UTAUT-QiU: Technology Acceptance Evaluation Model with Integrated Quality-in-use for Mobile User Interfaces adapted for Low- and Post-literate users

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Abstract

UTAUT-QiU: Technology Acceptance Evaluation Model with Integrated Quality-in-use Assessment for Mobile User Interfaces Adapted for Low- and Post-literate Users

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Mobile technology evolution has greatly affected our lives, in terms of performing our daily tasks more efficiently and effectively. It includes recent advances in voice-enabled technology empowered by artificial intelligence, machine learning and natural language processing. Then again, technology evolution has created a problem for low and post-literate population in terms of understanding and using mobile devices with complex functionality. Low- and post- literate individuals are the ones who have difficulties either reading a text or understanding a new technology.

We propose a new technology acceptance evaluation model UTAUT-QiU with the aim of assessing both user acceptance of text free mobile applications' user interface (MUI) and MUI's quality-in-use. We intend to increase the quality-in-use of MUI for low- and post-literate users by applying text-free approach combined with voice as a service. UTAUT-QiU is inspired by UTAUT (Unified Theory of Acceptance and Use of Technology) and integrates it with Quality-In-Use model for Mobile Applications. The UTAUT-QiU model is used to investigate empirically the effect of text free UI approach on low- and post-literate users in performing their daily tasks with the help of mobile applications.

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Chapter 1. Introduction

The post-literate and low-literate population is increasing in both developing and developed countries. By definition, these people have problems either with reading the text or understanding interaction and functionality of new technology [23,7]. They are not illiterate in terms of language, but they lack the knowledge needed to use the latest technology or they experience problems in interacting with technology, such as mobile applications, because of their cognitive level. In the last decade, an enormous growth has been seen in the use of mobile applications to support healthcare and mobile banking [1]. Statistics claims that, by the end of 2018, 50% of the downloaded mobile applications will be from the health care domain or e-commerce applications which effects the life of a user particularly health domain [1].

Low-literate people have a problem reading text and also have a problem when they encounter mobile applications, which have limited space for interaction and for showing content. Current popular input mediums available today among the mobile applications are touch screens with a virtual keyboard present on screen, but these input mediums feature smaller text or have very advanced touch functionality, such as 3D touch, which makes it harder to learn. Latest technological development has introduced voice as a new input source, and it's getting popular as well. Recent progress in technology such as AI (Artificial Intelligence), ML (Machine Learning) and NLP (Natural Language Processing) have made the voice-enabled user interface more powerful and easy to use. Voice as input technology can be used in health care and e-commerce applications to help the low and post-literate users to complete tasks effectively and efficiently. Stringent scrutiny is required for quality-in-use and usability of such user interfaces when used by the post-literate or low-literate communities. Also, analysis of acceptance of such technology is essential to provide a better method for the application.

In this thesis, we propose a new technology acceptance model, UTAUT-QiU, integrating the UTAUT acceptance model and quality-in-use principles. As a proof of concept, we present a low fidelity survey application, MedPro, which is an Android application adopting a text-free UI approach where the input and output medium is mostly from voice.

In this chapter, we bring out the motivation of this research, define research goals and objectives as well as our contribution and suggestion towards acceptance of such a technology. We also provide an outline of the organization of the thesis.

1.1 Research Motivation

Evolution in mobile user interfaces development has made the use of smartphones more accessible to various domains of life, such as health and other daily life tasks. These developments in mobile applications are enhancing the quality of life. Interacting with the mobile applications can be possible in several ways, such as with touch, hand gesture and now voice as well. Natural Language Processing (NLP) has made voice-enabled interactions with mobile applications more effective and efficient. Voice assistants, such as Siri, Google home, Alexa, prove that voice can be used as an interactive medium in accomplishing complex applications related to daily life.

Such interactions can be beneficial to people with low literacy or people who are not literate but don't feel the technology as more complicated when they try to use it. The difficulty for low-literate people is reading text. Specifically, they don't scan the word as literate people do. They read it word by word, and sometimes they miss the essence of the sentences. However, these people do not have a problem with writing. For the post-literate people, reading is not a problem, but the knowledge to work with technology efficiently and effectively is a matter of concern. Making the application text-free by providing instructions, input as voice and feedback while using the application, will certainly be a solution for low and post-literate people. Voice-enabled devices can help these people by giving guidance on how to use the application, by providing real-time feedback and by producing the output when performing task. Voice as a service in the mobile application can reduce the cognitive load of low-literate people, while real-time feedback and guidance can solve the problem for post-literate people.

Assessing voice as the interaction medium for the entire application is essential and, at the same time, is also important to evaluate the acceptance of such technology. An analysis of various studies carried out in the past shows that there is no technology acceptance model which assesses and identifies the issues encountered in performing tasks for low and post-literate people on text-free UI.

This thesis intends to provide the analysis of the acceptance of such technology and the usability of such user interfaces. There are various challenges when providing such interactions and it's important to understand in what condition these types of interaction are acceptable or unacceptable. The research described in this thesis constitutes an attempt to analyze the acceptance of text-free UI for low and post literate people. Together, HCI (human computer interaction) [1], UTAUT (unified theory of acceptance and use of technology) [2] and MUI guidelines [1] provide the methodology for assessing usability and acceptance.

1.3 Research Objectives

The objectives of this research are the following:

Objective 1. Analyze if the text-free UI approach will assist post-literate users in using information effectively and efficiently for performing their daily life's tasks and evaluate the performance of such.

Objective 2. Propose a new technology acceptance evaluation model, UTAUT-QiU, which integrates Quality-in-Use and UTAUT.

Objective 3. Empirically evaluate the proposed UTAUT-QiU model on low fidelity prototype MedPro (text-free mobile application).

The significance of this research is to evaluate the concept of text-free UI in mobile applications for the low and post-literate people. Also, it is to assess the task performance and acceptance of text-free UI using the new proposed model UTAUT-QiU. As a proof of concept, UTAUT-QiU model is evaluated on the low fidelity MedPro application which adopts text-free UI.

1.4 Organization of the thesis

The organization of this thesis is as follows:

In **chapter 2**, we discuss the background and summarize what all work has been done to label the issues of low and post-literate population, and how quality-in-use originated for evaluating the usability of mobile user interface. We also discuss the text-free user interface guidelines used before, and prior studies which show text-free user interface can be useful in improving mobile applications' usability.

In **chapter 3**, we discuss the UTAUT theory and its derivatives, as well as the studies carried explain the issues of low and post-literate people encountered on the available MUI and rewrite the scales for all derivates of UTAUT constructs.

In **chapter 4**, we integrate the quality characteristics from the quality-in-use model and constructs of the UTAUT model through HCI principles to propose a new model UTAUT-QiU to evaluate technology acceptance. UTAUT-QiU model uses measures of quality characteristics and analyze the acceptance of technology.

In **chapter 5**, we validate the new technology acceptance model proposed in chapter 4, by performing a usability test on both versions of the MedPro application. We also discuss the results obtained the test of subjective characteristics of the application.

In **chapter 6**, we discuss how the text-free UI is useful for low and post-literate people, and how UTAUT-QiU model can be used to evaluate the acceptance of this approach. Finally, we discuss future work using this model and the types of issues that can be solved.

Chapter 2. Background and Literature Review

2.1 Notion of low-literate & Notion of low-literacy

Low literacy is a known problem in developing and developed countries. According to data provided by UNESCO (United Nations Educational, Scientific and Cultural Organization), 15% of the total world population are illiterate [6]. Low literacy was always compared or generalized as a form of illiteracy, but they are actually different. Low literate people can read and write but they face difficulties or require a considerable effort in doing so. Also, the data from OECD (Organisation for Economic Co-operation and Development) shows that 50% of US adults can't read a book written at eighth grade level [31]. This low-literate population falls covers both illiterate and literate population (see fig 2-1). Moreover, to understand the low literacy phenomena, and by comparing low literacy with higher-literacy, low literate people cannot understand a text by scanning at it or as fast as literate people can. Low literate people read word by word and plow the text line by line, similar to an early grade child. This difficulty in reading certainly narrows their field of view, and hence they sometimes miss words which are little out of the flow in reading or get exhausted if the text is too long. Inability to scan texts like higher literate people do causes some problems, such as skipping a large amount of data when reading becomes complex, and mainly when scrolling text on web pages: it breaks their visual concentration and they forget where they left off. User interfaces now have millions of options to make the words catchy, such as blinking on the screen for a few seconds, moving objects and animations, etc. These people find it hard to use such interfaces [23]. Moreover, the same situation has affected mobile user interfaces, and due to limited screen size, this becomes a more complex situation for them. Accessing information via the internet has grown exponentially in the past decade and, in the coming years, technological evolution, such as artificial learning, will push more people to the internet [33]. Information on the internet is accessible via web 3.0 technology where user interface design plays an essential role. An article published on the internet by Nielsen Norman Group discussed some design difficulties that low literate people come across. [23] Navigation style and its depth, page scrolling, animations and search have shown how these affect the low literate people cognitive mind.

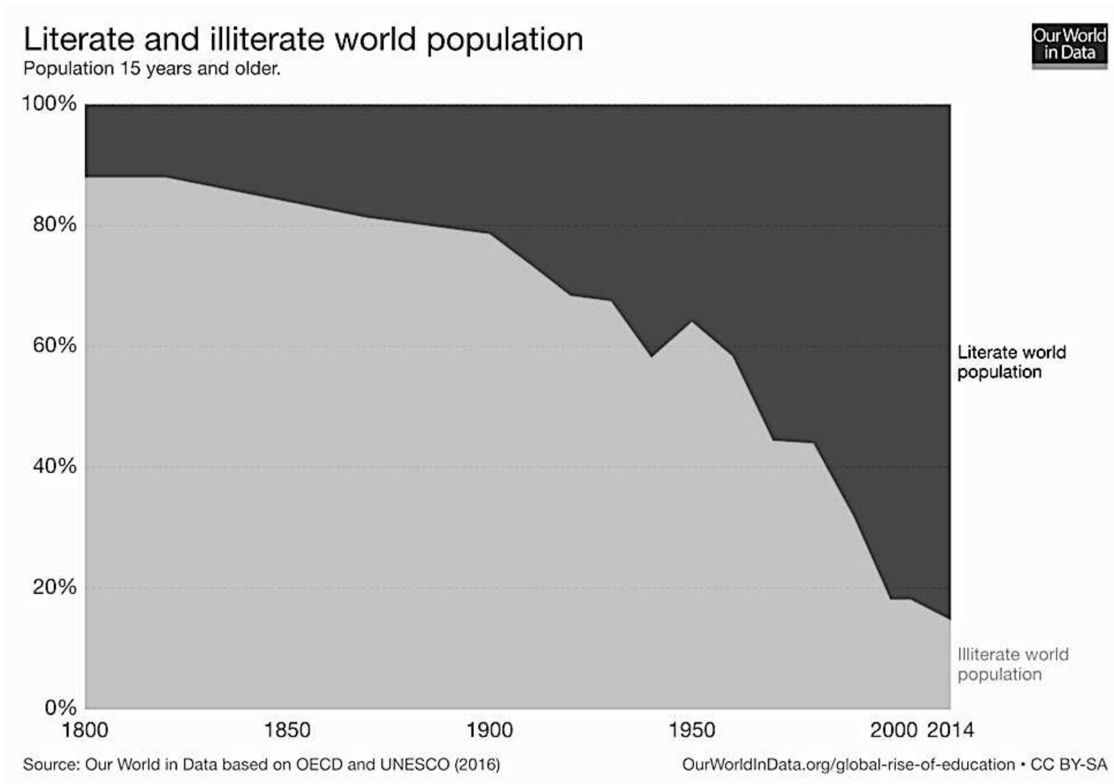


Figure 2-1 Literate and Illiterate world population [6]

2.2 Existing Guidelines of UI design for Low-literate

A Nielsen Norman group article discusses the measures to follow to improve usability for the low literate user on web-based user interfaces [23]. Considering the problem in reading information and skipping behavior of low literate people, it suggests putting the most important information at the top of the web page so that users do not lose interest while reading. Avoiding animation or fly out menus will help them reading instead of having to manage their field of view to better understand the written text. Adopting a linear approach to the menu items is also crucial because low literate people read in linear flow. These discussed guidelines are focused on web-based interfaces. The studies show that mobile devices are easier to learn, as compared to desktop devices for low literate people [3]. They feel comfortable with mobile devices and rely mostly on that [4]. However, the literacy level required for most of the popular app marketplace, like App Store or Google Play, is up to 10th grade. So, these complex functional applications if it's to be used by low literate people have to follow guidelines similar to the web pages'. Since the voice assistants or the text-free user interface can affect the life of low literate people in terms of how they perform the task, the economic and cultural conditions are also part of the concern. Factors such as language and the message's accent are barriers for the acceptance of such a technology [24].

2.3 Notion of post-literacy

Post-literacy is the competency in using media or technological skills and information to function efficiently and effectively in daily life. To function efficiently, one requires to be functionally literate. According to the UNESCO [6], it is the level of skills required to function fully in society. Abilities such as interchange of information between people, between the people and technology, use of technology or the system, are important in fulfilling requirements, either on the job or in daily life. According to the book "Beyond the literacy", post-literacy is the technology, tool or collection of tools and technologies that will enable us to transfer information more efficiently and effectively than reading and writing [7]. Post-literacy is the emerging issue in the developed countries, and the study does not show any work for addressing such an issue. These people come under literate population which is 85% in the world [6] (see fig 2-1).

Defining what precisely post-literacy means is hard and ambiguous because technology and types of interaction with the system are changing very frequently. Artificial intelligence, IoT, voice assistant and all the new technologies determine and modify the way we interact with information [25]. One study has shown how the voice assistants in e-commerce and retail shopping will be helpful. So, to be able to use the technology we need to know how it works and the challenge here is to determine what sort of information is lacking to educate user. Reading information written on guidelines or handbooks has been replaced with educational, unboxing videos. As we see here, the fundamental problem for the post-literate is the learnability of the new system. Whenever there is a new system, or a new technology is launched, post-literate people find difficulties in understanding the system and using it on their first experience. This research proposed a new technology acceptance evaluation model adapted for low and post-literate people

2.5 Related work on text free UI

Smartphones and multimedia devices nowadays provide a range of input medium, from keyboard to touch interfaces. These input mediums have greatly affected the market of mobile devices. Among all these, the latest evolving medium of interaction is the voice or speech. Using voice as a medium of input and output in the user interface can be treated as text free UI. Transition from text-based interface or traditional UI to fully text free have challenges and will take time to completely overshadow text-based UI, however the integration of voice with traditional mobile UI (touching graphic icons for input) into application is used in mostly today [34]. Also, the study shows that the trend for adopting the text-free UI has evolved more in the developing countries where the illiteracy rate is higher or where most people are semi-literate or low literate. Low literate users require someone to intervene while using these devices.

