Factors Affecting the Usability of Mobiles in Healthcare- A Peep into the Indian Scenario

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Abstract

Mobiles today have proliferated as a ubiquitous means of communication. Every industry is depending on this medium in some or the other form. Healthcare industry is also leaping ahead with its might to come at par with other industries in terms of communication and use of information and technology. Earlier use of mobiles in healthcare was limited due to lack of memory, small screen space, poor graphical display and inability to transfer or store huge data. Emergence of tablets and smart phones has changed the overall experience of using mobiles. It has improved service delivery, empowered consumers, businesses and entrepreneurs and changed the way in which people access information and make transactions (Darrel West, 2011). The real time tailored personalized information available through mobile devices has the potential to transform healthcare. When integrated properly this technology has the potential to provide solutions to increased demands in quality, efficiency and improved workflow to help streamline healthcare operations (Beaver, 2003). In various hospitals ICT has shown improvements in adherence to guidelines, enhanced disease surveillance and reduced medication errors (Chaudhary et al., 2006).

Use of mobile in the healthcare can offer many benefits to the various stakeholders than any other ICT medium. The patients can monitor their condition, stay connected with the providers and also get involved in the decision making process about their health with the healthcare provider. The healthcare providers or organizations can reduce their cost of communication and treatment by reducing the number of hospital visits and hospital stays and enhancing the productivity and availability of staff (Gollol, et al., 2004). The providers can be offered access to patient's records, consultation with the experts, access to medical knowledge databases anytime and anywhere and thus enhancing their productivity.

The objective of this research is to study the current status of usability of mobiles in healthcare and to analyze the factors affecting the usability of mobiles among the healthcare professionals. This study was conducted in four districts of Karnataka: two with good health indicators (Bangalore urban and Belgaum) and two with poor health indicators (Koppal and Raichur).

Keywords: ICT, mobiles in healthcare, Usability, TAM, UTAUT, PMT, HER.

1. Introduction

There are some studies indicating positive effects of implementations, Hertzum and Simonsen, 2008 conducted a simulation study and investigated the effects of fully integrated EHR systems on clinician's work and results indicated reduction of mental workload on clinicians and increased clarity of physician's work tasks. Whether negative, positive or promising finding all the studies emphasizes the need for further research. Some studies reveal that physicians may be reluctant to use and implement the IT systems as it interferes with their traditional routines (Chau and Hu, 2002). There are other studies which have pointed out a positive attitude by the users towards the healthcare information systems (Moody et al., 2004; Hayrinen et al., 2008) and some that have reported negative reactions (Darbyshire, 2004; Jensen et al., 2007). Based on systematic reviews both Chaudhary et al., 2006 and Hayrinen et al., 2008 concluded that technology related effects on efficiency in use have mixed responses.

To support healthcare delivery the healthcare information system has to have characteristics such as interoperatibility and its effectivity to manage complex information of great sensitivity (Weber- Jahnke and Price, 2007), support healthcare functions through an integrated and seamless flow of information among various participants and locations (Lenz et al, 2002), support intensive data manipulation and enhance synchronous decision making and support information utilization at the administrative and central level (PAHO, 1999). Consequently health informatics has a big role to play in shaping our future healthcare delivery system (Berg et al., 2002).

Inspite of the above mentioned benefits of using the mobile services their usage is still in infancy especially in developing country like India. There are many issues and challenges that have to be resolved to have wide acceptability and usage of these services. Privacy and security, protection of sensitive data, limited capabilities of wireless communication technologies, involvement of various stakeholders in the system (like consumers, providers, insurers, employers and government), less interoperatibility, limited capabilities of mobile devices (like small screen size, display, processing capability etc) legal and regulatory rules and complexity of different healthcare service and information systems (Varshney, 2007; Standing and Standing, 2008; Istepanian et al., 2004).

2. Research Motivation and objectives

A peep into the failed systems reveals that there is no problem in the technology but a system fails if it is not rendered usable by the respective audience and thus usability is a very important aspect of any system or product. Enhancement in usability results in increased productivity with fewer errors and savings in development cost and time (Dumas J.S and Redish 1999). According to Jushu Smith and Bruce Schatz, (2010) mobiles are technically feasible to support a number of chronic illnesses but the success of such initiatives are associated with the design, user interface, usability and proper training with usability being the most important criteria.

