

Evaluation of User Experience in Mobile Applications

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Abstract--Mobile technologies have improved dramatically over the years which has allowed users to execute more functions when compared to previous models of mobile devices. Although there has been an increase in the effectiveness of mobile technology, it has come at the cost of usability. A well-designed and optimised user experience is important in a successful mobile application. A poor user experience can certainly contribute to application or product failure. The objectives of this research are to study and evaluate the user experience in mobile applications. Data for this research will be collected through observations and interviews. Both methods will help in evaluation of user experience. It is expected that the different methods proposed for evaluation of user experience will be helpful and serve as a source for enhancing knowledge regarding user experience in mobile applications.

Key words: *user experience evaluation, mobile applications, user experience factors*

1.0 Introduction

The effectiveness of mobile technology has improved dramatically over the years which has allowed users to execute more functions than previous mobile devices. Although there has been an increase in the effectiveness of the current mobile technology, it has come at the cost of usability. Kjeldskov and Graham (2003) argued that mobile applications have become more aware of the user patterns which individual users display when operating their device. They also stated that these alter the individual experience of how users interact with these mobile technologies. Therefore, an important and relevant topic of research has now arisen in terms of the design of new applications based on individual experiences and how they interact with their technology.

Consolvo et al. (2002) claimed that applications are required to take note of the user's desires and preferences during the design stages in order so that they will be useful. There have been problems that have arisen when attempting to evaluate how prevalent computing systems and how they influence the individual user because it involves going out into the world to look at real situations in which this is demonstrated. Bellotti et al. (2002) also commented on this problem; there is a requirement of the tools being 100% functional and reliable. Using an incomplete prototype will undoubtedly give unfair and improper test results when it comes to evaluate these tools. However, early tests regarding how the product develops, are required in order to gather the necessary information of users' desired preferences.

The development and growth of mobile technology now allows for a wide array of applications to be used by and developed for people who require them wherever they might be. It has been observed that developers seem to not take into consideration the fact that users are constantly moving around and have created devices that are filled with inconvenient limitations and faults such as the size of the screen, speed or lack of connection, and the staggering amount of power consumption that is a result of creating a small and easy to conceal device. The success of portable devices lies heavily on the individual user's experiences and mobility with their devices (Guerreiro et al., 2010). Small screens and a limited connectivity are a hindrance to the success of products because they are hard to use when out and about.

1.1 Problem Statement

User experience (UX) is how a person feels when interfacing with a system. The system could be a website, a web application or desktop software and, in modern contexts, is generally denoted by some form of human-computer interaction (HCI) (Jacob Gube, 2010). In recent years, the use of different mobile products such as mobile phones and Personal Digital Assistant (PDA) devices has increased rapidly. Moreover, ubiquitous computing has become a popular topic in research and design areas. Nowadays, systems are more and more aware of their context of use (Dey & Abowd, 1999).

In order to be useful, ubiquitous applications need to be designed so that the user's needs and preferences and the context of use have been taken into account (Consolvo et al. 2002). However, the evaluation of pervasive computing systems and their influences on users is quite difficult because the evaluation will require analysis of real users in a real context (Bellotti et al. 2002).

There has been a rise in the importance and relevance in Human-Computer Interaction (HCI) research in understanding user experience while using a new technology. There are many ways in which to capture user experience such as surveys, interviews and general observations (Johanson et al., 2002). Chen and Zhu (2011) argued however, that although there are ways to

capture these experiences, HCI research lacks the ability to provide a clear understanding of the users' experience.

Mobile application has developed its importance in the world of technology. It is significant for businesses to learn more about this technique as it helps them to develop positive user experience (Johanson, et.al, 2002). User experience, which is the way a person feels when using a desktop software or web application in the modern context is denoted by HCI (Jacob, 2010). Effectiveness of present day mobile applications come with the cost of usability. When a user downloads an application, it is important for companies to track the preferences of the user and to make the same available to them whenever they use the application. This helps in reducing time of the user and increase efficiency.

This is a possible result of the difficulties in defining user experience which can then affect the interpretation of issues relating to the devices usability. It is also worth noting that with continuing developments in mobile technology and their environment now highlighting new issues it is necessary to add more scope to the research of user experience.

This research will consider the social and cultural factors which will affect user experience evaluation in mobile applications. The possible user experience factors include user, context of use, social, cultural and product factors. These factors contain several attributes that will be measured by user interaction using a mobile application prototype.