A study made in Bangalore, India, for low literate users used the ethnographic design process to understand what kind of application subject would be interested in such UI and how they would react to the elements of it. Moreover, the result surely confirms the effectiveness of text-free user interfaces over the standard text-based interface [5]. IVR (Interactive voice response) is another medium that have been using in the telephonic architecture and in call centers which have proven its success over the years. Such architecture is remodelled to provide an approach for the text-free user interface. Components like getting input, error-recovery, and play results (output) are said to be critical when designing the text-free user interface for low-literate users [8]. Another study discussing the speech recognition for illiterate users says the success of the speech-driven interface is still far way and analyzes the challenges when designing or producing an application for such users. Dialectal variation, multilingualism, cultural barriers, choice of appropriate content and expense of creating linguistic resources are some known difficulties [9]. The UI of an ATM (Automatic teller machine) was analyzed in Nigeria because they don't perceive ATM as an easy-to-use medium for banking. The study emphasized the strategies that should be considered while creating the UI for ATM and discovered graphic image and voice prompts as being the two most important aspects of it [10].

Computational support provided by mobile in fields such as healthcare, education and finance is huge, but the usability of such applications to illiterate and low literate users is a major issue. During a study, two sets of applications were created for testing purposes, and they found that pre-recorded voice instructions in various languages with color-coded graphics can be used effectively [11]. A learnability and usability study done in Pakistan tested a mobile banking application with low literate users. They discovered that the usability of the application was poor in the first phase when it was tested without any changes. However, the usability started increasing when audio guidance to perform the task was provided during the test. Addition of audio support decreased the need of intermediated help to low literates [12]. The use of voice-based navigation via Google Map, which we have been using for years, has made a huge effect in daily life: for example, while driving, a voice instruction helps to concentrate more on the road rather than looking at the map on the mobile screen.

Text-free or voice-based interfaces have made an amazing change toward people with disabilities as well. In a study, a navigation interface for only blind people was developed to let them know the routes using voice-based instructions in the language they understand. Also, the team has successfully completed this project and results confirm that voice-based interface will certainly benefit in terms of learning and ease of use [13]. Progression of the smart home is also getting influenced by the use of voice-based interfaces, not only for giving commands but as a two-way communication, or should we say acting like voice agents to perform daily life tasks [14].

Mobile applications these days support a high level of computation and technicality, and this is becoming a challenge for voice-based interfaces. However, recent developments in NLP (Natural language processing) are improving and making it stronger [26]. Complex programming tasks are also becoming possible using the voice-based interfaces. A group from Brown University presented a query paradigm called Query-by-Voice (QbV) to do the task from a relational database. They created a prototype called EchoQuery which uses Deep learning mechanisms to translate the human voice commands to SQL (structured query language) [15]. All these studies show that the text-free user interface can be applied to different area of our lives.

2.6 Related work on quality in use for MUI

Software products and software-intensive computer systems need to maintain a considerable level of personal satisfaction, improve business success, and human safety by incorporating high-quality software and systems [27]. Figure 2-2 shows the structure used for quality models.

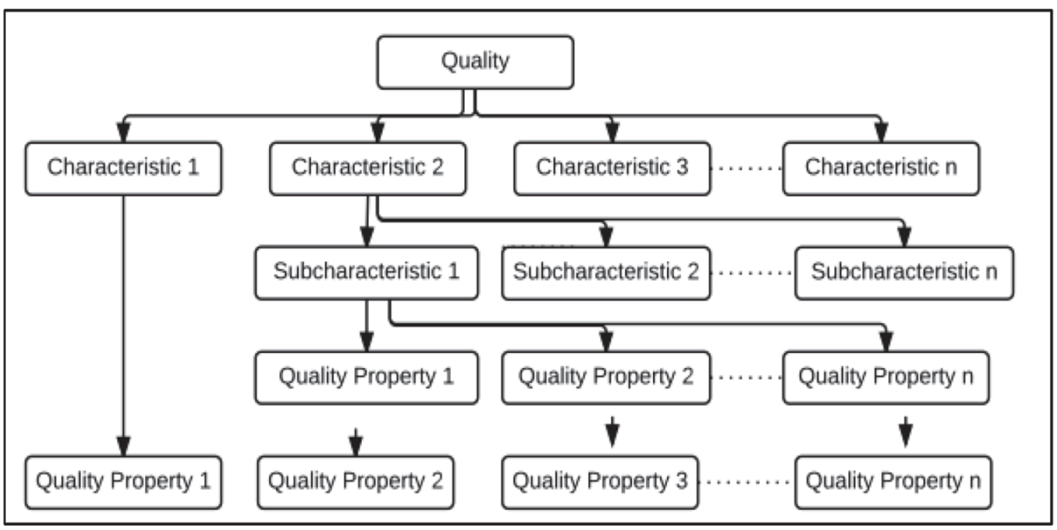


Figure 2-2 Structure used for the quality models [27]

Quality in use is defined (based on ISO/IEC 25010:2011(E) and ISO/IEC 25022:2014) as the degree to which a product or system can be used by specific users to meet their needs in achieving particular goals with effectiveness, efficiency, freedom from risk, and satisfaction in a specific context of use. Quality in use characteristics defined in ISO/IEC 25010, and ISO/IEC 25022 are as follows: Effectiveness (measures completeness and accuracy with which goals can be achieved), Efficiency (level of effectiveness achieved to the expenditure of resources), Relevant resources (measures physical or mental effort, time, materials or financial cost), Freedom from risk (the risk of operating the software or computer system over time, condition of use and the context of use), Satisfaction (measures the extent to which users are free from discomfort and their attitudes towards the use of the product).

The capability of the software to achieve specific goals effectively, productively and safely in a specified context of use by specified users is defined as quality in use [28] [16]. The term “quality in use” is based on the view of the user towards the quality of the system which contains the software product. Quality in use of the software product does not measure its properties, such as what it is made for and what functions it performs. Measurement of the quality in use is done concerning outcomes of software while using it.

Quality in use for mobile interfaces has been a topic of discussion since the growth of the mobile industry. The desktop user interface (DUI) that had been discussed for years, the quality characteristics and their measurement have inspired the quality-in-use model for MUI (mobile user interface). Mobiles having a smaller screen size, limited input resources, specific running environment and less computational power let us think of a different “quality in use” model.

Alnanih et al. 2013c presented the “quality in use” model for MUI (Mobile user interface) and their result is confirmed by empirical study considering HCI (human-computer interaction) principals such as Mental Model, Visibility, Affordance, Feedback, Metaphor (See fig 2-3).

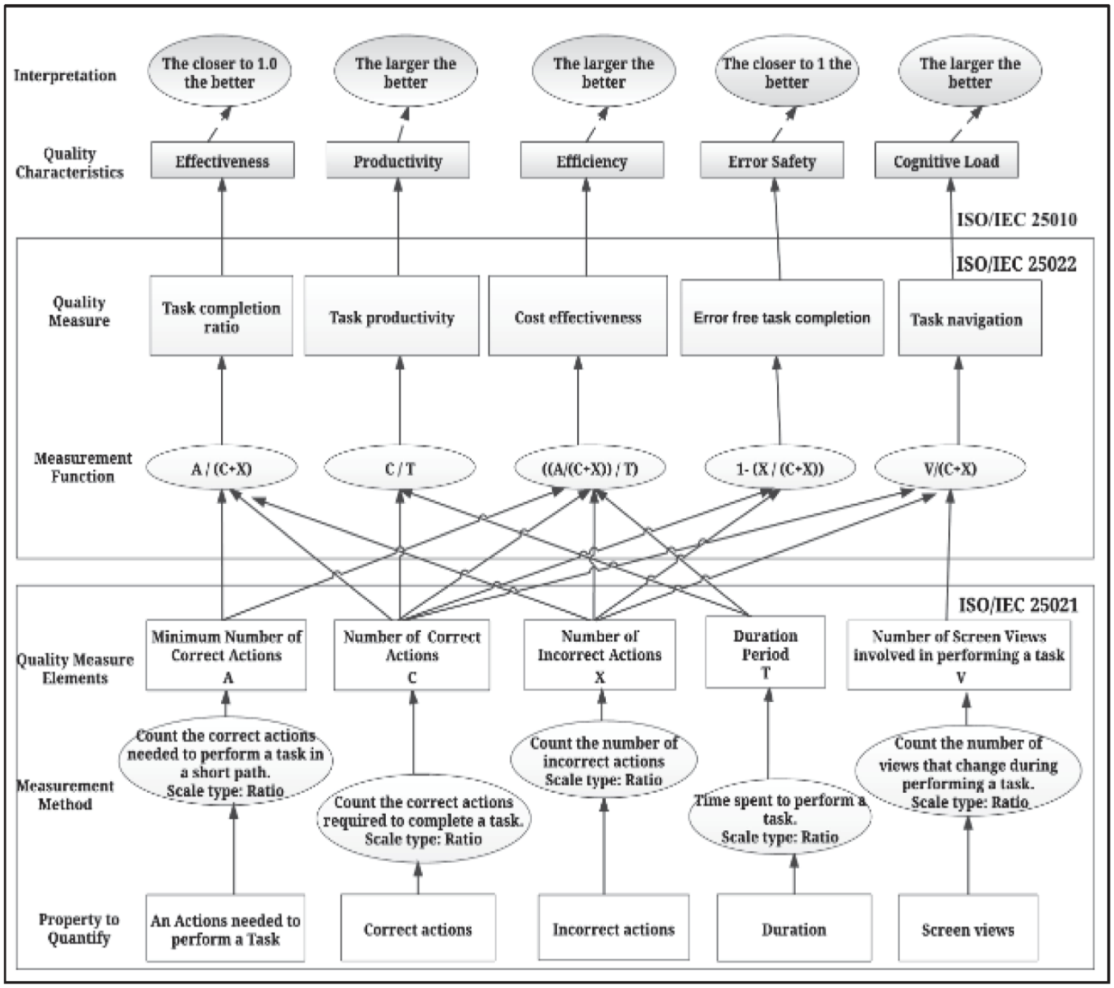


Figure 2-3 Quality-in-Use Model for MUI [1]

"Quality in use" model for MUI contains the following objective characteristics: Effectiveness (completion of tasks to be performed with a minimum number of actions), Productivity (amount of completed tasks in relation to time spent on the task), Efficiency (level of effectiveness with which users achieve tasks in ratio with time required to complete the task), Error Safety (concerned with minimizing the number of errors during the completion of the tasks), Cognitive Load (level of the cognitive load of the users with which tasks can be achieved in a specific context of use); as well as one subjective characteristic, such as Satisfaction (user's level of enjoyment as a result of interacting with the application in a specified context of use.

The context of use and goal are the two key aspects when measuring the quality in use characteristics of the application.

Summary

In this chapter, we highlighted how low literate people face a problem when encountered with currently available technology, with the specific mobile application design guidelines available for these people. However, there is no work done in providing a new approach to interaction with the current mobile applications with sophisticated functionality. Also, we explained the notion of post-literacy, which is an emerging phenomenon in developed countries, showing that there is less work done to address its issues. A “quality in use” model, used to evaluate the usability of a MUI, is adopted in this thesis to propose a solution using an empirical study.

In the next chapter, we present the UTAUT (Unified Theory for Acceptance and Usage of Technology) which is used to assess the acceptance of the technology. UTAUT constructs are redefined for text-free user interfaces and we explain at what specific scale it effects the acceptance of such an approach.

Chapter 3. UTAUT for Text Free UI

Technology's capabilities are growing broader every day. The last decade has witnessed the exponential growth in the advancement of technology. Artificial intelligence, IoT and Voice Assistant are changing the way of doing things in our daily lives. Analysis of the technology used, and its adoption is important in order to understand the problems associated with the system and to improve it. In the past years, consumer research has used different models to find the factors which help in making decisions to adopt new technology. In this research, we focus on UTAUT (Unified Theory of Acceptance and Usage of Technology), a model which was proposed by Venkatesh in 2003[2]. UTAUT is widely used to understand the adoption of technology from the perspective of the novice user or a specific context of users. UTAUT is derived from the following eight theories: the theory of reasoned action (TRA), the technology acceptance model (TAM), the motivational model, the theory of planned behavior (TPB), the PC utilization model, the innovation diffusion theory (IDT), the social cognitive theory (SCT) and the integrated model of technology acceptance and planned behavior. UTAUT is widely used to analyze the acceptance of technology for various domains of lives. If the technology fails to be accepted on the parameters of UTAUT, it provides suggestions and feedback to improve it. The theory of UTAUT explains that user adoption and usage of technology is influenced by the following four constructs: performance expectancy, effort expectancy, social influence and facilitating conditions [2]. These four constructs are explained the following section. Any application or system is developed keeping potential user and their characteristics. Such characteristics are the mediating factors in UTAUT. Figure 3-1 shows UTAUT model and with factors effecting the basic constructs of the model. There are four factors which mediate the effect of these constructs, and they are gender, age, experience, and voluntariness.