Research has shown that poor usability of critical systems in healthcare is also statistically related to medical errors by medical professionals (also known as the technology induced errors) (Kushniruk A W and Triola M, 2005).These errors mainly arise due to the use of technology which is not designed and adequately tested from a usability perspective. Thus it has become a safety and quality issue for the healthcare policy makers, administrators and vendors. As the technology is more and more put to use in the healthcare environment care needs to be taken and usable systems have to be designed so that the end users feel it safe to use them. Thus usability is an indispensable quality of a system (Hartson, Andrel and Williges, 2001).

Mobiles were introduced to general public or consumers in 1990s and so the related research community also has had a short history and is still evolving and thus there is little knowledge about established methodologies and realistic practices

which can be used to evaluate the usability of mobiles (Klockar et al., 2003). Usability guidelines for mobile applications are still lacking and relatively unexplored and unproven (Azham and Ferneley, 2008; Gong and Tarasewich, 2004. Thus this research was conducted to fill this gap and comeup with factors that affect usability of mobile devices especially in healthcare sector.

Usable systems can provide a number of benefits including improved product, enhanced user well being, avoidance of stress, increased accessibility and reduced risk of harm. (ISO 9241-210, 2010). Thus ISO came up with new standards which provide the guidance for designing new systems with high usability. These principals have focused primarily on user-centered design.

Very few researchers have systematically investigated the benefits and barriers of user involvement in healthcare technology development. Some of the key impediments found out by Shah and Robinson, 2007 are lack of resources, attitude of technical developers, lack of understanding and appropriate knowledge of the method to be used.

The concept of usability has gained importance with the work of Shackel in 1991 as he provided a definition of usability along with its constructs. He stated that "usability of a system or equipment is the capability in human functional terms to be used easily and effectively by the specified range of users, given specified training and user support to fulfill the specified range of tasks within the specified range of environmental scenarios" (Shackel, 1991, p.24). He also provided the usability criteria as:

Effectiveness: level of interaction in terms of speed and errors;

Learnability: level of learning needed to accomplish a task;

Flexibility: level of adaptation to various tasks and Attitude: level of user satisfaction with the system.

Shackel's idea of usability was well accepted and supported by various researchers like Booth and Chapanis. He further improved his criteria of usability and said "it is the extent to which an interface affords an interesting and satisfying interaction to the indented users performing the indented tasks within the indented environment at an acceptable cost" (Sweeney, Macguire and Shackel, 1993, p 690). Another researcher who gained acknowledgement in this field is Nielson who further refined the usability context and gave some more operational criteria:

Learnability: ability to reach a reasonable level of performance;

Memorability: ability to remember to use a product;

Efficiency: trained user's level of performance;

Satisfaction: subjective assessment of how pleasurable it is to use;

Errors: number of errors

This idea and constructs are very much similar to Schniederman (1986) but Nielson gave it in a very elaborate manner. Finally ISO (International Organization for Standardization) came up with a detail definition of usability and various constructs. According to ISO usability is the *"extent to which a product can be used by specified users to achieve specified goals with efficiency, effectiveness and satisfaction in a specified context of use"*. Thus usability has been defined and shaped by various researchers in the usability engineering area.

Usability is essential for user satisfaction and user acceptance of a product/ system. It is a measure of the quality of user's experience when interacting with the product or system (Dumas and Redish, 1993; Guillemette, 1989; Neilsen, 2000; Rosenbaum, 1989; Rubin, 1994; Shackel, 1991). Usability attributes are an outcome of a usable product or system. Thus if a system is usable it should have both the *objective usability attributes* and the *subjective usability attributes*. The objective usability attributes are effectiveness, efficiency, attractiveness, memorability and reliability and the subjective usability attributes are positive attitude, user satisfaction and product attractiveness (ISO, 1991; Neilsen 1993, 2000; Rosenbaum, 1989; Shackel, 1991).It is an important aspect and due to this reason it is included in the product development cycle of

mobiles and other electronic products. Electronic mobile products have gradually taken the place of personal appliances as its usage involves personal meanings and personal experiences (Sacher & Loudon, 2002). Various studies and surveys have highlighted the use of mobile devices, technology, applications and services to be on a rapid increase and being a part of consumer's lifestyle.