1.2 The Motivation

As mentioned earlier, there is a lack of studies regarding user experience with mobile applications; Chen and Zhu (2011) argued that although there are ways to capture user experiences, still HCI areas lacks the ability to provide a clear understanding of the experience of users. There are many important as well interesting issues of user experience that need to be evaluated to improve user experience with mobile applications.

1.3 Research Objectives

The research will focus on the following research objectives:

1. To identify user experience factors that might affect user experience in using mobile applications;
2. To evaluate the social and cultural attributes which can affect user experience in mobile applications;
3. To design a prototype for evaluating the social and cultural attributes that might affect user experience in using mobile applications.

1.4 Research Questions

1. What are the user related factors that might affect user experience in using mobile applications?
2. How social and cultural attributes affect user experience in using mobile applications?
3. How social and cultural attributes can be evaluated in mobile applications?

1.5 Scope of Study

Identify as well as evaluate the social and cultural factors proposed by Leena and Marika, (2003) that were not evaluated in the comparison of UX frameworks (Wei Song et al., 2012), that might affect user experience in using mobile applications in an integrated manner.

1.6 Research Limitations

The current research is only applicable to study the user experience in mobile applications not for mobile platforms; the prototype will be developed in the manner of mobile computer based simulator. This research will only focus on the social and cultural factors which will affect the user experience evaluation in mobile applications.

1.7 Significance of Study

The preliminary implication of this form of user experience evaluation is to design a working prototype so that users can become hands on with the application. The second involves two separate methods which are interview situations and observations. Because individuals may not be fully aware of all the experiences they feel during the testing of the prototype, observation was used to gather this information which suited perfectly the situation as well as taking into account the resources. Interviews were also used and information was calibrated from the perspective of user experience. In addition, there will be further changes in testing so that there is a more accurate consideration of user experience when using these applications.

2.0 Literature Review

2.1 Introduction

In this section, the literature related to this research will be discussed. This includes the description about user experience, mobile applications and importance of user experience for mobile applications. Moreover, it will cover the study related to user experience and mobile applications and factors affect user experience.

2.2 Definition of Terms

2.2.1 Mobile Application

Mobile apps refers to a term used for the description of internet applications that run on mobile devices and other smart phones. (Arhippainen & Tahti, 2003)

2.2.2 Context of use

Context of use refers to factors influencing user experience defined as place, time, temperature, accompanying persons etc. that is factors that affect a user's mobile application usage experience (Leena & nteMarika, 2003).

2.2.3 Product factor

Product factor refers to aspects that influence user experience like functions, usability, weight, size etc. that affect a user's mobile application usage experience (Leena & Marika, 2003).

2.2.4 Cultural factors

Cultural factors refers to user experience factors like sex, religion, habits, fashion, language, norms, symbols etc. that affect a user's mobile application usage experience (Leena & Marika, 2003).

2.2.5 Social factors

Social factors refer to factors like pressure of success or failure, time pressure, implicit, and explicit requirements that affect a user's mobile application usage experience "As one of the user experience factors defined as time pressure, pressure of success and failure, explicit and implicit requirements, etc. that affects the user while they are using mobile applications" (Leena & Marika, 2003).

2.2.6 User factors

User factors refer to factors like emotions, prior experiences, expectations, motor functions, physical characteristics, personality, motivation, age, and skills etc. that define the values of a mobile application, and affect a user's mobile application usage experience.

2.3 User experience

User experience refers to an individual person's responses and perceptions, related to usage and it includes consequences from anticipated and current use of a system, service or product (Law et al., 2009).

2.4 Mobile application

Also called mobile apps, it is a term used to describe internet applications that run on smartphones and other mobile devices. (Arhippainen & Tahti, 2003). Modern trends in mobile applications have inspired a new paradigm for the development of applications and services. Because of the variability which characterises the context of such environments, it is important that the software used is developed so that its extra functional behaviour is adapted at runtime with the aim of dynamically optimising the end user's experience.