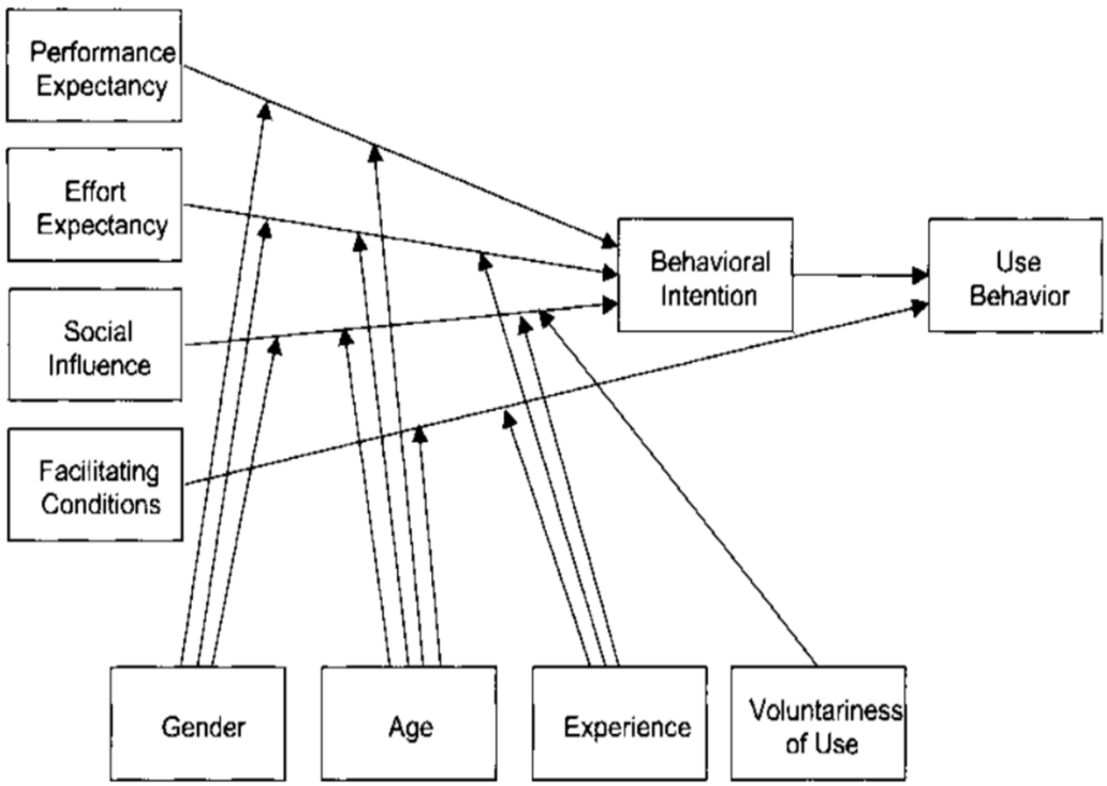


Figure 3-1 Traditional UTAUT model and correlation with user characteristics [2]

3.1 Related work on UTAUT

A study conducted in Finland [17] showed that performance and effort expectancy are two basic determinants for adoption of mobile services. Tao and Yaobin surveyed to understand the mobile banking adoption in China and found out that, except for effort expectancy, the other three constructs of UTAUT model, performance expectancy, social influence and facilitating condition, have high influence [18]. An empirical study adapted UTAUT to show the acceptance of e-learning technologies and services (Moodle) to the students. They found that performance expectancy and social influence have a significant role in students' attitude towards using these services [19]. However, there is less research done in the case where the user interface is entirely text-free, such as with applications using tools like Google Voice Assistant or Siri, to find out if it is adopted and what factors will decide its acceptance. UTAUT has four fundamental constructs which are: Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions.

3.2 UTAUT Constructs

3.2.1 Performance Expectancy

Performance Expectancy is defined as the degree to which an individual believes that using the system will help him or her attaining gains in job performance [2]. There are five constructs from different models which pertain to performance expectancy: perceived usefulness (TAM/TAM2 and C-TAM-TPB), extrinsic motivation (MM), Job fit (MPCU), relative advantage (IDT) and outcome expectations (OCT). Table 3-1 shows the definition of all five constructs which pertain to performance expectancy. The third column is the new redefined items in the context of a text-free user interface.

The five constructs explained here are the views of the user when using new technology. We can see from the definition column how UTAUT defines all these constructs concerning performance in a work environment. Similarly, we have redefined the scale for the context of this research, which is the text-free user interface.

Table 3 - 1 Performance Expectancy constructs

Performance Expectancy: Root construct, definition, and scale for text free UI		
Construct	**Definition**	**Items**
Perceived usefulness (Davis 1989; Davis et al 1989)	Degree to which a person believes that using an application with text free user interface would enhance his or her task performance.	1. Using the application with the text free UI in daily life would enable me to accomplish task more quickly. 2. Using the application with text free UI would improve the task performance in daily life.

		3. Using the application with text free UI would make the task easier. 4. Using the application with text free UI will increase my productivity in daily life.
Extrinsic Motivation (Davis et al. 1992)	The perception that user will want to perform an activity because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself, such as improved job performance, pay, or promotions	1. Extrinsic motivation is operationalized using the same items as perceived usefulness from TAM.
Job-Fit (Thompson et al. 1991)	How the capabilities of an application with text free user interface will enhance the task performance	1. Use of the application with text free UI will have no effect on performance in daily life tasks. 2. Use of the application with text free UI can decrease the time needed for my important job responsibilities. 3. Use of the application with text free UI can increase the effectiveness of performing job tasks.

		4. Use can increase the quantity of the output for the same amount of effort.
Relative Advantage (Moore and Benbasat 1991)	The degree to which using an innovation is perceived as being better than using its precursor.	1. Using the application with text-free UI enables me to accomplish tasks more quickly. 2. Using the application with text free UI improves the quality of the daily work I do. 3. Using the application with text free UI enhances my effectiveness in daily life work.
Outcome Expectations (Compeau and Higgins 1995b; Compeau et al. 1999)	Outcome expectations relate to the consequences of the behavior.	1. If I use the application with text free UI, I will spend less time on routine tasks. 2. If I use the system, I will increase the quality of output in daily task. 3. If I use the system, I will increase the effectiveness in daily task.

3.2.2 Effort Expectancy

Effort expectancy is defined as the degree of ease associated with the use of the system [2]. The concept of effort expectancy is captured from three constructs of the existing model, which are: perceived ease of use (TAM/TAM2), complexity (MPCU), and ease of use (IDT).

Table 3-2 explains all construct which pertains to effort expectancy and their respective definitions, and each construct validates if using the new technology will provide ease of use. We have redefined the items in the context of a text-free user interface to assess.

Table 3 - 2 Effort Expectancy constructs

Effort Expectancy: Root construct, definition, and scale for text free UI		
Construct	**Definition**	**Items**
Perceived ease of use (Davis 1989; Davis et al 1989)	The degree to which a person believes that using an application with text free user interface would be free of effort or will have less effort relatively.	1. Learning to operate the application with text-free UI would be easy for me. 2. My interaction with the application with text-free UI would be clear and understandable. 3. I would find the application with text free UI to be flexible to interact with. 4. It would be easy for me to become skillful at using the application with text-free UI.

Complexity (Thompson et al. 1991)	The degree to which a system is perceived as relatively difficult to understand and use	1. Using the application with only text as input and output. medium will take too much time from my normal duties 2. It takes a long time to learn how to use the system to make it worth the effort. 3. Using the application involves too much in doing mechanical operation (e.g. text input).
Ease of use (Moore and Benbasat 1991)	The degree to which using innovation is perceived as being easy to use.	1. My interaction with the application with text-free UI is clear and understandable. 2. Overall, I believe that the application with text-free UI is easy to use. 3. Learning to operate the application with text-free UI is easy for me.

3.2.3 Social Influence

Social influence is defined as the degree to which an individual perceives that other important people believe he or she should use the new system [2]. Behavioral intention is defined as a individual intention to use a particular technology that directly affects actual usage [2]. Behavioral intention is the direct determinant for social influence and presented as a subjective norm from TRA, TAM2, TPB/DTPB, and C-TAM-TPB, social factors from MPCU and image construct from IDT.

In today's world, our decisions are somehow affected by our social presence. Social media, like Facebook, Twitter, LinkedIn and Instagram, has largely influenced our interpretation of technology and its usage. These platforms provide sharing options which let us learn easily about the new technology, and its usage, meaning Reviews and comments of people in our circle lets us make decision about products. Table 3-3 presents all three constructs and their definition, redefining their scale considering that the current option of social influence is essential before assessing the social influence of text-free user interface.

Table 3 - 3 Social Influence constructs

Social Influence: Root construct, definition, and scale for text free UI		
Construct	**Definition**	**Items**
Subjective Norm (Azen 1991; Davis et al 1989; Fishbein and Azen 1975; Mathieson 1991; Taylor and Todd 1995a, 1995b)	A person's perception that most people who are important to her/him think s/he should or should not perform the behavior in question.	1. People who influence my behavior think that I should use the application with text-free UI. 2. People who are important to me think that I should use the application with text-free UI.

Social Factors (Thompson et al. 1991)	The individual's internalization of the reference group's subjective culture, and specific interpersonal agreements that the individual has made with others in specific social situations.	1. I use the application with text free UI because of coworkers use same UI. 2. I use the application with text-free UI because someone suggested me to do so.
Image (Moore and Benbasat 1991)	The degree to which the use of an innovation is perceived to enhance one's image or status in one's social system.	1. People in my organization who use the application with text free UI have more prestige than those who do not. 2. People in my organization who use the application with text free UI have a high profile.

3.2.4 Facilitating Condition

Facilitating condition is defined as the degree to which an individual believes that an organization and technical infrastructure exist to support the system [2]. The definition of facilitating condition encapsulates three constructs from different models which are: Perceived behavioral control from TPB, DTPB, C-TAM-TPB, facilitating condition from MPCU and Compatibility from IDT.

Table 3-4 presents all three constructs which derive facilitating condition construct of UATUT, and the scale is almost same which are defined in the main UTAUT model but are modified in the context of text-free user interface.

Table 3 - 4 Facilitating Condition constructs

Facilitating Condition: Root construct, definition, and scale for text free UI		
Construct	**Definition**	**Items**
Perceived behavioral control (Azen 1991; Taylor and Todd 1995a, 1995b)	Reflects perceptions of internal and external constraints on behavior and encompass efficacy.	1. I have the resources necessary to use the system. 2. I have knowledge necessary to use the system. 3. Given the resources, opportunities and knowledge it takes to use the system, it would be easy for me to use the system.
Facilitating condition (Thompson et al. 1991)	Objective factors in the environment that observes agree to make an act easy to do, including the provision of computer support.	1. Guidance was available to me in the selection of the system. 2. A specific person is available for assistance with system difficulties. 3. Specialized instruction concerning the system was available for me.

Compatibility (Moore and Benbasat 1991)	The degree to which an innovation is perceived as being consistent with existing values, needs, and experiences of potential adopters.	1. Using the system is compatible with all aspects of my work. 2. I think that using the system fits well with the way I like to work. 3. Using the system fits into my work style.

3.3 UTAUT 2

UTAUT has a second version UTAUT 2 [32], which is an improvised version of UTAUT. Apart from the four constructs discussed above, UATUT 2 has three more constructs which are – Price value, Hedonic motivation (fun or pleasure while using the technology), Habit. We choose UTAUT for this research because the constructs added by UTAUT 2 are following:

1. Price value is related to the cost of application which does not sound relevant because on Google play store has 94% free application, so this construct does not fit in our objective.
2. The constructs such as hedonic motivation and price value related to the most commonly used population, not the low-literate people.

Summary

In this chapter we explained the basic principle of UTAUT, as it is used to assess the adoption of technology related to software, while we tried to adopt the UTAUT constructs to assess text-free user interface adoption. We redefined the scale of each construct in terms of how text-free UI will impact the user's daily life either at the work place, at home or in a social environment. Performance and ease of use of a mobile application with text-free

UI in daily life is assessed based on the type of task a person performs with it and assessing these aspects are achieved by understanding two constructs: Performance Expectancy and Effort Expectancy. There are different technology acceptance models, such as TAM, TAM2, TPB, C-TAM-TPB, from which performance expectancy and effort expectancy constructs of UTAUT are derived. These models explain the capabilities or the specific nature of tasks which can be seen as measurement to evaluate performance and ease of use of the technology. The other two constructs, social influence and facilitating condition, can be seen as measures which a technology has a loose hold on and yet impact in a greater way in today's arena where social presence is very important. Facilitating conditions, like internet and mobile capabilities, effect the largely when a new technology or new approach to technology is applied.

In the next chapter, we present how HCI (Human computer interface) and quality-in-use characteristics can be mapped to UTAUT, and then we propose a new model, UATUT-QiU, for the assessment and evaluation of text-free user interfaces.

Chapter 4. A New Technology Acceptance Model UTAUT-QiU

One of the objectives of the present research to is to analyse the acceptance of the standard text-based user interface through quality-in-use characteristics of an application and determine if text-free user interface will improve the experience of low-literate and post-literate people. In order to analyse the acceptance of technology, we integrated the Unified Theory of Acceptance and Usage of Technology (UTAUT) model [2] and Quality-in-Use model for mobile UI [1].

The root of UTAUT-QiU model is divided into two basic categories of characteristics, which are: i) objective characteristics, and ii) subjective characteristics.
The measurement of objective characteristics is obtained from the quality measure elements which are fitted to the measurement function to collect data quantitatively based on the user's results while conducting the test. Consequently, to doing so, we made sure that different users would produce the same kind of measures, because numerical rules define the quantification of objective characteristics.
The measurement of subjective characteristics varies with the person measuring it, and so it ponders the view of measurement. The responses received on the post-questionnaire that users filled out based on their experience, after conducting the test, indicate subjective characteristics. Therefore, the quantification of subjective characteristics involves human judgment.

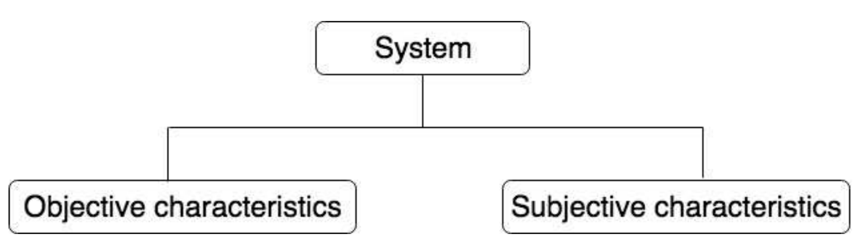


Figure 4-1 System characteristics

As per the standard definition of UTAUT's constructs [2], we found that two of the constructs, Performance Expectancy and Effort Expectancy, can be used to analyze objective characteristics. Performance Expectancy of any system depend on whether the new system or technology will enhance their task performance, meaning, if the number of steps to complete the task increases or decreases as compared to the ideal number of steps. Also, effort expectancy is related to how easy to use the system is while performing the task, or how easily a given functionality can be found.