Table 1 Comparison of various constructs of usability

Usability Construct	Shackel	Nielson	ISO (9241 and 9126)
Efficiency		✓	✓
Effectiveness	✓		✓
Learnability	✓	✓	
Flexibility	✓		
Attitude	✓		
Memorability		✓	
Satisfaction		✓	✓
Errors		✓	
Understandability			✓
Operability			✓
Attractiveness			✓

The most dominating theories in the information system research are Theory of Planned behavior (TPB) (Fishben and Ajzen, 1975), Innovation Diffusion Theory (IDT) (Rogers, 1995), Technology Acceptance Model (TAM) (Davis 1989; Davis *et al*., 1989), the FITT framework (Ammenwerth *et al*., 2002), and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh *et al*., 2003; 2012). The most accepted theory is TAM by Davis which says that user's intention to adopt a new technology is dependent on two variables namely perceived usefulness (PU) and perceived ease of use (PEOU). Another profound theory accepted worldwide to explain the technology acceptance is the unified theory of acceptance and use of technology (UTAUT) (Yu, 2012; Zhou, 2012). This theory defined three new constructs as performance expectancy, effort expectancy and social influence (Venkatesh et al., 2003).

All the above mentioned theories lay emphasis on the behavioral aspects of the users whereas for healthcare scenario the health related theories also have to be considered. For adoption of health services technology acceptance perspective and the health behavior perspective has to be considered (Laugesen et al., 2011). There are four major theories that are used to explain the health behavior: health belief model (HBM), protection motivation theory (PMT), subjective expected utility theory (SEU), and theory of reasoned action (TRA).Among all the health behavior theories PMT is the most widely used theory. According to this theory an individual's evaluations on the severity and vulnerability of the potential threats and the extent to which they can cope with the threats by conducting certain health behavior will determine their intentions to perform the health behavior (Rogers, 1983). In this context the health acceptance behavior is regarded as a behavior to cope with the potential

threats to health. SEU and TRA are considered to be more general theories. Thus they are generally used to explain the general behavior of an individual and not just the health behavior.

Thus Perceived effectiveness (Effort expectancy of UTAUT), Perceived efficiency and satisfaction are the three most important determinants of usability for the mobile devices. These in turn are influenced by certain other constructs.

Various variables used for the study are defined as under:

2.1 Perceived Effectiveness (PE)

It is defined as the perceived ability of a user to complete a task in a specified context. It is measured by evaluating whether or not the participants can complete a set of specified tasks. In this research context when users consider that using mobiles would enhance their skills to do the job at hand they will consider it to be more effective. This deals with accuracy and completeness with which the users achieve their specified goals. It will lead to satisfaction of using this technology and further will motivate the user's intention to adopt the technology. Thus we propose that:

H1 PE has a positive relationship with satisfaction and positive relationship with BI

2.2   Perceived Ease of Use (PEOU)

Previous studies conducted on the healthcare professionals indicate that since these are people with competence to learn and operate the technology perceived ease of use is found to have an insignificant impact on the satisfaction and thus behavioral intention. However the elderly professionals are not so skilled technology users and thus they are unlikely to try out new technology if they perceive it to be complex and feel that it requires a lot of effort. In this study PEOU is considered a significant determinant of satisfaction and in turn of BI which is also supported by UTAUT in which age is an important moderator between PEOU and BI. Thus we propose that:

H2 Perceived Ease of Use has direct and positive influence on satisfaction.

2.3   Perceived Efficiency (PEf)

It shows the customer perception about how quickly he/she will be able to perform the system functionalities once he/she has become familiar with it. It also deals with the time taken to complete the task at hand and amount of resources taken in relation to the accuracy and completeness of the goals using this system. If users take less time and less resources to complete the task using the mobile devices they perceive this to be efficient system and thus this will lead to satisfaction and motivate them to use the technology more often. Thus,

H3: Perceived Efficiency has a positive relationship with satisfaction and positive relationship with BI.

2.4   Satisfaction

Jokela, 2004 related usability in mobile devices to user satisfaction. Satisfaction is a positive attitude towards the use of the product and it is a freedom from discomfort when the user of the system feels good and happy to use the system and recommends the system to others also. Thus,

H4: Satisfaction has a positive relation with the behavioral intention to use the system.