As the popularity of mobile applications constantly increases, the study and adaption of relevant technologies, such as those studied in the ubiquitous autonomic and proactive mobile paradigms (Horn 2001), is a necessity. Altogether, these paradigms suggest the need for a new generation of mobile systems, as a means for improving the quality of the services delivered to the end users. Naturally, the development of software applications featuring such a sophisticated behaviour is not easy. It has been suggested that although researchers have made tremendous progress in almost every aspect of mobile applications, major challenges still remain related to the increased complexity which characterises the development of software (Horn 2001), and the necessary development methods and environments are still an area of ongoing research (McKinley et al. 2004)

2.5 Study Related to User Experience and Mobile Applications

2.5.1 Product

The definition of experience given by Alben (1996) indicates seven attributes of experience in user product connections (shown in Table 1). The overall appearance of the product, the user's first perception of it, and the user's physical resources hands, the product's functionality and usability reflect the understanding of how the product works and using it involves the attributes. User needs and the usage context implies how well the product serves people's purpose and satisfactions.

2.5.2 User

The elements of user product interaction, including the user's emotions, prior experiences, values and cognitive models and product's features, usability, and aesthetic qualities; and the interaction surroundings, such as a context of use and social, culture and organisational behaviour patterns have direct impact to the user experience. The user's values and cognitive models are relevant to prior experience or knowledge and personality, and the aesthetic quality of the product is associated with the user's pleasure of using the product (Forlizzi & Ford, 2000).

2.5.3 Social and cultural factors

User experience forms in the interaction between user and product in a particular context of use and social and cultural environment, but they separate social, culture and context of use into independent components (Arhippainen & Tahit, 2003).

The interactivity of the product, meaning that cognition dimension of experience enables the product to offer the user a learning experience (Forlizzi & Ford, 2000). A good amount of attributes for each components were listed in Arhippainen and Tahti's (2003) work, however, some of these attributes were not recognised in their testing with two mobile application prototypes. This indicates that the attributes affecting user experience are variable in different cases.

Regarding the temporal dimension of UX, there are three levels (visceral, behavioural and reflective level) of interaction (Donald & Norman, 2004). At the visceral level, people have the first impression (i.e., perception) of a product through its appearance and their feelings, e.g., like or dislike, occur spontaneously. At the behavioural level, when people start to use a product, their experience is about how well the product's functions fulfill their needs, and how easily the product can be used. The experience of users comes from the product functionality and user need satisfaction. Therefore, this level involves the product's functions, usability, and user needs. At the reflective level consciousness takes part in the process; whereby people understand and interpret things and remember past experiences and may use their current experiences for future actions. The reflection level is relative to the product's interactivity and aesthetic quality and may also engage the user's prior experience and social context when it affects the user's understandings of the product and its usage for social purposes (Alben, 1996). An extension of Norman's structure was proposed, by increasing a pre experience level prior to the visceral level to indicate people's pre experiences with similar product/services (Obrist et al, 2010).

Experience with technology, can be analysed using four intertwined threads of experience and six sense-making processes (Wright & McCarthy, 2004). The four threads: "sensual,

emotional, spatio-temporal and compositional” represent the visceral character of experience, value judgment ascribed to emotions, place and time effects, and coherent experience, respectively. The sense-making processes are anticipating (expectation associated with prior experience), connecting (immediate and pre-conceptual sense), interpreting (working out what is going on), reflecting (evaluation in the interaction and reflection with feelings), appropriating (making an experience one’s own) and recounting (storytelling with others or oneself about the experience). Compared to Norman’s framework, this framework emphasises the effects of physical context and the connections of previous sense with the product.

Social factors like social acceptability play a major role in building a positive user experience. It is not a simple issue of being acceptable or unacceptable, rather it is a continuous decision process that is developed over time. A given action is performed by users, and performance is adjusted according to their experiences. Individual decisions are influenced by members’ individual memories, which in turn influence large scale societal changes. Social acceptability of gestures, for example influences and affects user evaluation of actions and visibility. Video prototypes play a main role in the assessment of social factors influencing user experience in mobile applications, as it allows for context specific analysis (Montero et al, 2010; Reeves et al, 2005). Social context in essence refers to the expectations users have in the given context, and their willingness to participate in a social situation. Sharing browsing results, undetected browsing, and secure browsing are some social factors that influence user experience to a great extent (Forlizzi & Battarbee, 2004).

Use of context significantly influences user experience. Physical, task, social setting, and other environments influence the user experience (Hiltunen et al, 2002, pp. 21). It is essential to study all identified contexts using the concept of culture as relations between variables can be examined in depth, by developing an understanding of the cultural aspect. Previous studies have listed cultural dimensions, and associated user experiences, finally analysing the relationship between the variables. The degree of uncertainty in a mobile design is found to be reduced when user experience is understood in the culture context (Marcus, 2006; Choi et al, 2006).