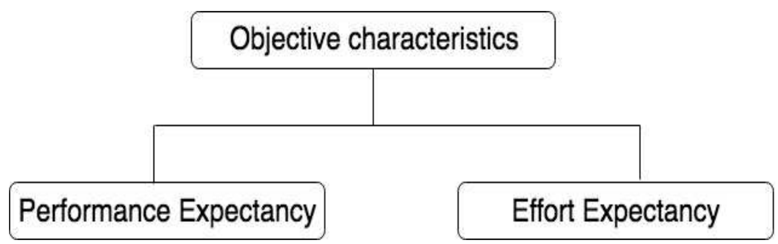


Figure 4-2 Objective characteristics

Subjective characteristics are the external or environmental measures related to the user's resources or how comfortable s/he is in the application's environment and how s/he feels about the use of the application. Does the application satisfy their needs and are there any external issues encountered while using the system? Therefore, the UTAUT's constructs of Social Influence and Facilitating Condition fall into the subjective characteristics category. Social Influence defines how the people in the entourage of the user think of the system and how much their response affects the acceptance of such system. Facilitating Condition depends on the resources needed for using the application.

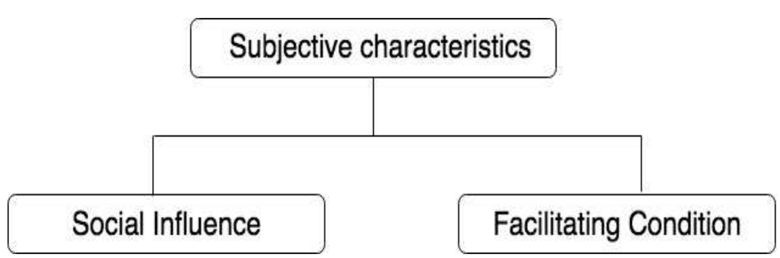


Figure 4-3 Subjective characteristics

4.1 Mapping of UTAUT and HCI Principals

To relate the UTAUT standard principals to the quality-in-use model for MUI, we will first try to understand how HCI principles are related to UTAUT. Human computer interaction (HCI) principles acts as the basis for design methodology, and it includes the following:

Affordance - Affordance is the quality that makes it easy for a user to spot and identify the functionalities that a UI offers. To have the property of affordance, the UI or system should suggest how it is to be performed.

Feedback - Feedback is the information that is sent back to the user about what action has been accomplished upon the use of a control. This principle is linked to visibility and affordance.

Metaphor - A figure of speech in which a word or phrase denoting one kind of object or action is used for another to suggest a likeness or analogy between them.

Visibility - Visibility states the current state of the system or application and what operations are available to perform.

Mental model - A set of beliefs about how a system works.

Performance Expectancy is defined as the degree to which an individual believes that using the system will help him or her to attain gains in job performance. A higher Performance Expectancy of the system means that the system and its functionality was easy to spot and identify, which relates Performance Expectancy to Affordance. Also, to have a better Performance Expectancy, a system should be user-friendly, providing feedback on actions, and there should be a good interaction between the system and the user. This relates Performance Expectancy with Feedback Principle of HCI. Metaphor is the HCI principle which relates the design elements related to real world objects in the interface so that the user can easily relate and grasp the meaningful functionality of the system. So, for a system to have good performance expectancy it should follow metaphor principle of HCI.

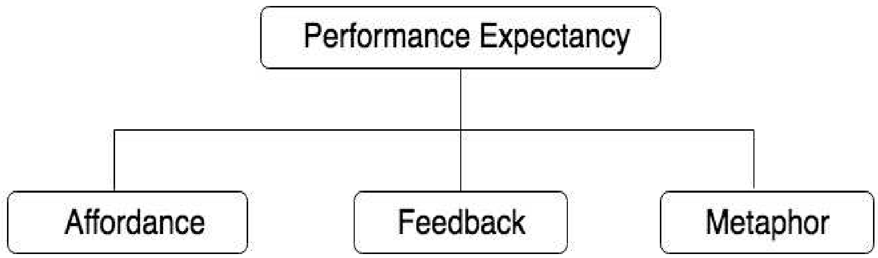


Figure 4-4 Performance Expectancy to HCI

Effort Expectancy is the degree of ease associated with the use of the system. For a user interface to have better effort expectancy, it should be easy to use, meaning that users should be able to easily find the operations that can be performed through it. Thus, effort expectancy relates to visibility. If the user is able to easily do the task on the interface and it's possible only if the user perception of the system or interface is true or if it can find the functionality easily. This relates mental model to effort expectancy.

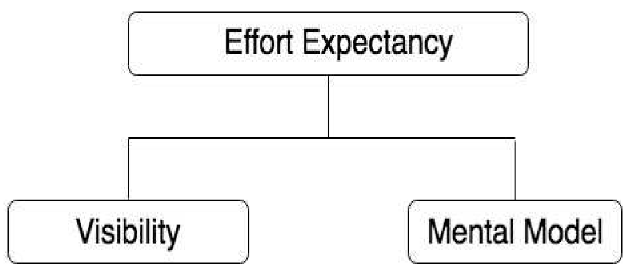


Figure 4-5 Effort Expectancy to HCI

The Social Influence construct of the UTAUT model describes how the beliefs of people around us let us make a decision about using the technology. What the people who influence our decision think about the application (does the application add some benefit to the social circle, does the application add any benefit to the society) has an influence on choosing whether to use the system or not. Since the current decade has seen immense growth in the social networking platforms, how other people respond to certain technology and what they say about it is influencing our decision making. The reviews made of any product or the reputation of a company which is developing such a technology has become common decisive factors.

Facilitating Condition, another construct of UTAUT, explains how external behaviour affects the acceptance of technology. This construct defines the organizational or the technological barriers that must be taken care of to make the technology easy to use. The definition of this construct consists of three other constructs: perceived behavioral control, facilitating conditions and compatibility. Perceived behavior and facilitating condition overlap each other theoretically [2]. Compatibility is the gap between the user's personal experience and needs and facilitating condition's environmental and technical support for using the system easily. Availability of internet, electric power or type of resource on which the application is heavily dependent upon let the users decide if the technology or the system is useful to them, and if it is useful, does the environment support allows them to use it more easily.

4.2 Mapping of HCI Principles to Quality-in-Use model

Today, the major concern of the UI designers is to make such an interface which helps novice users become proficient faster without any extra cost such as training aid [20]. Novice users need a UI that is easy to use so that they can master it, and the system should be able to communicate with them by providing feedback in their language [21]. The traditional approach of HCI to interface design is good enough to follow, but in the case of mobile user interfaces, it's challenging as the number of devices and their complexity is increasing day by day.

The quality-in-use model that we adopted for this research work considers the following HCI principles: Mental model, metaphor, feedback, affordance, and visibility as the quality characteristics for mobile user interface. Quality-in-use characteristics, such as effectiveness, productivity, efficiency, error safety and cognitive load are used to analyse the effect of the HCI principle on design quality. Thus, it is important to map the HCI principles to the quality-in-use characteristics for mobile user interfaces, as per the following:

1. Mental Model to Effectiveness - UI designers must think about the knowledge that the user gains from his or her experience from the daily life. Mental model is the set of beliefs that user makes before using the system or interface. Interacting with any system at the start comes from the user's belief and therefore, while designing the system, these beliefs or experiences must count. A good perception of system or understanding should always lead to higher effectiveness, as effectiveness is measured by the number of correct actions a user did while performing a given task [36].

2. Affordance to Productivity - Spot and Identify the functionalities of the system makes the job of the user easier. Affordance is the principle quality of the system which lets the user easily identify and spot the functionality of the system. If the user is able to understand what a system can do while performing any task, it certainly decreases the total time required to complete that task. Therefore, if the affordance of the system is higher, it increases productivity [36].

3. Visibility to Efficiency - Visibility lets us identify what are the current states of the system and what operations are allowed. For example, if the user has logged into the application, according to visibility, the user should be able to see if he logged in correctly and what are all operations that can be performed. And if the interface provides a good visibility, then the user will take less time to understand the next action and will make less incorrect actions, which increases efficiency measure of quality [36].

4. Feedback to Error Safety - When interacting with any user interface, it's important that the system should respond, so that the user should know at what state the task is. Feedback is the information that a user receives as the response to any action on UI. Feedback improves the system's performance and eliminates errors in action. Applying feedback to the user interface increases safety from errors. In other words, it lets users understand errors and hence prevents them from happening [36].

5. Metaphor to Cognitive Load - Metaphor principle provides the user with simple shortcuts to the complex user interface concepts, and also provides ease to the user who does not have any prior experience or circumstances. This principle, when applied on complex UI elements, always decreases the cognitive load on users, since they don't have to think or use cognizance much [36].

4.3 Newly proposed composite model

To analyse the acceptance of the technology through quality-in-use characteristics, we combined the quality-in-use model for MUI and UTAUT model through HCI principles. The figure below (Fig. 4-6) shows UTAUT constructs which are objective, mapping them to the quality-in-use characteristics. HCI principles play a bridge role for mapping between the UTAUT constructs and quality-in-use characteristics.

Performance Expectancy – Affordance – Productivity

We have clearly discussed that Performance Expectancy of the system affects the Affordance and Affordance affects the Productivity, therefore Performance Expectancy relates to the Productivity. So, we propose that measuring Productivity, which is a quality-in-use characteristic, we can then find the Performance Expectancy as well.

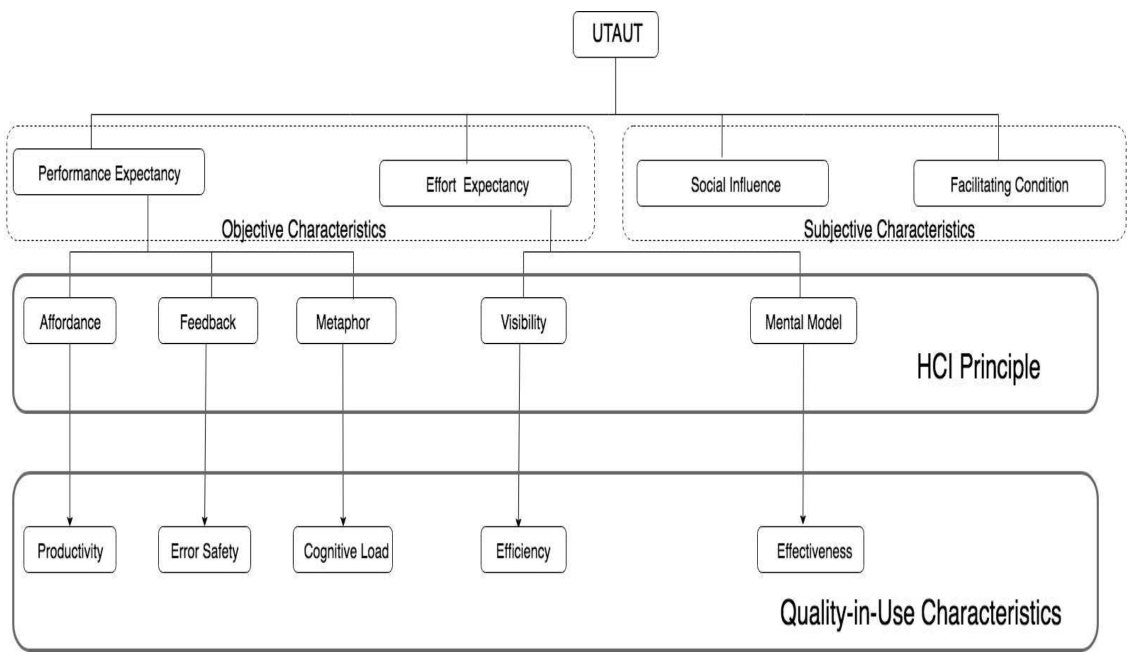


Figure 4-6 UTAUT-QiU model

Performance Expectancy – Feedback – Error Safety

We have clearly discussed that Performance Expectancy of the system affects the feedback provided by the system while interacting with it, and also provides the error safety mechanism. Therefore, Performance Expectancy relates to the error safety, which is a quality-in-use characteristic, and we can find the Performance Expectancy as well by analysing Error Safety measures.

Performance expectancy – Metaphor – Cognitive Load

As discussed in the previous section of the chapter, Metaphor affects the performance of the user and it depends on the cognitive load put on the user while performing tasks. This relates Performance Expectancy with cognitive load, meaning that, by measuring cognitive load, we can analyse the Performance Expectancy of the UI.

Quantitative assessment of Performance expectancy

In order to analyse the quantitative effect of QiU characteristics Productivity, Error Safety and Cognitive Load on performance expectancy, we propose a new performance expectancy measurement defined as follows:

$$\textbf{Performance Expectancy} = W_{\_productivity} * \textbf{Productivity} + W_{\_error\ safety} * \textbf{Error safety} + W_{\_cognitive\ load} * \textbf{Cognitive load}$$

$W_{\_*}$ represent the weights of the corresponding characteristics set to 1 by default. Users can modify the weights according to their preferences.

Effort expectancy – Visibility – Efficiency

Clearly, if the user interface provides the current state of the system and all operations that can be performed further on, then it provides ease to the user and also provides greater efficiency. Therefore, the Efficiency characteristics of the quality-in-use model let us analyse the Effort Expectancy.

Effort expectancy – Mental Model – Effectiveness

Mental model affects the effectiveness of the interface because the user can relate the UI with its previous experiences or may guess work and, as such, it provides ease in doing tasks. This relates Effort Expectancy to the Effectiveness of the user interface.

Quantitative assessment of Effort expectancy

Similarly, to analyse the quantitative effect of these characteristics on effort expectancy, a new effort expectancy measurement formula is defined as follows:

$$\textbf{Effort Expectancy} = W_{\_effectiveness} * \textbf{Effectiveness} + W_{\_efficiency} * \textbf{Efficiency}$$

Again, W_* represents the weight of the corresponding characteristic and is set to 1 by default. Users can modify the weights according to their preferences.