2.5   Self Efficacy

Bandura, 1982 conducted extensive research on self efficacy and defined it as "judgments of how well one can execute courses of action required to deal with the prospective situations". Thus it is a feeling when user of the system feels that he/she is capable of using the system even if there is no one to guide them or just by reading the manual. Hill et al., (1987) concluded in their study that self efficacy exerts an influence over the user and becomes a determinant of user behavior. This makes the user feel more effective and thus *self efficacy has a positive relation with perceived effectiveness*. Using the system enhances their positive attitude towards the system and thus gives them satisfaction. Therefore

H5: SE has a positive relation with satisfaction.

2.6   Social norms

This means how the user's decision to use the system is affected by other's perception about the system. When users are motivated to use the

technology as their peers or people important to them are using it, this exerts a positive pressure on the users to use the technology. This can be related to social influence in UTAUT (Venkatesh et al., 2003). Thus *social norms are positively associated with satisfaction.* In this study it was found that relation between social norms and satisfaction is stronger for older users and this complies with previous studies also (Venkatesh et al., 2003).

H6: Social norms are positively associated with satisfaction.

2.7 Response cost

This deals with the extent to which individuals have adequate resources (in terms of money) to perform a behavior. If users have to spend a considerable amount of money to use a particular technology they are more unlikely to adopt this technology and thus *there is a negative influence between the response cost and adoption intention (Rogers, 1975).*

Furthermore elderly users who care more about the value of expenditure, response cost are an important factor which influences their decision of system adoption. In this study it is found to be relevant.

H7: There is a negative influence between the response cost and adoption intention.

2.10 PROPOSED RESEARCH MODEL

A conceptual research model was proposed based on the literature review and established hypothesis. The model shows that Perceived effectiveness, perceived efficiency, perceived ease of use, self efficacy and social norms ultimately influences the dependent variable behavioral intention directly or indirectly through other variables (satisfaction).

Figure1

Proposed Research Model of Hcp
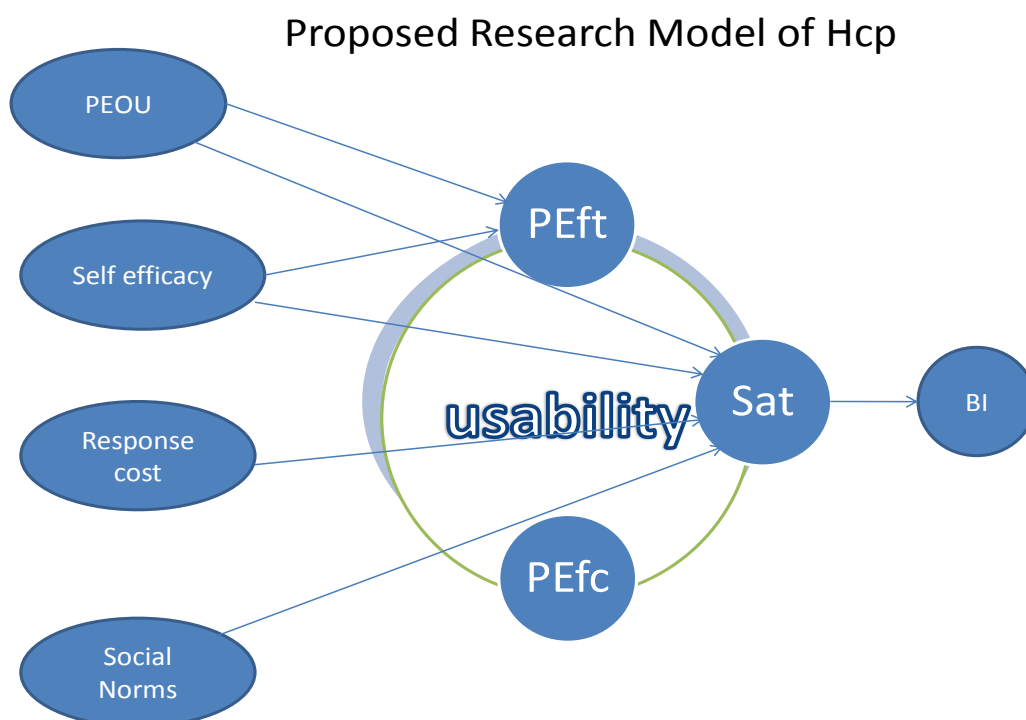
PEOU: Perceived Ease of Use
PEft: Perceived Effectiveness
SAT: Satisfaction

