient referral centers, significantly reduces mistakes during data entry.

In addition to the qualitative survey, a questionnaire was also made available to participants that showed willingness to use different types of input devices on a scale ranging from of *strongly agree* to *strongly disagree*. Figure 2 compares the group preferences for choice of data entry device. The mean responder score for each type of data entry device was calculated. Table 1 shows the priority data entry device by group based on the average rating of participant responses.

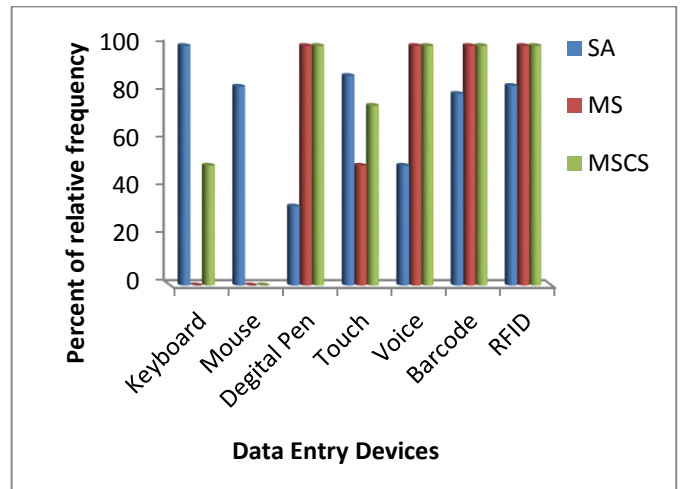


Figure 2. Comparison of group tendency to choose data entry technology, data entry device/percent of relative frequency
SA: System administrator, MS: Medical staff without computer skills, MSCS: Medical staff with computer skills

Table 1: Priority choice of data entry device in groups based on the average rating of the participants' answers.

SA	MS	MSCS
Keyboard (3.37)	Voice (4.00)	RFID (4.00)
Barcode reader (3.20)	RFID (3.60)	Voice (3.75)
Touch (3.12)	Digital Pen (3.60)	Digital Pen (3.00)
Mouse (3.00)	Barcode reader (3.50)	Barcode reader (3.00)
Voice (2.66)	Touch (2.50)	Touch (2.75)
Digital Pen (2.50)		Keyboard (2.50)

SA: System administrator, MS: Medical staff without computer skills, MSCS: Medical staff with computer skills

4.2. System Language and Vocabulary

Another example of adaptation is the ability to choose between the languages used to explain the elements on a page. Each user can select the desired language (Persian or English) with which to interact with the system. The selection of a particular choice several times by a user will result in automatic selection of that choice by the system; however, users can manually change the system language during interaction if desired. All participants agreed to a combination of Persian and English with the ability to change the language.

The vocabulary used in the system is different for the different user groups. The reason for the difference in vocabulary is that words used by different user groups differ in terms of users' knowledge and experience and should be adapted to

1
2 the target users. The use of scientific vocabulary,
3 standard codes, abbreviations and non-academic
4 words in the content of HIS was discussed. Doctors
5 and nurses sometimes use non-academic vocabulary
6 for drug names or required actions at the bedside
7 when recording clinical data in paper charts. The SA
8 group's preference is to provide non-academic words
9 along with scientific words to transfer data to the
10 electronic system. They believe it can be done easily
11 and quickly. One participant from the MS group
12 stated "*the use of abbreviations will increase the*
13 *speed of data entry*". In contrast, some MSCS and
14 MS group participants were opposed to the use of
15 abbreviations. Lack of standardization and several
16 possible meanings for an abbreviation were
17 mentioned as reasons for opposing this idea. They
18 insisted on the use of full scientific terms to preserve
19 high accuracy in the system.

20
21 The use of standard codes was also a matter of
22 disagreement. One participant said: "*The probability*
23 *of error due to the conversion of a disease to a*
24 *standard code is high*". An opponent of the use of
25 standard codes stated: "*Not all codes assigned to all*
26 *diseases, diagnoses or actions are unique.*
27 *Sometimes we are forced to use codes having the*
28 *greatest similarity to the diagnosis, which it is not*
29 *accurate enough and could be much generalized and*
30 *not include sufficient detail*".

31 32 4.3. Information Presentation

33
34 Adaptive presentation can be implemented to hide
35 some of the content on the page or provide different
36 information and links on a particular page based on
37 the user's knowledge of related concepts. Adaptive
38 presentation techniques must focus on multimedia
39 items such as images, videos, and audio in addition
40 to text for each page. For example, for a complete
41 patient record, if the user is a medical staff member
42 from the MS or MSCS groups, the user interface can
43 display advanced medical details that can be entered
44 or obtained from the patient. If the user is in the SA
45 group and has limited medical knowledge, those
46 fields can be hidden and later displayed to medical
47 staff for complete details.