The concept of persona is the best methodology to understand user experiences in the culture context. Introduced first by Alan Cooper (2004), the concept of persona makes use of an imaginative character having detailed profile information that represents what the users need including their goals and wishes. Life scenarios are also included to identify best suited design for efficient user interaction with products. Several cultures could be adopted by using a narrative form, and it helps researchers gain a deeper understanding of the concept of culture, and its influence in mobile application user experience. Why consumers choose mobile, and what they do with it will give an overview of their preferences and choices.

2.5.4 Context of Use

The attributes for each user experience component can be defined using internal and external states. The user’s internal state includes expectations, needs, motivation, mood, etc.; the system has the characteristics of complexity, purpose, usability and functionality; and the context involves physical environment, organisational, social setting, and task context (e.g., meaningfulness of the activity or voluntariness of use) (Hassenzahl & Tractinsky, 2006). By using this definition, user experience building blocks consisting of three main components user, system, and context can be developed (Roto, 2006). Here, “System” is suggested to replace “product” in order to include all involved infrastructures (such as products, objects, and services) in the interaction. Furthermore, based on the study on user experience for mobile web browsing, contextual attributes are divided into four categories: physical, social, and temporal and task contexts. The physical context refers to physically sensed circumstances and geographical location; social context refers to other people’s influence on the user and the user’s social contribution goals; temporal context refers to the time available for task execution; and task context refers to the role of the current usage task (which is mobile browsing) related to other tasks (Roto, 2006). Shown below (table 1) (Wei Song et al. 2012).

Table 1: Comparison of UX frameworks (Wei Song et al., 2012).

Com-ponents	Attributes	Alben (1996)	Forlizzi & Ford (2000)	Arhip-painen & Tahti (2003)	Norman (2004) & Orist et al. (2010)	Mc-Carthy & Wright (2004)	Has-senzahl & Tractin-sky (2006)	Roto (2006b)
User	Emotion		√	√	√	√	√	√
	Needs	√		√	√	√	√	√
	Prior experiences		√	√	√	√		√
	Perceptions	√	√		√	√		√
	Expectations			√			√	√
	Motivation			√			√	√
	Profile (age, sex, preference, skill/knowledge)		√	√			√	
	Physical resources	√		√				√
Product/System/Service	Product appearance or system complexity	√	√	√	√	√	√	√
	Functionality	√	√	√	√	√	√	√
	Usability	√	√	√	√	√	√	√
	Aesthetic quality		√	√	√		√	
	Interactivity		√	√	√	√		√
Context	Context of use or physical context	√	√	√		√	√	√
	Social context		√	√	√		√	√
	Culture context		√	√				
	Temporal and task context						√	√

2.6 Factors and Attributes to Evaluate User Experience

Five variables of user experience are: product, context of use, user, culture factors and social factors. This is shown in Figure 1 (Leena & Marika, 2003).

Context of use: time, place, accompanying persons, Temperature.

Product factor: usability, functions, size, weight, etc.

Cultural factors: as religion, sex, fashion, habits, norms, language, symbols, etc.

Social factors: time pressure, pressure of success and fail, explicit and implicit requirements, etc.

User factors: such as values, emotions, expectations, prior experiences, physical characteristics, motor functions, personality, motivation, skills, age, etc.

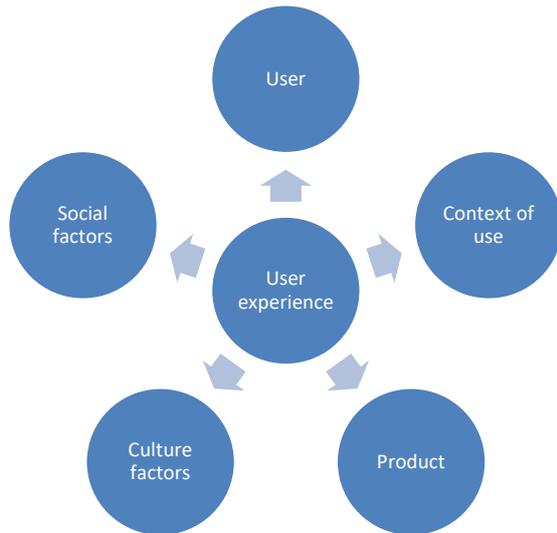


Figure 1: Five factors of user experience

Source: (Leena & Marika, 2003)

A framework for evaluation of user experience in the mobile industry is presented in figure 2.