PEFc: Perceived Efficiency
BI: Behavioral Intention

3. Research Methodology and Design

3.1 Model Instruments and sample

The current study is an explanatory study designed using the survey method. It was quantitative in nature and primary data was collected from the respondents using tool developed after extensive review of literature. Population of the study was 100 healthcare professionals which consist of 71 physicians and medical doctors, 20 nurses, 9 other specialists (i.e. therapists, residents, and pharmacists) and Population was determined based on the objectives of the study. The study was limited to Karnataka region.

This study adopted SPSS18.0 statistics software to study the hypothesis test and data analysis. The statistic method adopted in this study includes descriptive statistical analysis, common method variance, reliability analysis, confirmatory factors analysis, and correlation analysis. Then, this study adopted a structural equation model to analyze the relation among the variables in the model and interpret the study model and hypotheses.

All measurement scales used in the present study were adapted from the original standardized existing scales (reliable and valid scales) with limited modifications. Since the original scales were developed in a foreign environment; semantic and cultural transportability issues were examined and changes/modifications were incorporated where ever necessary. All the existing scales used for present study were tested again for reliability and validity.

The questionnaire was designed in such a manner that it is easily understood by the target audience and it fulfills the objective. The busy schedule of the doctors was kept in mind while designing the questionnaire of the healthcare professionals thus keeping the questions simple and straightforward. Before the questionnaire was administered to the field it was validated by the experts. A brief introduction about usability was also mentioned in the beginning of the questionnaire so that the respondents are aware of the terms. Individuals may choose the paper version or the online survey. The scale varied from 1(never) to 7(always). The questionnaire used in the study is attached in the A*ppendix*.

3.2 Analysis and Interpretation

Cronbach's coefficient α is widely used to estimate the internal reliability of multi-items and its rate of 0.70 or higher is considered acceptable. *The subscale reliability was 0.9 for BI, 0.8 for satisfaction, 0.9 for Perceived Effectiveness, 0.9 for Perceived Efficiency, 0.9 for Perceived Ease of Use, 0.8 for Response Cost, 0.8 for Social norms and 0.8 for Self Efficacy.*

One can see that the construct with the highest internal reliability is Perceived Effectiveness (0.93) and the one with least internal reliability is Response cost (0.87).

Table 2: Reliability Test

Construct	Composite Reliability	AVE	Cronbach Alpha
Behavior Intention	0.904	0.784	0.926
Satisfaction	0.899	0.798	0.896
Perceived Effectiveness	0.829	0.699	0.933
Perceived Efficiency	0.854	0.699	0.917
Perceived Ease of Use	0.817	0.775	0.923
Response Cost	0.822	0.729	0.877
Self Efficacy	0.779	0.688	0.897
Social Norms	0.800	0.720	0.879

Table 3: Correlation analysis

	BI	Sat	PEFT	PEFFC	PEOU	RE_CO	SE_EF	SO_NO
BI	1							
Sat	0.605**	1						
PEFT	0.395**	0.732**	1					
PEFFC	0.542**	0.533**	0.456**	1				
PEOU	0.604**	0.599**	0.479*	0.489*	1			
RE_CO	-0.319*	-0.698*	0.245**	0.324**	0.337**	1		
SE_EF	0.303**	0.677**	0.476**	0.309*	0.703**	0.520*	1	
SO_NO	0.437**	0.410**	0.386*	0.365**	0.400**	0.322**	0.454**	1

  **. Correlation is significant at the 0.01 level (2-tailed).

  *. Correlation is significant at the 0.05 level (2-tailed).