Summary

In this chapter, we presented a new technology's acceptance model UTAUT-QiU, which integrates the quality-in-use characteristics with UTAUT constructs through HCI principles. UTAUT constructs are categorised into objective and subjective characteristics. Performance Expectancy and Effort Expectancy are incorporated into objective characteristics and then mapped to HCI principles. Mapping of HCI and quality characteristics is adopted from the work done by the doctoral student Reem Alnanih under the supervision of Dr. Olga Ormandjieva [1]. Finally, a relation between HCI principles, quality characteristics and UTAUT constructs is created. The idea behind creating this new composite model is to create such a model which assesses the usability of the UI as well as the technology acceptance using the measurements of quality characteristics.

In the next chapter we explain the empirical study that we performed on low fidelity prototype, an Android application called MedPro. We assess the usability and technology acceptance for text-free user interface on this prototype using our new acceptance model UTAUT-QiU.

Chapter 5. Empirical Study and Results

In this chapter of the thesis, we investigate the effect of applying HCI principles to the design of text-free user interfaces through a controlled experiment and evaluating its acceptance using UTAUT-QiU model (see Chapter 4) for both versions of the MedPro application (v1 and v2).

We assess our composite model through a carefully controlled experiment in a real time environment, taking the context of two types of users: low-literate and post-literate. The chapter is organized as follows:

Section 5.1 introduces the hypotheses to be assessed in this controlled experiment, Section 5.2 describes the controlled experiment on Android Application MedPro v1, Section 5.3 presents the second controlled experiment on Android Application MedPro v2, Section 5.4 summarizes the usability testing material, Section 5.5 explains data collection procedures, Section 5.6 discusses results, 5.7 tackles the result of the analysis of social influence and facilitating condition

5.1 Hypotheses

5.1.1 Hypotheses for quality characteristics (Objective characteristics)

To empirically investigate the effect of Text free user interface on the MedPro applications used by different participants in the same context, we formulate the following pairs of hypotheses:

HYP1^0: there is no significant difference between effectiveness of MedPro v1 and effectiveness of MedPro v2.

HYP1^a: there is a significant difference between effectiveness of MedPro v1 and effectiveness of MedPro v2.

HYP2^0: there is no significant difference between productivity of MedPro v1 and productivity of MedPro v2.

HYP2^a: there is a significant difference between productivity of MedPro v1 and productivity of MedPro v2.

HYP3^0: there is no significant difference between efficiency of MedPro v1 and efficiency of MedPro v2.
HYP3^a: there is a significant difference between efficiency of MedPro v1 and efficiency of MedPro v2.

HYP4^0: there is no significant difference between error safety of MedPro v1 and error safety of MedPro v2.
HYP4^a: there is a significant difference between error safety of MedPro v1 and error safety of MedPro v2.

HYP5^0: there is no significant difference between cognitive load of MedPro v1 and cognitive load of MedPro v2.
HYP5^a: there is a significant difference between cognitive load of MedPro v1 and cognitive load of MedPro v2.

5.1.2 Hypotheses for UATUT constructs (Objective characteristics)

HYP6^0: there is no significant difference between performance expectancy of MedPro v1 and performance expectancy of MedPro v2.
HYP6^a: there is a significant difference between performance expectancy of MedPro v1 and performance expectancy of MedPro v2

HYP7^0: there is no significant difference between effort expectancy of MedPro v1 and performance expectancy of MedPro v2.
HYP7^a: there is a significant difference between effort expectancy of MedPro v1 and performance expectancy of MedPro v2.

5.1.3 Hypotheses for UATUT constructs (Subjective characteristics)

HYP8^0: Less than 50% people will suggest text free UI to friend and family

HYP8^a: More than 50% people will suggest the text free UI to friend and family

HYP9^0: Less than 50% people agree that this kind of application will add something to their image towards friends and family

HYP9^a: More than 50% people agree that this kind of application will add something to their image towards friends and family

HYP10^0: Less than 50% people agree that their smartphone have software and hardware capabilities to support this application

HYP10^a: More than 50% people agree that their smartphone have software and hardware capabilities to support this application

HYP11^0: Less than 50% people agree voice-based navigation will make the application easy

HYP11^a: No More than 50% people agree voice-based navigation will make the application easy

5.2 Controlled experiment on MedPro v1 Application

A controlled experiment can be defined as the investigation of testable hypothesis in which one or more independent variables are manipulated to measure their effect on one or more dependent variables. A controlled experiment must be planned in advance, and it allows us to define the terms how the variable is related to each other, specifically to determine if there is cause-effect relationship exists between them. Each combination of values of the independent variable is called a treatment [37]. In most software engineering experiments, human subjects are required to perform some task and the effect of the treatments on the subjects is measured.

In this thesis, we focus primarily on controlled experiments. We have chosen to apply this method here for the following reasons:

1. Our investigation is planned, and not retrospective.
2. The treatments that we propose have not been applied previously.
3. The level of replication in our study is high, since we conducted the same test many times, with different UIs, and different types of users.
4. A limited number of participants took part, and they were carefully controlled.
5. We had a high level of control over the variables that could affect the outcome.

In the next section we will be discussing how the independent variables effected the dependent variables which are the quality-in-use characteristics.

5.2.1 Description of MedPro application

This prototype aims to use emerging mobile technology to assist low-literate patients in self-managing their health care and achieving success in reaching self-selected health goals. The core concept of the proposed prototype is the ability of patients and caregivers to listen to narratives on a given health condition or topic and to record their own. The application offers three types of functionality, 1. It gives the narration about the application using voice, 2. Its asks user set of questions and record their response as a story of user, 3. It allows users to listen to the story of another person. The basic proposition is that patients can benefit from listening to other patients' experiences and, by putting their personal experience in, they gain greater self-awareness of their own situation. Keeping low-literacy population as the target user for this application, we propose a text-free user interface, which will put a lower cognitive load on such users of the application. Thus, the prototype can be considered similar to an online patient forum or patient advocacy group, with the significant differences that communication takes place in a spoken rather than written form, and that the service design assumes a low-literate, non-computer savvy user population, hence making it accessible to a broader community.

This prototype aims to assess two needs. The patients will be encouraged to share their own experience via mobile applications. Thus, the first need assessment is concerned with adapting mobile technology for the specific needs of low-literate patients with chronic diseases; the adaptation will ensure that the application is easily accessible to all. The second need is to test if the text-free user interface will have greater usability and assess the acceptance of such interface among low-literate people. For this the reason, we intend to make the MedPro application text-free by using voice for feedback and navigation, and symbols for the buttons which functionality should be easy to understand or figure out by users. Currently, the application is supporting one language but contains flexibility to add-on various languages in the future.

5.2.2 User Selection Methodology and Task Description

To formulate our investigation, people suffering from chronic diseases were chosen and were divided into two groups based on their age which are:

1. 25-40 years (Group 1)
2. 40 years and above (Group 2)

A total of 10 participants were selected in the controlled experiment on MedPro v1 application, five in each group. Participants were selected based on the chronic disease condition that they are having, more specifically diabetes for our study. The study participants were from both low literate and post literate as we did this experiment in India, which is a developing country. For low literate we choose people who do not use English as their primary language in daily life. And for post literate we choose the people who are young and in their work environment English was primary language for communication.

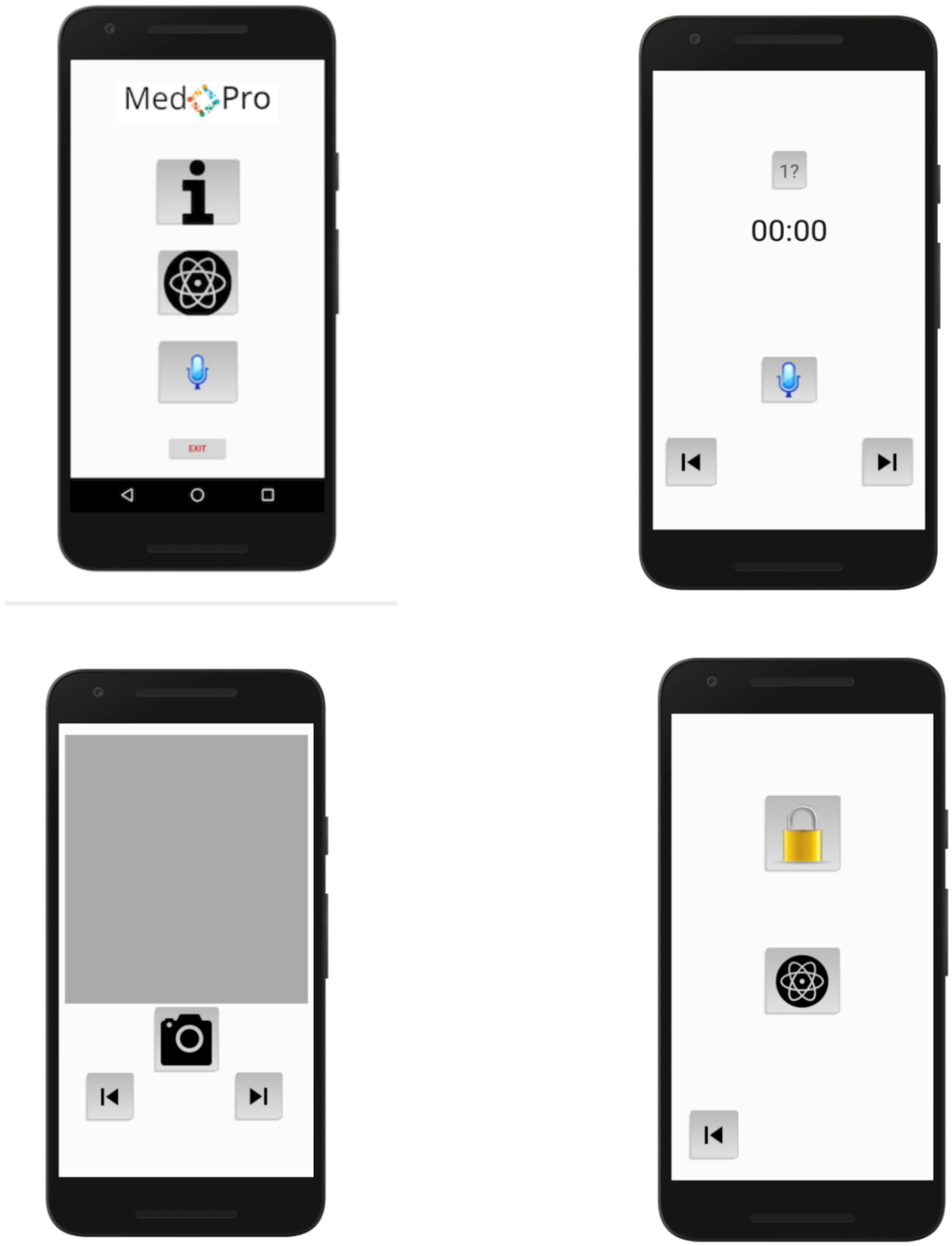


Figure 5- 1 User interface of MedPro v1 application (Task steps)

Task List

Two essential features of the prototype were selected as the tasks for this experiment in terms to evaluate quality in use of the user interface.

Task 1: Using the application to tell your experience with diabetes. Record story

Task 2: Listen to the story of other people with diabetes from the library

Table 5 - 1 MedPro v1 application usability testing task

Tasks	MUI Features	Task Functionality	Task Type
Using the application to tell your experience with diabetes. Record story	Click, Record	Select, Click	Input information via voice
Listen to story of other people with diabetes from library	Click	Click, Listen Story	Read the output via voice

5.3 Controlled experiment on MedPro V2 Application

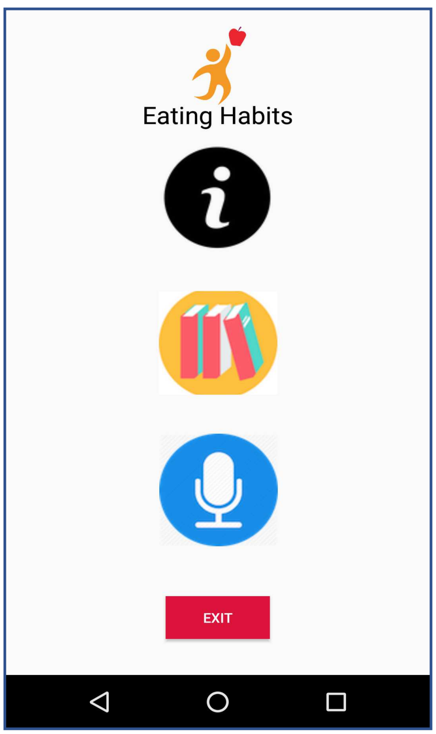
After getting results and feedback from the last experiment, MedPro Application was modified, and some functionalities were added to improve the application's usability. The changes to be done were based on the principle of quality-in-use and UTAUT composites. The following changes were made:

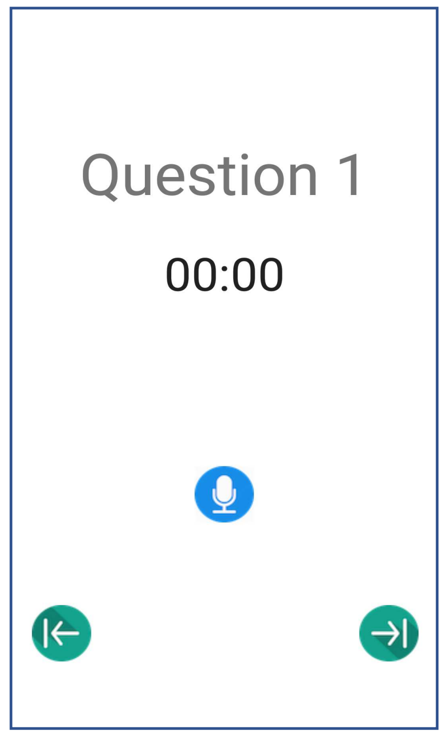
Table 5 - 2 UI changes in MedPro v2 application

Changes	Quality in Use Characteristics	UTAUT
Timeout – when the first-time application plays question and user does not listen or do nothing after 6 seconds it will again play the question	Error Safety, Effectiveness, Efficiency	Performance Expectancy and Effort Expectancy
Addition of the soundwave and only single stop button while recording	Cognitive load	Performance Expectancy
Making the buttons more colorful to differentiate between buttons and action more effectively	Error Safety, Cognitive Load	Performance Expectancy

5.3.1 User Selection Methodology and Task Description

With the improved version of the MedPro application, this time we changed the scenarios and tested over the eating habits of people in Concordia University. To experiment with the prototype, ten people were asked to perform the two tasks to analyze the effect of the changes made to the application.