The management of icons and objects in the
interface by the software is an example of an
automatic adaptive user interface. Re-arranging or
highlighting user interface objects and icons based
on user activity is another type of adaptation in a user
interface. This was discussed with participants.
Some believed that reordering may confuse users and
that consistency is better because users learn the
places of objects on pages and operate according to
what they have learned to more easily select them.

Object manipulation on pages by users was also
discussed. Some of the medical staff (MS/MSCS
groups) liked this idea, while others believed that
consistency is better. All participants of the SA group
agreed and knew that this is a step towards
customization. Table 2 compares the response
frequency to information presentation of the groups.

44 45 4.4. Help, Warning and Feedback

46
47 Help can be provided differently to the different
48 user groups or individuals. Novice users need more
49 guidance while expert users may not require
50 guidance. Helps can be designed for beginner users
51 and then adapted for expert ones [8].

52
53 Participants in all three sessions agreed to guidance
54 and alarms in the system to help users and reduce
55 errors in data entry. Users without computer skills
56 and the MS group need a multimedia form of help
57 because they are unable to work the system correctly
58 and need more guidance. One participant from the
59 MS group pointed out that "*help that requires us to*
60 *read text to work with the system is not interesting*
61 *and it is better to have guidance in ways other than*
62 *reading text*". For users of the MSCS and SA groups,
63 shortcut keys for help are sufficient; when they need
64 it, they can click a button.

65
66 While recording incorrect, duplicate or irrelevant
67 information, the system should give good tips in
68 addition to alerts. Guidance to users should be given
69 upon request, even if information is properly
70 recorded. For example, tips including information on
71 dosage and time of medication use are embedded on
72 the same page for the user when recording patient

prescriptions. The interface should show the consequence of an act to the user and state whether or not an action has been done successfully by use of indicators [8, 31]. Feedback should be informative for the user. Changing in the color, text, light, vibration or sound are examples of system feedback for different devices. In medicine, feedback requiring minimal attention, such as light and voice [23, 22] are recommended.

All participants of the MSCS group believed that system feedback to physicians' mistakes in

interaction with the system, using text and color changes is sufficient and that light, voice or any other type of feedback that draws a patient's attention can endanger the perception of the physician and have serious negative effects on patient confidence in the medical staff. Some MS work group participants prefer system feedback that draws less attention to the interface and a combination of multiple feedbacks including text with color changes, voice and light.

Table 2: Comparison of frequency of response to information presentation between groups

	USER GROUP	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Total
Ability to manipulate objects in interface by user	SA	3	4	0	0	0	7
	MS	0	2	1	1	0	4
	MSCS	0	2	0	1	1	4
	Total	3	8	1	2	1	15
Ability to show relevant information to each user group and hide the rest (e.g. according to the user's level of knowledge)	SA	0	0	0	0	0	0
	MS	2	2	0	0	0	4
	MSCS	2	2	0	0	0	4
	Total	4	4	0	0	0	8
Automatic link management (activating, inactivating, deleting or reordering a link)	SA	0	0	0	0	0	0
	MS	2	1	0	1	0	4
	MSCS	0	2	0	2	0	4
	Total	2	3	0	3	0	8

Differences in the total amount of data occur because of missing data

Table3: Comparison of frequency of response to help, warning and feedback

	USER GROUP	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Total
Provide the key to Help to be used if needed (Such as F1)	SA	7	1	0	0	0	8
	MS	2	2	0	0	0	4
	MSCS	1	2	1	0	0	4
	Total	10	5	1	0	0	16
Provide guidance when registering false, duplicate or irrelevant information in addition to warnings.	SA	4	4	0	0	0	8
	MS	3	1	0	0	0	4
	MSCS	2	1	1	0	0	4
	Total	9	6	1	0	0	16
Embedded help on the same page when recording information (show help for information on medicine for nurses on medical record page)	SA	3	5	0	0	0	8
	MS	2	1	0	0	0	3
	MSCS	1	2	1	0	0	4
	Total	6	8	1	0	0	15
A combination of above features	SA	7	1	0	0	0	8
	MS	3	0	0	0	0	3
	MSCS	3	1	0	0	0	4
	Total	13	2	0	0	0	15

Differences in the total amount of data occur because of missing data

1
2 In the SA work group, some participants preferred
3 voice feedback and others preferred feedback with
4 text, color and images. One preferred images for
5 better understanding of feedback. Another said that
6 it is better to first attract the attention of the user with
7 a color change, then open text boxes to express the
8 details. The opinions of the majority of participants
9 indicated that, because the attention of an SA group
10 user is on the information system monitor for data
11 entry, using text, color and image feedback is most
12 effective. Table 3 compares the response frequency
13 for help, warning and feedback.
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20 **5. CONCLUSION AND FUTURE WORK**