Figure2: PLS results
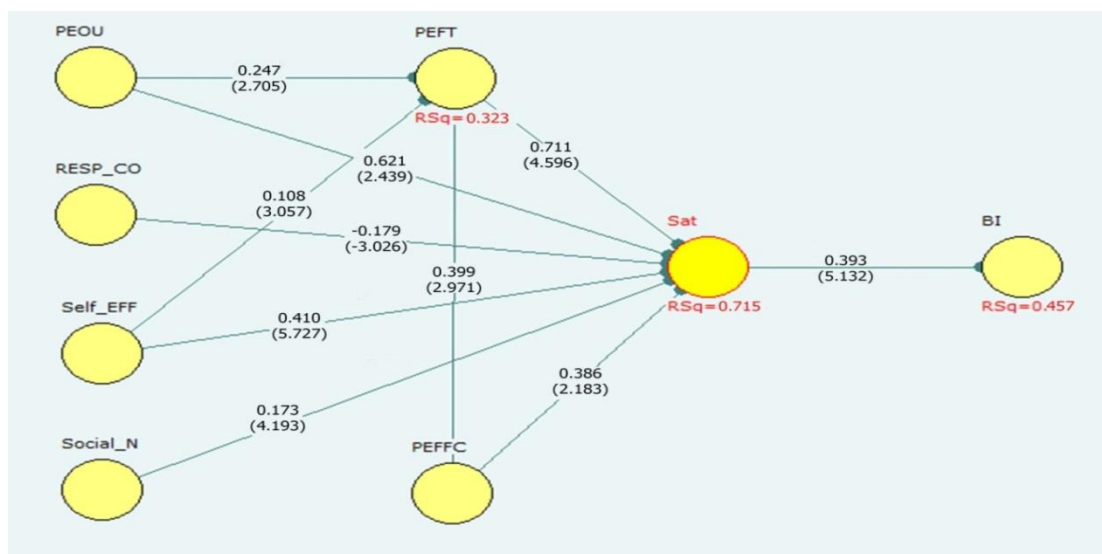
3.3 Assessment of the structural mode

The structural model was assessed by checking the significance of path coefficients (β) between different factors. As illustrated in Figure 2, the results showed that all the proposed relationships were significant.

Specifically, the results indicated that Perceived Effectiveness has strongest influence over satisfaction (β=0.711; t=4.596) followed by Self Efficacy (β=0.410; t=5.727) (similar as Venkatesh et al., 2003).The construct with the highest internal reliability is Perceived Effectiveness and the one with least internal reliability is Response cost .The response cost is a stronger determinant for system adoption in older adults (as Dodds et al., 1991) and so is social influence. PEOU and self efficacy explain 33% of variation on perceived effectiveness (Rsq=0.323). It was found

that there is a significant difference in behavioral intention across age groups. It is a major factor in the age group of 40-49 males. It was found older doctors are not so comfortable using the mobiles as the younger doctors. PEOU, SE, RC, SN, PEfc, PEft explains 71.5% of variation in satisfaction (Rsq=0.715). Satisfaction explains 45.7% of variation in BI (Rsq=0.457).

4. Discussion and implications

The findings from the study enhance the knowledge about the factors influencing usability of mobiles in the healthcare industry. The usability ultimately influences the decision of a user to intend to use a certain technology. In case of doctors it should enhance their overall experience with the patients and should not act as a barrier. This is clearly revealed in the model and

is a good insight for the industry. The industry and the providers have to keep this in mind that *usability is not just technical issue but the context in which mobiles are used i.e mobility has to be also considered while developing the products or services.*

Various policy makers and academicians have suggested time and again for an expanded use of m-health in developing countries for better decision making, increased data collection and to promote better health (Gerber, et al., 2010; Mechael, 2009a; Mechael & Sloninsky, 2008; United Nations Foundation, 2010; WHO, 2011b). Telecom network providers should open up networks via APIs which can allow the third parties to utilize the network infrastructure for new services. Government can lay down the rules and norms clearly forming specifications, guidelines which can be strictly adhered to by all the stakeholders such as the providers, users and technology companies.

5. Suggestions for further research

Model can be applied to other industry apart from the healthcare industry as well. Future researchers might take these insights to other industries. The Model developed can be examined in other cities and countries also. This can be tested in other cultural context as well. There is a scope for testing competing alternate models with varying relation structure that can be tested and compared with proposed model.

Finally, while the explanatory power of the model (43.6% for intention) was acceptable, it could potentially be enhanced through the inclusion of additional factors in future research.

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