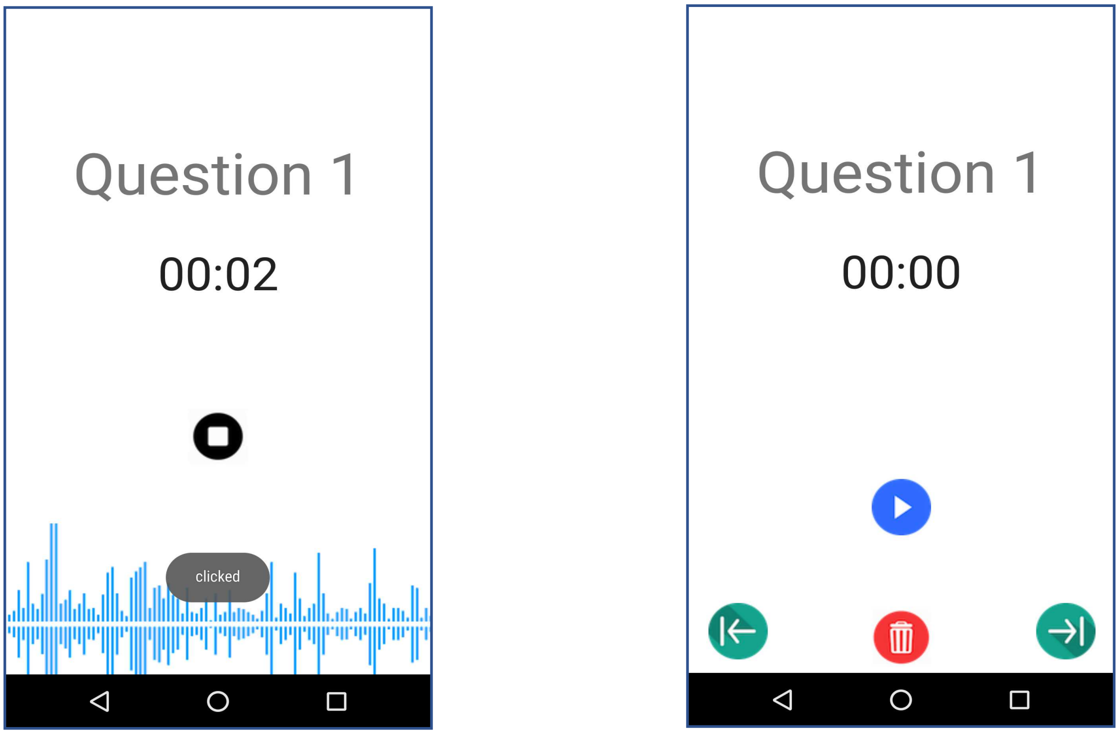


Figure 5- 2 Updated UI of MedPro v2 application

Task List

In order to do comparable analysis of the usability of the application, this experiment choose same kind of task as done by MedPro which are –

Task 1: Using the application tell about your eating habits in daily life.

Task 2: Listen to the eating habits of other person by playing recorded answers from library.

Table 5 - 3 Tasks for MedPro v2 application

Tasks	**MUI Features**	**Task Functionality**	**Task Type**
Using the application tell about your eating habits in daily life.	Click, Record, Timeout	Select, Click	Input information via voice

Listen to the eating habits of other person by playing recorded answers from library.	Click	Click, Listen Story	Read the output via voice

In the following section, we investigate the effect of applying HCI principles to the design of text-free user interface through a controlled experiment using UTAUT-QiU model for both versions of the MedPro application.

5.3.2 Usability Testing of MedPro v1 and MedPro v2

The empirical study discussed in this section covers the usability testing of two versions of the MedPro application.

The usability testing was conducted on two different occasions (summer 2017 and summer 2018) with two different groups of people, in order to verify the effect of text-free user interface design on the objective quality characteristics (effectiveness, productivity, efficiency, error safety, and cognitive load), using the UTAUT-QiU model. We implemented the changes given in Table 5-4 and created MedPro v2, based on the MedPro v1 usability tests' feedback.

Table 5 - 4 UI changes for MedPro v2 application

Changes	Quality in Use Characteristics	HCI Principles
Timeout – when the first-time application plays question and user does not listen or do nothing after 6 seconds it will again play the question	Error Safety, Effectiveness, Efficiency	Feedback, Mental Model, Visibility
Addition of the soundwave and only single stop button while recording	Cognitive load	Metaphor

Making the buttons more colorful to differentiate between buttons and action more effectively	Error Safety, Cognitive Load	Feedback, Metaphor

Since the text-free UI is the new approach for UI and while performing the usability testing for MedPro v1, most of the time, when users did not understand the question at the very first instance, it was very hard for them to find out how they can listen to the question once again. Also, when the user was idle for some time while performing a task, the application was doing nothing. To solve this problem, we applied Visibility, Mental Model and Feedback HCI principles. We adopted the solution of automatically playing the same question again after 6 seconds, which implements the Feedback HCI principle.

Second feedback from the participants was a confusing presence of next and *previous* buttons while recording their story. To solve this problem, we applied Metaphor HCI principle and reduced to only one *stop* button while recording. Also, we added a gif that shows the progress of the recording to provide real time feedback to the participants.

In addition, all buttons had the same (black) color, which increased the cognitive load on the participants. To address this issue, we applied Metaphor and Feedback HCI principles and changed the color of the button to a more colourful one.

For both usability tests, the application was deployed on Moto G4 mobile phones with Android 7.0 Operating System.

The MedPro v1 (the first version of the application) usability test was conducted in a park's cultural hall (due to the subject of context) with minimum background noise. For MedPro v2, the test was conducted at the Concordia University's lab with minimum background noise. For both versions of the applications, the participants were asked to do the same type of tasks involving basic functionality of the application. The following Figure 5-3 shows the test environment which includes the participants, Android phones, and the experimenter.

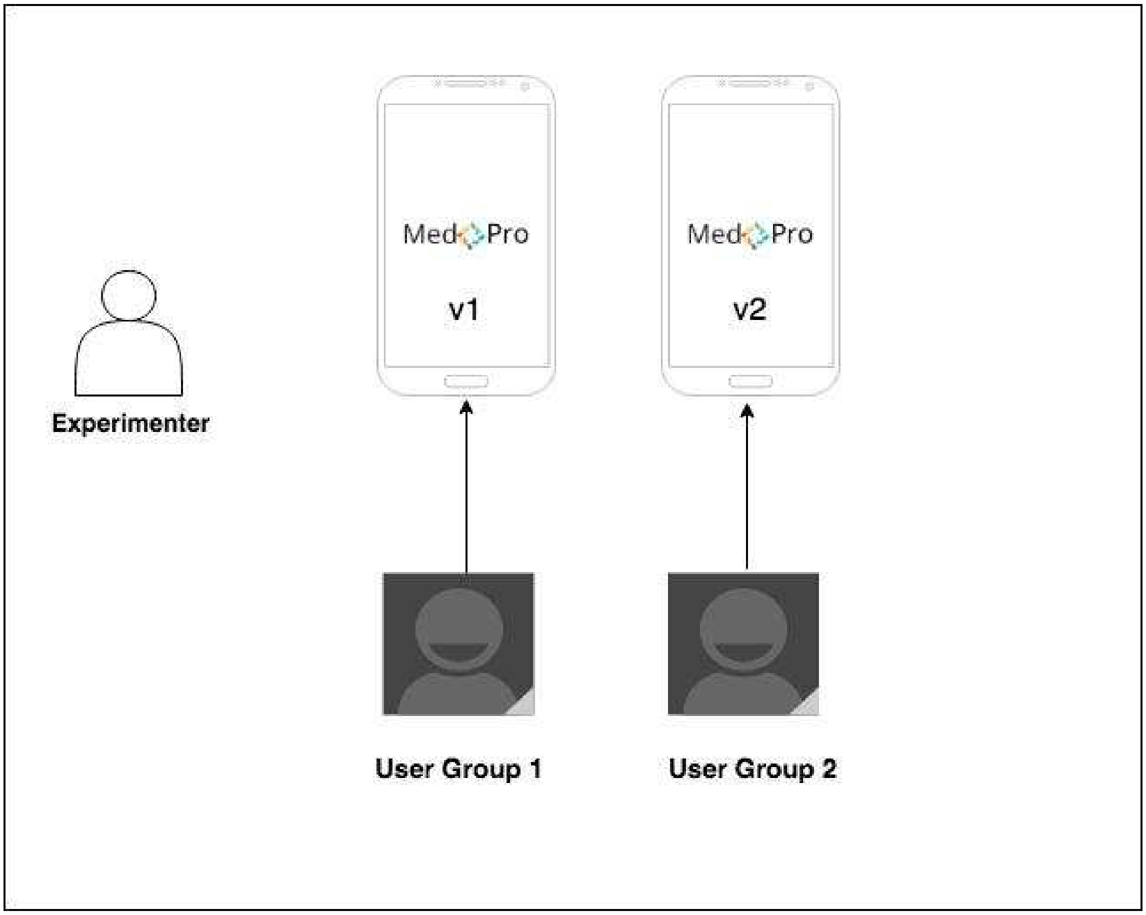


Figure 5- 3 Usability test environment

5.4 Usability Testing Material

Before conducting the usability test for MedPro v1 and MedPro v2, a checklist of materials which will be used during the empirical study was prepared following the suggestion by Dumas and Redish [35]. The materials are the following:

- The two tasks that will be given to each participant in the usability test. These tasks are the two-basic functionality of the application which is shown in Table 5-5.

Table 5 - 5 List of participant task

	Task for MedPro v1(Context - Diabetic patient)
1	Using the application to tell your experience with diabetes. Record story

2	Listen to story of other people with diabetes from library

	Task for MedPro v2(Context – Eating habit)
1	Using the application to tell your Eating habits. Record story
2	Listen to story of other people's eating habit from library

- A paper-based form was used to record the quantitative measurement required to analyze the result of Quality-in-Use. Here is the list of quantitative measurements that were recorded during the test –

Table 5 - 6 List of quantitative measurements

Quantitative measurements
number of actions(click) performed
number of incorrect actions
number of screen views
time taken to complete each task

- A post-test questionnaire was given to analyze the subjective characteristics and Social Influence and Facilitating Condition of UTAUT.
- A feedback form to provide additional comments about the applications

5.5 Data Collection

For this usability test, we used two different data collection methods which are: observation and interview. The observation method was used to record the participant's movements in the application while performing tasks, whereas the interview method included a list of questions based on the Likert scale for subjective characteristics to collect responses to analyze the Social Influence and Facilitating Condition construct of the UATUT-QiU model.

5.6 Results

5.6.1 Analysis of quality characteristics (Objective characteristics)

To analyze the objective characteristics of UTAUT-QiU: Effectiveness, productivity, efficiency, error safety and cognitive load, measurement data were collected during the usability tests performed with 10 people. All 10 people were asked to complete two basic tasks of the application on MedPro v1 and MedPro v2, on different occasions.
Raw data for this empirical study was tabulated in the excel sheet for each participant. Using the formula given in Table 5-7, we calculated the quality characteristics value for each participants and calculated mean.

Table 5 - 7 Quality-in-Use measurement formula

Quality Characteristics	Quality Measure	Measurement Function
Effectiveness	Task completion ratio	= A/(C+X)
Productivity	Task productivity	= C/T
Efficiency	Cost Efficiency	= ((A/(C+X))/T
Error Safety	Error free task completion	= 1-(X/(C+X))
Cognitive Load	Task navigation	= V/(C+X)

A= minimum number of correct actions

C= number of correct actions

X= number of incorrect actions

T= Total time taken to complete the task

V= number of screen viewed in completing the task

We compared the mean of all the quality-in-use measurement data collected for all participants for both versions of the application (See Table 5-8 & Figure 5-4).

Calculated data clearly shows an improvement for MedPro v2 compared to MedPro v1 in effectiveness and error safety characteristics. This comparison shows that MedPro v2 is more effective than MedPro v1, which clearly indicates that the "timeout feature" and the changes made in navigation let the users perform the tasks more effectively.
Error safety is also comparatively higher for MedPro v2, which shows that error handling is better when buttons are more visible and relevant to the daily use items. Also, the timeout feature which let the user re-listen to questions after a certain time interval has also reduced the error rate.

Efficiency and productivity characteristics involve the time component, so when users performed tasks on MedPro v2, users were more talkative and took more time to record their story as compared to MedPro v1 where the context of the application was diabetes and participants were more sophisticated in their responses; this is why these two features show the big drop. This drop indicates that UI changes in the MedPro v2 decreases productivity. Hence, a better navigational prompt or maybe a clear prompt improves that feature.
Since cognitive load shows a very small improvement, which we can say virtually amounts to the same, and shows that there is no extra effort needed by the user to understand functionality, also the UI with voice used as input and output makes it easier to understand the task. This is a very important aspect when the post-literate and low-literate population is concerned.