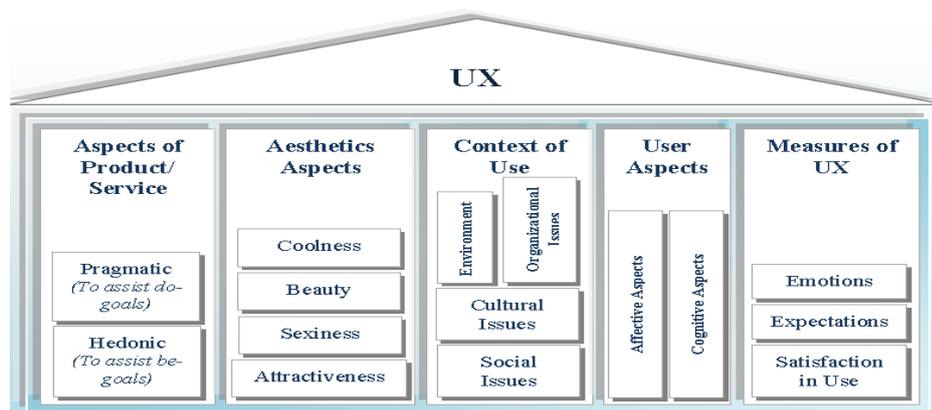


Figure 2. User experience in the mobile industry (Bevan, 1995, Clarke & Furnell, 2005)

2.6.1 How factors influence user experience in mobile application

The above discussed factors influence user experience, as mobile phones are largely becoming an extension of our physical body. Mobile telephony that was developed nearly half a century ago now offers advanced features like music players, cameras, and useful applications. The

increase in mobile phone enchantments have resulted in increasing user expectations when it comes to usage, and usability of mobile phone applications (Roto, 2004). The factors in the conceptual framework affect user experience as they influence attitude towards a specific system or product, or an object after or during an interaction. Various aspects like conditions under which the interaction takes place, user expectations, and ability of the mobile application to meet the user's needs increases user satisfaction (Clark & Furnell, 2005).

2.7 User Experience Evaluation Methods

2.7.1 Observation Method

Observing and measuring the world around, including observations of people and other measurable events (Kosso, 2011). Observation is the active acquisition of information from a primary source. In living beings, observation employs the senses. In science, observation can also involve the recording of data via the use of instruments. The term may also refer to any data collected during this activity (Kosso, 2011).

2.7.2 Interview Method

To gain an insight into what happened during user interaction, as well as into the context of use we need to ask the users. Interviews can be controlled or more open, but the researcher should avoid questions that can lead to confusion or use terms that are too technical. We often use a semi-structured interview approach: we have a set of predefined questions, but allow for follow up questions and discussions depending on the user answers (Charlotte et al, 2010). The interviews can be done both before and after use, to gain insight in the context of use, the background of the user, and to obtain reflections on the test. Interviewing is a standard technique and has been used in most of our studies, and also in many of the studies made by other researchers as mentioned in (Nielsen et al., 2006).

3.0 Research Methodology

In this research, the adopted method, Blumberg et al. (2008) model describes research method as illustrated in figure 2. The method begins with the development and the exact definition of the research question. Preceding the research design, researchers might have to provide a written research proposal. The research proposal describes the exploration of the management research question. The next phase, the research design, describes the activities leading to the fulfillment of the research objectives. The research design begins with the definition of an overall design strategy. Based on this, the relevant population and sampling methods as well as data collection methods are determined. The actual collection of data is generally collected by prototype testing. If necessary, the prototype is revised before collecting the data. The data

is then analysed and interpreted. Finally, the research results have to be reported to come with results and findings.