21
22 In order to adapt the interface to users during data
23 entry into the system, user needs and requirements
24 must first be identified. System designers must
25 understand user interactions with the system and
26 identify their needs and preferences. Interface design
27 cannot be adapted to users otherwise; as a result, they
28 will not be comfortable with the system, will avoid
29 using it and the system will eventually be abandoned
30 or underused.
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34 The present study observed user interactions,
35 interviewed users about their interactions with HIS
36 and studied resources about user interface design
37 principles. It was concluded that a data entry device
38 has a significant impact on user interactions with the
39 system. The medical staff preferred data entry
40 devices that do not require typing. The lack of such
41 devices in medical settings is a major obstacle to
42 medical staff interactions with HIS; however, data
43 entry by typing is not difficult for system
44 administrators. The differences in the features
45 desired and preferences of the various user groups
46 are crucial to usability and user interface design.
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53 To ensure the accuracy of identification of user
54 requirements, several focus group sessions were held
55 with users of the HIS to discuss user preferences
56 when interacting with the system. Sixteen end users
57 from different hospitals that have worked with HIS
58 attended three focus groups. They ranged in age from
59 25 to 47 years and recorded average work experience
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of 7 years on average. In addition to open-ended
questions about user preferences in interface design,
a questionnaire was also designed for detailed
analysis. The questionnaire focused on participant
preferences expressed using a Likert scale (strongly
agree, agree, neither agree nor disagree, disagree,
strongly disagree).

The results obtained from the discussions with
users were expected in some cases and unexpected in
others, or conflicting with results of previous studies.
Most users chose a combination of Persian and
English for system language, which was predicted.
The use of light and sound feedback was advocated
for HIS in the literature, though the medical staff
participants in the current study were opposed to the
use of sound and light. It was possible to identify the
features and preferences of different groups of users
from the results. These can be applied for HIS
interface design so that during user interaction with
HIS, the interface is in accordance with user
requirements, needs and preferences.

The novelty of this research is that end users of HIS
were involved in the first step of the design and their
requirements were evaluated using both qualitative
and quantitative methods. User preferences were
obtained in accordance with the user group to which
they belong. This study provides guidelines based on
UI requirements gathered from focus groups.
Designers can benefit from these guidelines for
adaptive HIS interface design. This is a major
contribution to the field of user interface design in
HIS settings.

This research study has several implications. First,
the results indicate different preferences for different
HIS user groups. Preference difference, even without
considering the priority list of preferences obtained
by this specific study, is a confirmation of the
necessity for adaptive user interfaces in health
settings. Adaptive user interfaces can provide better
usability and user experiences for each user group.

A second important implication of the study is
that it derives from the findings on priority choices
of data entry devices, information presentation, help,
warning, feedback, system language and vocabulary
in three groups of HIS users. Adaptive interface
design for three groups of users will become possible

1
2 by considering the identified user requirements for
3 each group. Users will become more comfortable
4 using an adaptive interface and a major obstacle to
5 the acceptance and routine use of HISs will be
6 removed.

7
8 As an example, priority choices for data entry
9 devices in groups based on the average rating of the
10 participants' answers indicates a similarity of
11 choices by medical staff with or without computer
12 skills and a difference with the system administrator
13 group. This means that two sets of devices are
14 sufficient for all three HIS user groups. This is a
15 valuable piece of information for choosing and
16 buying devices for different user groups in HIS
17 settings. There is no need for adaptation in the form
18 of providing help and multimedia help is interesting.
19 Help content can be adapted based on users' domain
20 knowledge. Different choices for information
21 presentation emphasize the necessity for adaptation,
22 however user groups are not decisive in such matters
23 and it is better to give more control to each user rather
24 than implement automatic adaptation by the
25 software.

26
27 The third important implication of this study is that
28 some interface design choices have direct impact on
29 patient health and at times on the physician-patient
30 relationship. The choice of language and vocabulary,
31 including use of standard codes, influences the
32 probability of error and consequently will have a
33 direct impact on patient health. In some cases, such
34 as feedback about physicians' mistakes when
35 interacting with the system, voice or any other type
36 of feedback that draws a patient's attention can
37 endanger patient perceptions about the physician and
38 have serious negative effects on patient confidence
39 in the medical staff.

40
41 Directions for future research include the design
42 evaluation of an adaptive user interface for HIS
43 based on the results of this study. It is also possible
44 to use the results of this study to improve user
45 experience about existing user interfaces in HIS. In
46 addition, another method can be used to gather user
47 requirements and compare requirements obtained by
48 applying different research methods. The design
49 guidelines resulting from this study can also be tested
50 and evaluated one-by one in HIS.

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