Table 5 - 8 Quality-in-Use characteristics measures

	Effectiveness	**Productivity**	**Efficiency**	**Error Safety**	**Cognitive Load**
MedPro v1	0.82	0.11	0.10	0.80	0.88
MedPro v2	0.94	0.05	0.005	0.94	0.91

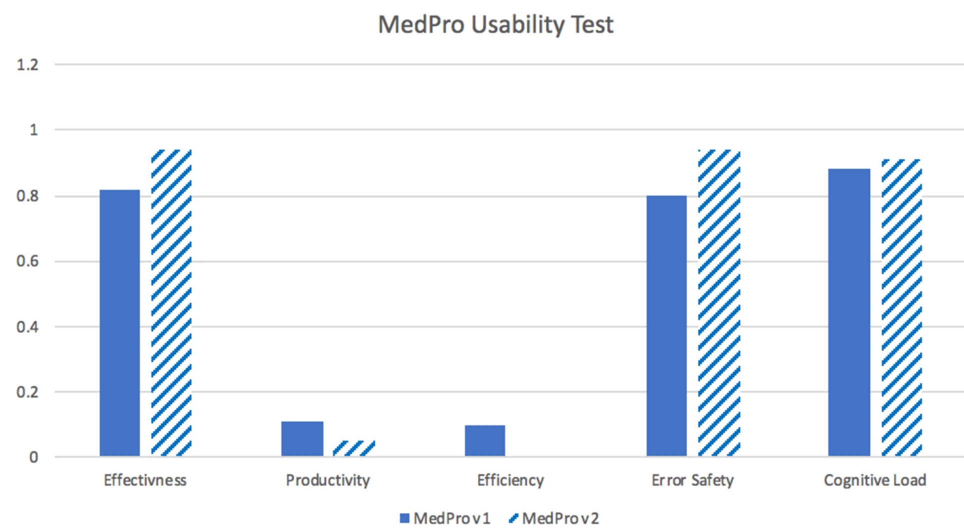


Figure 5- 4 Comparison graph for MedPro v1 vs MedPro v2

Normality Test

Before testing the significance difference between two samples and perform t-test, we did normality test of data. We performed Shapiro-Wilk test and Kolmogorov-Smirnov test to check if sample data are normally distributed. From the figure 5-5 we can see that significance value for each quality characteristics is higher than 0.05(at significance level p=0.05), so we can conclude that the data are normally distributed.

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Effectiveness_v1	.181	10	.200*	.933	10	.479
Effectiveness_v2	.206	10	.200*	.877	10	.120
Productivity_v1	.175	10	.200*	.913	10	.302
Productivity_v2	.143	10	.200*	.964	10	.827
Efficiency_v1	.431	10	.000	.519	10	.000
Efficiency_v2	.149	10	.200*	.960	10	.789
ErrorSafety_v1	.114	10	.200*	.940	10	.551
ErrorSafety_v2	.206	10	.200*	.877	10	.120
CognitiveLoad_v1	.120	10	.200*	.968	10	.873
CognitiveLoad_v2	.148	10	.200*	.909	10	.273

Figure 5- 5 Normality test result

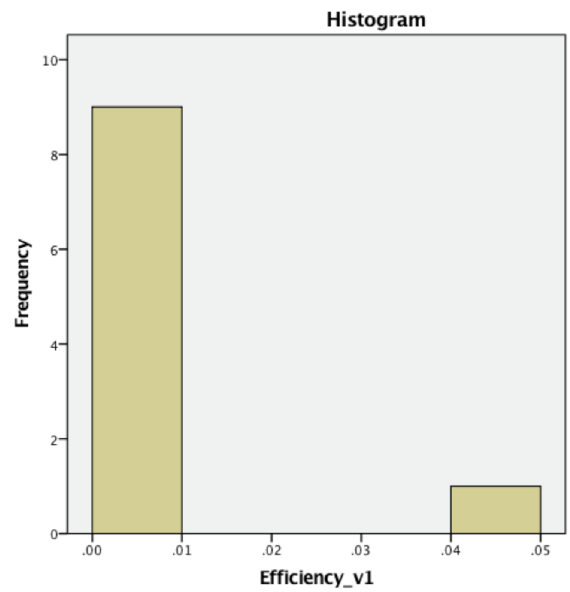


Figure 5- 6 Histogram for efficiency_v1

For Efficiency_v1 the significance value for S-W test (Shapiro-Wilk) is lower than 0.05 but looking at histogram (since sample size is small so hard to get complete curve) in figure 5- 6 and other pair of this quality characteristics efficiency_v2 is normally distributed. Thus, we can conclude this also to be normally distributed and can perform t-test on this pair.

From the above discussion we can see that data is normally distributed, so we can perform the t-test to test the significance of the two samples.

Hypotheses for each quality-in-use characteristic are assessed in order to investigate the statistical significance of the recorded difference between MedPro v1's and MedPro v2's objective quality characteristics of UTAUT-QiU (effectiveness, productivity, efficiency, error safety and cognitive load). Since we have two versions of the same application and context in terms of task and functionality (MedPro v1 and MedPro v2), then we can pair the two samples. The two groups of participants that tested the two versions of the application are different, thus we can use the paired two-tailed t-test with an independent variable to analyze the data. In order to test the validity of the hypotheses, we selected α= 0.05 for the two-tailed test. Our decision rule is to use the test's p-value to accept the hypothesis if the calculated p-value is higher than α (in this case α is 0.05) and reject it if it's lower than α. The Table 5-8 shows all t-Test and P-value for each quality characteristic to be valid statistically. Since we have used paired test with the independent variable and unequal variance, therefore the degree of freedom varies for quality characteristics (for all calculation of t-test, we have used Microsoft Excel data analysis domain)

Table 5 - 9 Paired t-Test and P-values for all quality characteristics

	Effectiveness	Productivity	Efficiency	Error Safety	Cognitive Load
t-statistic	| -2.84 |	| 4.77 |	| 1.43 |	| -3.45 |	| -0.311 |
t-critical	2.17	2.26	2.26	2.17	2.20
P-value	0.014	0.001	0.18	0.004	0.76
df	12	9	9	12	11

From table 5-9 we can see that t-statistic results for effectiveness is 2.84 (taking absolute value) and is higher than t-critical for the degree of freedom 12. Also, the p-value is lower than the α value, therefore we can reject the null hypothesis (**$HYP1^0$**) and accept the alternate hypothesis (**$HYP1^a$**) which concludes that there is a significant difference in the effectiveness of MedPro v1 and MedPro v2. Productivity show higher value for t-statistics, 4.77 and is higher than the t-critical, therefore we cannot accept the null hypothesis (**$HYP2^0$**). The p-values, 0.001 for productivity, are lower than the α (0.05), which means that we cannot accept the null hypothesis (**$HYP2^0$**). and accept the alternate hypotheses (**$HYP2^a$**). This concludes that there is a significant difference in Productivity for both versions of MedPro. Efficiency and cognitive both show lower value for t-statistics, 1.43 and 0.311 respectively. Both are lower than the t-critical, therefore we can accept the null hypothesis (**$HYP3^0$** and **$HYP5^0$**). The p-values, 0.18 and 0.76 for both characteristics, are higher than the α(0.05), which means that we can accept the null hypothesis (**$HYP2^0$** and **$HYP3^0$**). This concludes that there is a no significant difference in Efficiency and Cognitive Load for both versions of MedPro.

Since the t-test values obtained for error safety is 3.45 (considering absolute value), which is higher than the t-critical value, hence we can reject the null hypotheses (**HYP4^0**). Also, the p-value for error safety is lower than α (0.05). Therefore, we can reject the null hypothesis and accept alternate hypothesis (**HYP4^a**). Our conclusion is that there is significant difference between MedPro v1 and MedPro v2 for error safety.

5.6.2 Analysis of UTAUT characteristics (Objective)

From the section 5.6.1, we can see that null hypothesis is rejected for productivity. Also, from the Table 5-8, we see that productivity goes lower in the second version of the application, because the time taken by each user to complete the task is higher. Time is higher because context of use and users were of different age groups. On the other hand, we see that error safety rejects null hypothesis and for cognitive load we accept the null hypothesis. If we look at the relation of error safety, cognitive load and productivity with UTAUT construct (see chapter 4.3), these are directly proportional to performance expectancy and two out of three characteristics rejects null hypothesis so using this relation we can reject the null hypothesis **HYP6^0** and accept **HYP6^a** conclude that there is significant difference for performance expectancy in both versions of MedPro. Also, to analyse the quantitative effect of these characteristics on performance expectancy, performance expectancy we measured it as follows (see also section 4.3):

$$\textbf{Performance Expectancy} = W_{\_productivity} * \textbf{Productivity} + W_{\_error\ safety} * \textbf{Error safety} + W_{\_cognitive\ load} * \textbf{Cognitive load}$$

where $W_{\_*}$ are set to 1.

Table 5 - 10 Weighted Sum of Performance Expectancy

	MedPro v1	**MedPro v2**
Performance Expectancy	1.79	1.90

As we can see from the table 5-10 that performance expectancy of the MedPro v2 is higher than MedPro v1, so we can conclude that performance expectancy improved in the MedPro v2.

For effectiveness quality characteristic, the null hypothesis is rejected whereas for efficiency the null hypothesis is accepted. As in the proposed UTAUT-QiU model, we see that these two characteristics are proportional to effort expectancy. Using this relation, we can reject the null hypothesis for effort expectancy and accept the **HYP7[a]**. Also, looking at the Table 5-8, we notice that effectiveness has improved a lot in the later version of the application. Certainly, the efficiency has gone down because of the time component in the calculation, which is higher because of voice based navigation and context of application. Overall, looking at these two characteristics, we can see that effort expectancy has enhanced for this text-free UI. Similarly, to analyse the quantitative effect of these characteristics on effort expectancy, we measured effort expectancy as follows (see also section 4.3):

$$\textbf{Effort Expectancy} = \textbf{W}_{\_effectiveness} * \textbf{Effectiveness} + \textbf{W}_{\_efficiency} * \textbf{Efficiency}$$

where $W_{\_*}=1$.

Table 5 - 11 Weighted Sum of Effort Expectancy

	MedPro v1	**MedPro v2**
Effort Expectancy	0.92	0.94

Table 5-11 shows that effort expectancy of MedPro v2 shows small improvement than MedPro v1, this conclude that adapting UTAUT-QiU improves the acceptance of technology.

5.7 Analysis of Social influence and Facilitating Condition

In order to make a conclusion based on the UTAUT-QiU model for adaptability of the application, we also need to analyze two other constructs which are: Social Influence and

Facilitating Condition. As previously discussed, these two constructs are external factors and cannot be analyzed with quality characteristics measurements. To analyze these features, we created a post-questionnaire based on the standard definition of social influence and facilitating condition. Furthermore, the UTAUT model was introduced later in the research, therefore testing these two features for MedPro v1 was not possible and so we asked only MedPro v2's participants the following questions based on Likert Scale:

Question 1. Will you suggest this text-free UI to your friends and family?
Question 2. Do you agree that using this kind of application with such UI will add something to your image towards your friends and family?

Each question had three options: "Yes", "No" and "Maybe". Graph (Fig 5-7) shows the responses to question 1 on social influence, and results reveal that 60% of the application's users will suggest this application or this type of UI to their friends and family. We also see that there are not many, but few users who think that suggesting this kind of UI to the people in their circle is not a good idea.

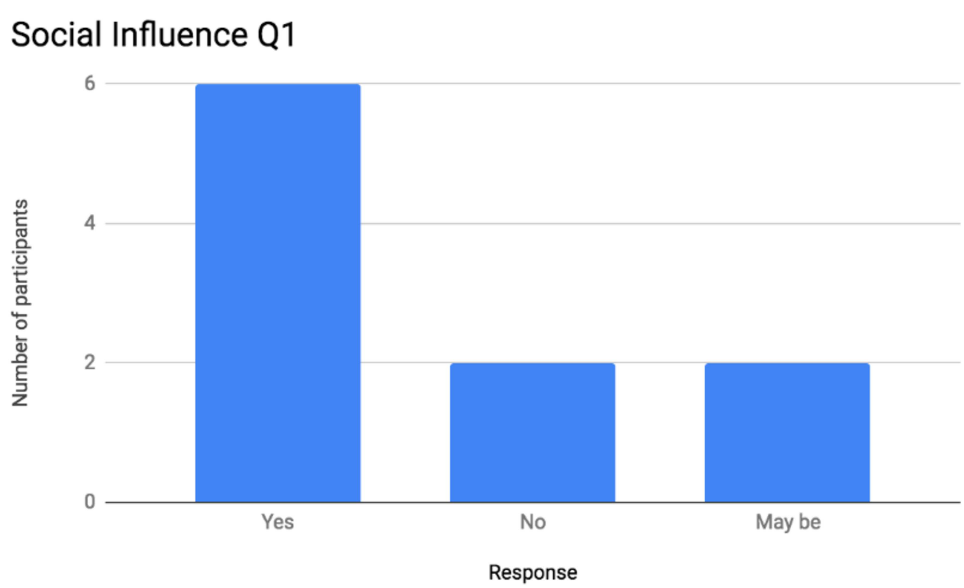


Figure 5- 7 Social influence Q1 response

Binomial Test

		Category	N	Observed Prop.	Test Prop.	Exact Sig. (2-tailed)
Response	Group 1	Yes	6	.60	.50	.754
	Group 2	No	4	.40		
	Total		10	1.00		

Figure 5- 8 Social influence Q1 binomial test result

We performed binomial tests on the sample of 10 users for α=0.05 and, as stated in the hypothesis (see section 5.1.3), the test proportion was set to 50%. For question 1, the observed proportion (in Fig 5-8) for "Yes" response is 60%, which is higher than the expected proportion (50%). Also, the p value obtained is 0.754, which is higher than α, therefore we can reject the null hypothesis (**HYP8^0**) and can conclude that more than 50% of users have influence of the text-free UI and will suggest it to their family and friends.

Graph (Fig 5-9) shows the responses to question 2 on social influence, and the responses depict the picture of the current work environment and adoption of voice-based services in daily life. As we can see, the number of responses for "Yes" is equal to 50% and shows that voice-based services are being adopted by users and that using this kind of user interface will add some value to their image at the workplace.