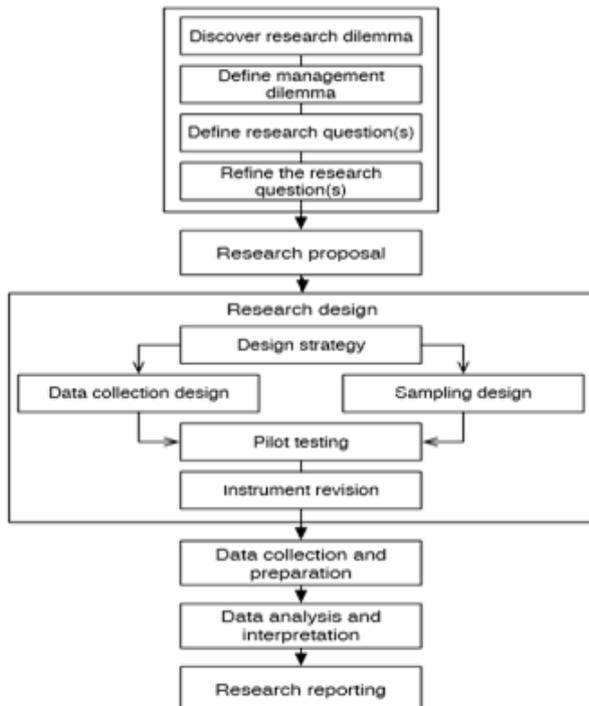


Figure 2: Research design (Blumberg et al. 2008)

3.1 Research Framework

This research will consider the user experience factors which will affect the user experience evaluation in mobile application, such as user, context of use, social, cultural and product factors, some of these factors weren't measured yet, these factors contains several attributes that will be measured by user interaction among using mobile prototype.

Table 2: UX frameworks (Wei Song et al., 2012)

User experience (UX)				
User	product	context	culture	social
<ul style="list-style-type: none"> •perception •motivation 	<ul style="list-style-type: none"> •language •usefulness 	<ul style="list-style-type: none"> •time •place 	<ul style="list-style-type: none"> •religion •sex •habit •language 	<ul style="list-style-type: none"> •time pressure •pressure of user interaction

Wei Song et al. (2012) identified three components of user experience, while Leena and Marika (2003) state five component of user experience which are including Wei Song's components

(user, product ,context) and two extra components which are the social and culture factors which will be evaluated in this research:

User factors: contain perception and motivation, perception refer to the ability to take notice of something by using your senses. Taking in your surroundings through sight, sound, taste, touch and smell give the perception of everything around you. While motivation refer to the desire and energy directed at achieving a task.

Product factor: contain language and usefulness, language is referring to the complexity of use, while usefulness refers to if the application has useful function to the user.

Context: contain time and place, time refers to the time of using the application, while place refer to where the user will use the application

Culture: contain the religion, sex, habits, language; using the mobile application must come up with these factors not violate them.

Social: contain time pressure and pressure of user interaction which refer to the time availability in using the application and the status of the user while doing function among mobile application; **this study will be on the following factors:**

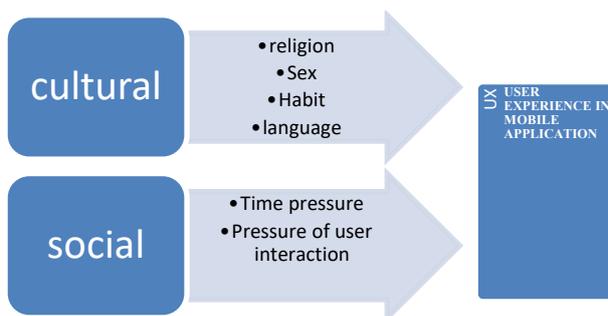


Figure 3: Cultural and social attributes

Source: (Leena & Marika, 2003)

3.2 Population and Sample

The data will be collected from groups of students .As this study will be based on observation as well as interviews the group consist of at least 30 students. Convenience sampling allows researchers to choose respondents who are in a better position to give quality response to research questions. This serves to increase the research's validity and reliability. For this research, convenience sampling technique will be preferred to get different users experiences (Saunders et al, 2009). Students who are known to have a technological undertaking or view towards mobile phones will be the prime target population. Apart from them, students who are known to have purchased a new mobile phone over the past three months, or who have a habit of changing their mobile phones often will also be interviewed, and observed.

3.3 Data Collection

As outlined before there are a number of techniques that are employed when acquiring research on user experiences, such as surveys and interviews which are the more effective, including the use of prototype models. The accounts of users discussing their experience are a useful way of gathering information. This is due largely to the fact that individuals are able to fully explain their experiences in a clear and concise way (Palen & Salzman, 2002). Individuals may not be aware of what they are actually feeling and experiencing and so would struggle to express these in the form of a discussion and so they developed a technique known as “experience prototyping” which allows for a more hands on approach to human interaction. This serves as a much better means that by having the devices merely demonstrated (Buchenau & Fulton, 2000).