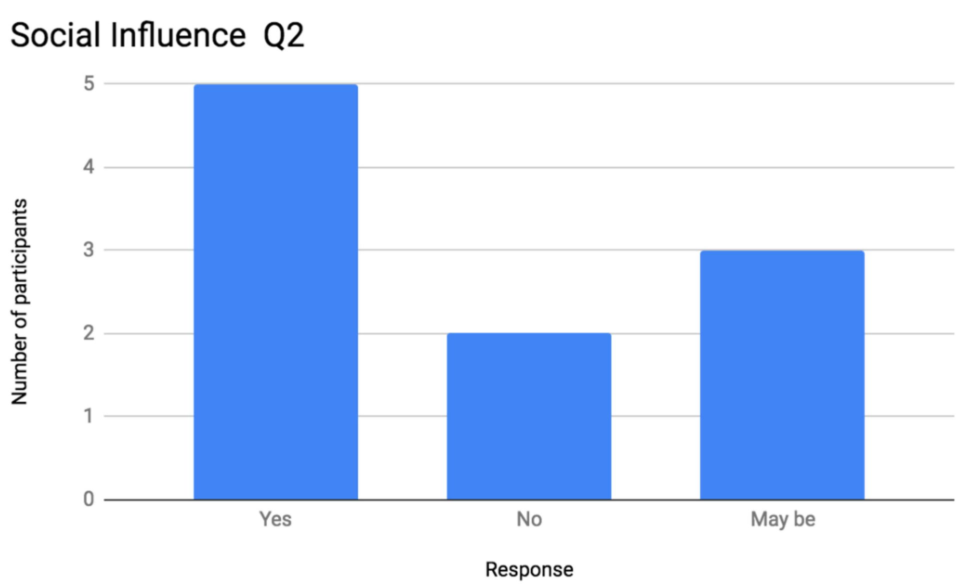


Figure 5- 9 Social influence Q2 response

Binomial Test

		Category	N	Observed Prop.	Test Prop.	Exact Sig. (2-tailed)
Response	Group 1	Yes	5	.50	.50	1.000
	Group 2	No	5	.50		
	Total		10	1.00		

Figure 5- 10 Social influence Q2 binomial test result

For question 2, the observed proportion for response "Yes" is 50%, which is equal to the expected proportion. Also, the p value is much higher than the α value. So, in this case also, we can reject the null hypothesis (**HYP9^{0}**). This concludes that using this text-free UI will add some value to the users' image in their social life.

To understand the Facilitating Condition parameter of UTAUT,

Question 1. Does your smartphone have good voice quality or is it equipped with voice functionality in order to support this application's features?

Question 2. Does voice-based navigation make working with the application easy?

The responses received from the post-questionnaire show that the facilities and environment required for adoption of such voice-based UI are available. Responses to question 1 on facilitating condition show that everyone had a smartphone with good voice quality, which is the primary requirement for using such a UI.

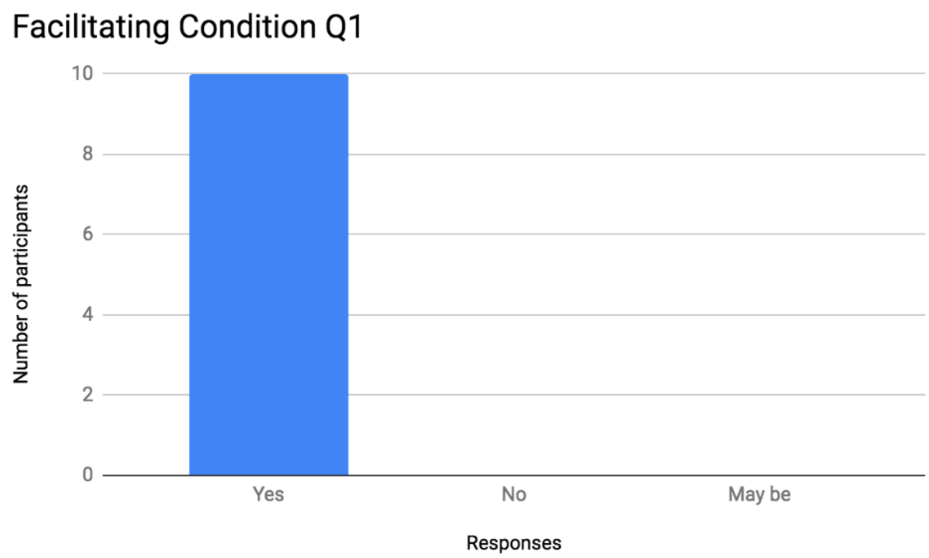


Figure 5- 11 Facilitating condition Q1 response

Binomial Test

		Category	N	Observed Prop.	Test Prop.	Exact Sig. (2-tailed)
Response	Group 1	Yes	10	1.00	.50	.002
	Total		10	1.00		

Figure 5- 12 Facilitating Condition Q1 binomial test result

In order to validate the hypotheses for the facilitating condition, binomial tests with a sample of 10 and $\alpha=0.05$ were performed. As seen in Figure 5-12, the observed proportion for the response "Yes" is 100%, which is higher than the expected proportion set to 50%. Since the observed proportion is 100% and the p value is so small, which is smaller than the α value, we can therefore reject the null hypothesis. But from the observed responses which is 100%, states that all the people have hardware and software required for the application and accept the alternate hypothesis (**HYP10[a]**).

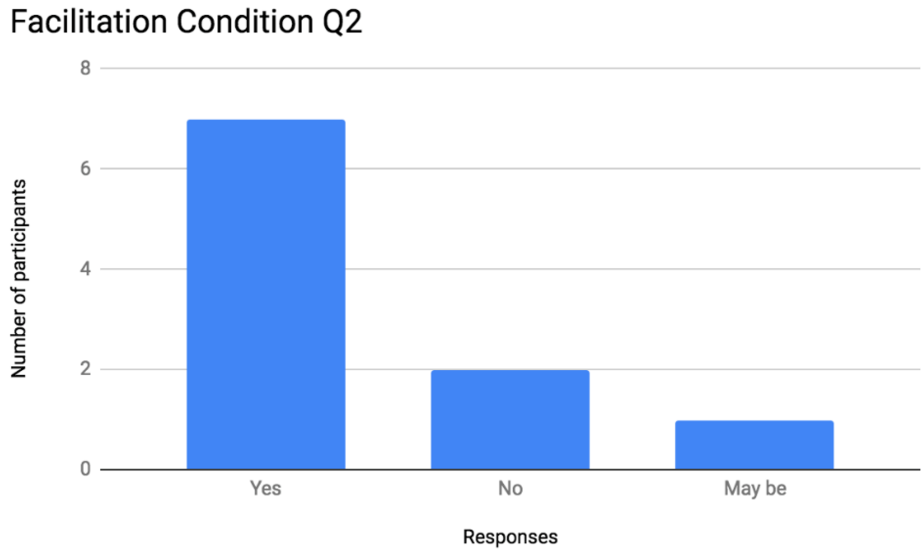


Figure 5- 13 Facilitating Condition Q2 response

Binomial Test

		Category	N	Observed Prop.	Test Prop.	Exact Sig. (2-tailed)
Response	Group 1	Yes	7	.70	.50	.344
	Group 2	No	3	.30		
	Total		10	1.00		

Figure 5- 14 Facilitating Condition Q2 binomial test result

Also, for question 2, Figure 5-14 shows that the observed proportion (70%) is quite higher than the expected one. And p value is higher than α=0.05, therefore we can reject the null hypothesis (**HYP11^{0}**) and can conclude that most users believed that voice-based navigation will make the application easier for them.

Threats to validity: A study can provide the misleading results in several ways. Wohlin [29] describes the following four categories of threats to validity:

1. Conclusion validity - In this controlled experiment, the primary goal was to find out how well the text-free user interface is adopted and does the changes made to later version of the application improves its adoption. To analyze the adoption, we performed Student t-test among the result of two usability tests. Results confirm

that later version of the application performed better and adopted, which confirms the closeness of the behavior with two variables.

2. Construct validity - We measured performance expectancy and effort expectancy using the quality measures, and results show that the two tests have different measures and later version performs better. In this research, we intended to test if assessing technology acceptance using UTAUT-QiU model will improve the adoption, and results prove that there is a significant improvement.
3. Internal validity - According to Fenton & Bieman [30], the study has internal validity if the experiment caused the effect shown in dependent variables. Independent variable can be manipulated to affect the outcome of the experiment which means it affects the dependent variable. In this research, the result is supported by the dependent variable, and both usability test shows that it's changing by altering independent variable.
4. External validity - The controlled experiment was performed with the user having the smartphone. So, the result can be generalized as anyone working with the smartphone.

Summary

Our goal of this chapter was to propose a text free UI approach for smartphone applications which has been evaluated empirically on the MedPro application (Android Application). The result of our research shows that the adoption of text free UI can be improved using the UTAUT-QIU model. By choosing the text free UI for low and post-literate users will have following benefits: i) it will solve the problem of reading text for low literate by a voice-based service in the application. ii) Voice-Based navigation will help post-literate users in understanding functionality and interacting with that.

From the usability test result, we conclude the following: first, the proposed text free UI in mobile applications is mostly accepted and can be useful. Low-literate people who have a problem with reading the text or understanding text in complex animated UI will have ease in using the system when input and output services are available as a voice in the mobile application. Second technological acceptance of text free UI is higher with some set of guidelines following the HCI principles such as Visibility, Mental model, Feedback and Metaphor. Social influence affects people's mind in adopting such new approach and making awareness in the society about technology. Also, there is enough supporting facilitating condition available today with smart devices which enables these kinds of UI approach ready to use.

Chapter 6. Conclusions and Future Work

In this thesis, we proposed UTAUT-QiU as a new model to evaluate the technology acceptance by integrating UTAUT and Quality-in-Use. Also, adopting text free user interface for mobile applications to solve the problem of low-literate and post-literate people, and assessing the acceptance of text free UI approach using new UTAUT-QiU model.

UTAUT-QiU consists of two parts, namely: UATUT and Quality-in-Use. UTAUT model covers four constructs, which are used to evaluate the technology acceptance, which helps designers and developers to assess the adaptability of their UI design. Quality-in-Use (QiU) consists of five quality characteristics: effectiveness, efficiency, productivity, error safety, and cognitive load. QiU is used to assess the usability of the system. We introduced the integration of QiU and UTAUT through the HCI principle to propose a new model UTAUT-QiU, which evaluates the technology acceptance through usability measures. UATUT-QiU model is validated on two empirical studies (controlled experiments) using MedPro, an android application which adopts a text-free UI approach.

We conducted a usability test for both versions of MedPro, which have the same text free UI approach but with a different set of users and varied context of use. MedPro v1 was tested on people suffering from chronic disease (diabetes). From the feedback and results obtained from the first usability test, we adopted changes such as playing prompt (voice navigator) again after a defined interval, redesigning buttons relevant to the real-world objects, adding the effect of soundwave and adjustment of the button to reduce the complexity when using the application. After adopting the above changes, MedPro v2 was tested for eating habits of people, and then we compared both usability tests. After the measurement of quality characteristics was obtained, UTAUT-QiU model was imposed to analyze the acceptance of text free UI.

We have analyzed the acceptance of text free UI using UTAUT-QiU model and found the following benefits:

1. Applying UTAUT-QiU model with the help of HCI principles to the second version of the MedPro application and results apparently, show that it has improved the usability and acceptance criteria.

2. UTAUT-QiU model does the two-way job for designers and developers by testing quality in use of the application and understanding how well this UI is accepted in the real world.

6.1 Major Contributions

In this section, we summarize the major contribution of this thesis as follows:

1. UTAUT-QiU a new acceptance model integrating quality in use and technology acceptance theory

The new model UTAUT-QiU validated the acceptance of text free UI via two usability tests. Previously QiU(quality-in-use) alone was used to investigate the usability of the system and UTAUT was to assess the acceptance of the system. Integrating both with the help of HCI principles does two jobs at the same time, measuring QiU to evaluate usability and acceptance of technology by quality measures. And this model can be used to analyse the technology acceptance by using the measurements of quality characteristics. Thus, we can conclude that 2nd objective this research is achieved.

2. The UTAUT-QIU model can be used to evaluate text free user interface adoption in Post and low literate users, and results shows that it improves

Text-free UI for low-literate and post-literate users which solves the problem for both types of users. Although the application has some part of the action achievable only through clicks but playing and walking the users through the application using voice-based navigation helps low literate, in terms of using the application. They do not have to put that much effort into reading and doing the task and makes life easier for them, which was our first objective of this research. Also, the lack of understanding for using a new system or technology creates a problem for post-literate users, using voice navigation to find the functionality or what to do next is much more comfortable. To achieve the last objective of this research, we carried out experiments with MedPro and the results (chapter 5) shows this text free UI has good usability. Also, from the assessment of this approach on new model UTAUT-QiU, we can conclude its well accepted.

6.2 Future Work

Since the development of Amazon's Alexa and Google's Home mini, the type and use of voice assistant devices are growing and improving the efficiency in performing the task in daily life. It will be interesting to use this model to evaluate the acceptance of voice assistants in the real world. But these devices do not come with any traditional UI, which inspires a need to redefine the quality characteristics measurement technique for these devices.

Also, the current version of the MedPro application was tested with very few features, but the population of low literate residing in various countries has the different context of use based on various domestic conditions. For example, they communicate in various languages and environments. Making changes based on these conditions in the application can be challenging and could be a good use case to test for acceptance of the technology.

One of the most critical aspects we came across when using this text free UI is for the people with disabilities, for example, people who do not have a hand or are blind. This approach can be beneficial as it can become a convenient source to access mobile applications for these kinds of people.

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Appendix A: (Controlled Experiment I)

MedPro

List of Tasks

<u>MedPro Android application usability testing</u>

Task 1: Using the application to tell your experience with diabetes.

Task 2: Listen to story of other people with diabetes.

Name: ______________________________

Paper Login Form

Data Collection Form

Participant No.:		**V=# of views**			
Date:		**X=# of Incorrect actions**			
Time to finish the test:		**A=# of Actions(clicks)**			
Task	Time	V	A	X	Comments
Task 1 Listen system prompts and record a story					
Task 2 Listen to a story					

Appendix B: (Controlled Experiment II)

Eating Habits

List of Tasks

MedPro v2 Android application usability testing

Task 1: Using the application to tell your Eating habits. Record story

Task 2: Listen to story of other people's eating habit from library

Name: ______________________________

Paper Login Form

Data Collection Form

Participant No.:		**V=# of views**			
Date:		**X=# of Incorrect actions**			
Time to finish the test:		**A=# of Actions(clicks)**			
Task	Time	V	A	X	Comments
Task 1 Using the application to tell your Eating habits. Record story					
Task 2 Listen to story of other people's eating habit from library					

Post-test Questionnaire

Social Influence

Question 1. Will you suggest this text free UI to your friend and family?

- Yes
- No
- May be

Question 2. Do you agree that using this kind of application which such UI will add something to your image towards your friends and family?

- Yes
- No
- May be

Facilitating condition

Question 1. Does your smartphone have good voice quality or equipped with voice functionality to support this application functionality?

- Yes
- No
- May be

Question 2. Does voice-based navigation make working with application easy?

- Yes
- No
- May be