Systems should not be intrusive to the user and their product however should still retain the ability to evaluate the user’s interaction and so that is why survey and observations are implemented (Weiser, 1991). Bellotti et al. (2002) have made use of a range of techniques in order to evaluate. One of the technique involved complete and incomplete questionnaires. The following year qualitative and quantitative data was taken from ethnographic observations. Johanson et al. (2002) have also developed spaces where interaction can take place and performed experiments with a range of different groups ranging from those in professional sectors and those who are not, such a laborers and students. Fleck et al. (2002) conducted interviews after testing a prototype for an interactive guide, which performed casual studies by observing individuals with the product.

In order to study the user experience, this research will undertake interviews (adopted from Fleck et al. (2002)) and observations (adopted from Bellotti et al. (2002) and Mark Weiser (1991)). Moreover, in order to better understand the mobile application, test cases will be performed using “PDA” “based mobile application prototypes (adopted from Johanson et al. (2002)).” Test cases will consider the user experience relationship in respect to social factors, cultural factors, product and context of use. The focus of test scenarios will be on testing user experience in respect to main characteristics of the suggested prototype. As far as evaluation environment for test scenarios is concerned, one can consider class rooms or the office environment as well.

The questionnaire for the interview will be developed using the theories, and concepts developed in the literature review. Focus group interview methodology is used for data collection. From the sample size 30, in each focus group there will be 5 students. During the interview, all responses will be recorded. The recorded data will be transcribed and coded in excel for further analysis.



4.0 Results

It is expected that by evaluating social and cultural factors by two different methods of mobile applications will better help in understanding the user experience. This research will be able to provide statistical analysis on user experience toward mobile application usage based on user experience factors (culture factors, social factors.), prototype with the evaluation techniques will improve the understanding the user experience in using mobile applications.

5.0 Conclusion

The purpose of this research is to define how user experience can be evaluated in mobile applications. In general, the capturing of user experience is difficult because there are so many different factors in user experience interaction. This study evaluates social and cultural factors that affect user experience in using mobile applications.



REFERENCES

- Alben, L. 1996. "Quality of Experience. Interactions", Vol.3, No.3, (May 1996), pp. 11-15, ISSN 1072-5520
- Arhippainen, L., Tähti, M. 2003." Empirical Evaluation of User Experience in Two Adaptive Mobile Application Prototypes". *Proceedings of 2nd International Conference on Mobile and Ubiquitous Multimedia*. pp. 27-34, Norrköping, Sweden
- Bellotti, F., Berta, R., Degloria, A., Margarone, M. 2002. "User Testing a Hypermedia Tour Guide". *IEEE Pervasive Computing*, 33-41
- Bevan, N. 1995. "Usability in quality of use", *Advances in human factors or ergonomics*, 20: 349 – 354.
- Blumberg, B., Cooper, D. C., & Schindler, P. S. 2008. "Business research methods". (7th Ed.). London, UK: McGraw-Hill
Brooklyn, New York, n. d.
- Buchenaus, M., Fulton, J. 2000." Experience Prototyping", in *Proceedings of the DIS 2000 seminar, Communications of the ACM*, 424-433
- C. M. Nielsen, M. Overgaard, M. B. Pedersen, J. Stage, & S. Stenild. 2006. "It's worth the hassle!" The added value of evaluating the usability of mobile systems in the field". In *NordiCHI '06: Proceedings of the 4th Nordic conference on Human-computer Interaction*, pages 272–280, New York, NY, USA, 2006. ACM
- Charlotte M. Kirsten Rasmus & Delphine Szymczak .2010. "Methods for understanding the mobile user experience". *Proceedings of the 1st International Workshop*. Held in Conjunction with Nordic HI". October 17.
- Chen, Z., g Zhu, S. 2011. "The Research of Mobile Application User Experience and Assessment Model". *International Conference on Computer Science and Network Technology 2011*, IEEE, 2832-2835
- Clarke, N., & Furnell, S. 2005. "Authentication of users on mobile telephone – a survey of attitudes and practices, *Computer and Security*, 24: 510 – 526.
- Consolvo, S., Arnstein, L., Franza, B. R. 2002. "User Study Techniques in the Design and Evaluation of an Ubicomp Environment", *In the Proceedings of UbiComp 2002*, LNCS 2498, Springer-Verlag, Berlin, 73-90
- DEY, A. K. AND ABOWD, G.D. 1999. "Towards a Better Understanding of Context and Context-Awareness". *GVU Technical Report*. GIT-GVU- 99-22. Georgia Institute of Technology
- Fleck, M., Frid, M., Kindberg, T., Rajani, R., Spaspjevic, M. 2002. "From Informing to Remembering: Ubiquitous Systems in Interactive Museums". *IEEE Pervasive Computing* 1/2, 17-25.
- Forlizzi, J., & Ford, S. 2000."The Building Blocks of Experience: An Early Framework for Interaction Designer". *Proceedings of Dis 2000*, pp. 419-423, ISBN 1-58113-219-0,
- Guerreiro, TJV, Nicolau, H, Jorge, J, Gonçalves, D .2010." Assessing mobile touch interfaces for tetraplegics". Lisbon, Portugal: ACM



- Hassenzahl, M., & Tractinsky, N. 2006. "User Experience - A Research Agenda. Behaviour & Information Technology", Vol.25, No.2, (March-April 2006), pp. 91-97, ISSN 0144-929x
- Horn, P. 2001. "Autonomic Computing: IBM's Perspective on the State of Information Technology". IBMresearch, <http://people.scs.carleton.ca/~soma/biosec/readings/autonomic_computing.pdf>
- Jacob Gube . Accessed: 9 December 2013." What Is User Experience Design? Overview, Tools And Resources". <<http://uxdesign.smashingmagazine.com/2010/10/05/what-is-user-experience-design-overview-tools-and-resources/>>
- Johanson, B., Fox, A., Winograd, T. 2002. "The Interactive Workspaces Project: Experiences with Ubiquitous Computing Rooms". *IEEE Pervasive computing* 1/2, 67-74.
- Kjeldskov, J, & Graham, C .2003." A review of mobile HCI research methods". Udine, Italy: In *Proceedings of 5th International Symposium, Mobile HCI*, September, 8–11
- Kosso, Peter .2011." A Summary of Scientific Method". Springer. p. 9. ISBN 9400716133,
- Law, E. L.-C., Roto, V., Hassenzahl, M., Vermeeren, A. P. O. S., & Kort, J. 2009. "Understanding, Scoping and Defining User Experience": A Survey Approach. *Proceedings of 27th international conference on Human factors in computing systems*. pp. 719-728, ISBN 978-1-60558-246-7, Boston, MA, USA, April 4-9
- Leena, A & Marika, T. 2003." Empirical Evaluation of User Experience in Two Adaptive Mobile Application Prototypes". 2003 ACM 1-58113-826-1/03/12
- McCarthy, J., & Wright, P. 2004." Technology as experience". MIT Press, Cambridge MA.
- McKinley, P. K., S. Masood Adjani, E. P. Kasten, & B. H. C. Cheng. 2004. "Composing adaptive software". *IEEE Computer* 37, no. 7: 56–64
- Nielsen, J. January 2010." How Many Test Users in a Usability Study? "Nielsen Norman Group. < <http://www.nngroup.com/articles/how-many-test-users/>> Accessed: 24 December 2013
- Norman, D. A. 2004. "Emotional Design: Why We Love (Or Hate) Everyday Things". Basic Book, New York.
- Obrist, M., Meschtscherjakov, A., & Tscheligi, M. 2010. "User Experience Evaluation in the Mobile Context. In: Mobile TV: Customizing Content and Experience", A. Marcus et al. (Ed.), pp. 195-204, ISBN 978-1-84882-701-1, Springer-Verlag, London, UK
- Palen, L., Salzman, M. 2002. "Voice-mail Diary Studies for Naturalist Data Capture under Mobile Conditions", *CSCW*, New Orleans, Louisiana, USA, November 16-20, 87-95.
- Roto, V. 2006." User Experience Building Block". *Proceedings of NordiCHI'06*. pp. 1-4, Oslo, Norway, October 14-18, 2006
- Wei S, Dian McMichael D. 2012. "Understanding User Experience of Mobile Video: Framework, Measurement, and Optimization". 20, January, 2012
- Weiser, M. 1991. "THE Computer for the 21st Century ". *Scientific American* 265(3), 94-104.