Tablet PC Usability Using Motion Capture in a Simulated Clinical Setting

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ATTESTATION OF AUTHOTSHIP

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent, has been accepted for the qualification of any other degree or diploma of a university or other institution of higher learning.

Signature of Candidate

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It is a pleasure to have the opportunity to express my appreciation to those who have supported me over my thesis. First of all, I would like to thank my God who is always supporting me and provides the encouragement to carry on. Being a SCAM student, it is an honour to thank the King of Humanity "King Abdullah".

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Abstract

Involvement of a tablet PC in healthcare organizations has played a major role in improving their day-to-day services by allowing healthcare professionals to perform a variety of tasks that are efficient and accurate at bedside or desk. As the patients are also users of the tablet PC, for example; in making appointments and providing personal information records; elderly patients must be easily able to use a tablet PC. This research was conducted to describe the usability of a tablet PC by elderly people in a healthcare environment.

The usability testing method was planned to be an observational study at North shore Hospital . However, due to approval issues it was canceled and replaced by a pilot study in a MoCap laboratory for recruited participants. It was conducted to find out whether a motion capture protocol could be adopted as a usability testing method besides observation.

In the pilot study three participants were observed in a motion capture session while performing specific tasks using a tablet PC in a simulated healthcare environment. All participants movements were recorded and interpreted by a 3D animator. In addition interview data were collected from a survey pilot study.

Motion capture protocols could be used as a usability testing method for its accuracy and real time recording of body movements. However, this method needs improvement to be a sufficient usability testing method. Additional interviews were used as a support to the findings for this method.

Note:

This thesis is linked to another thesis, both being supervised by Dr. David Parry. They are linked to the same topic, being clinical consultation using a tablet PC in a motion capture lab. The project was divided into two parts. The auther of this disertation conducted the first part, the interview and survey. The second part of the project was performed by Fawaz Alsabhen (the co-researcher), who performed the observation method and heuristic evaluation. However, each piece of research differs in data analysis and findings in regard to each study problem statement and significance.

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CHAPTER ONE

1.1 Introduction

The recent advances in information technology with the evolution of multi-touch devices and tablet PCs could have a potential influence on developing healthcare management. There is some research concerned with the involvement of multi-touch devices within the healthcare environment. Such research is important in solving healthcare problems through providing patients with the required high-quality health service. In this study, it will focus on finding out the impact of using a tablet PC for clinical consultation with elderly patients. In addition, motion capture technology was looked at for usability testing in order to understand basic requirements when designing an effective user interface (UI) for healthcare tablet application, which will be used by patients, especially elderly people.

The International Organization Standardization (ISO) (ISO 9241-11, 1998) defines visual display usability as "The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use."

Motion capture technology is a new technology used to record an objects movements and mapping the recorded data into 2D and 3D models. Usually, the usability of a healthcare system is concerned with the patient satisfaction and the reduction of related medical errors, all of which will lead to improved user productivity and quality of healthcare provided. A number of studies have indicated that the use of such devices has the ability to bring about a significant improvement in the healthcare industry. However, the reaction to these devices has been acceptance and rejection in equal measure by users.

Several studies such as Babcock (1997) and Czaja and Sharit (1998) studies, found that older people reacted negatively and were less comfortable with computer technology. Meanwhile, newer studies have come up with contradictory results, for example, Jayoe and Wofram (2012) reported a positive reaction by older people toward tablet technologies. Despite, changes in older people's reaction and acceptance of tablet technology, there are some difficulties with certain features of tablet technologies, and this was also emphasized in Jayoe and Wofram's (2012) research.

Other researchers for example, Caprani, O'Connor, and Gurrin, (2012) and Piper, Campbell, and Hollan, (2010), emphasized that elderly users are different from the other users in regard to technology. Healthcare and wellness services are areas in which older people could receive benefit from involvement in touchscreen technology. Based on the above perception, this research aims at discovering the impact of using a tablet PC with elderly patients.

The study will adopt a motion capture approach that primarily involves the recording of object motion and mapping the findings on 2D/3D planes. Motion capture is one of the most accurate procedures to capture object movements. This research used motion capture (MoCap) as a usability testing method for tablet PC applications within the healthcare environment.

1.2 Problem Statement

Technology has an enormous impact on healthcare organizations allowing the execution of many processes in an efficient manner. Healthcare is an important area for society

and the increased use of technology has brought about massive changes to the healthcare sector. One such change is the use of tablet PCs within the healthcare environment. As stated in the above paragraph, the tablet PC has received acceptance into the healthcare paradigm. Nonetheless, there are number of usability weaknesses that are likely to impede its application within the healthcare system.

Unlike the younger generations, elderly people have experienced inherent difficulty in using most gadgets that have emerged with recent rapid technological changes. Many of these people cannot easily master current technological concepts. Governments are playing an active role in bringing tablet PCs technology into healthcare institutions. However, despite the spirited efforts of governments to bring introduce these devices; elderly people may be unable to use them. A number of researches such as Hooper, (2007) and Taveira and Choi, (2009) have indicated that the prevalence of chronic illness is high among elderly people, but these patients equally constitute those unable to use current technology.

According to Taveira & Choi, (2009), elderly people could face difficulties when interacting with input devices on traditional computer systems such as keyboards and mice. Therefore, the use of a tablet PC as the input device provides an advantage by facilitating the interaction of elderly people with the input devices. Therefore, this study focuses on discovering the impact of using tablet PCs by older patients in NZ hospitals.

The fundamental challenge for older users with the tablet PCs is its perceived affordance. Nielsen's (2010) research highlighted that the absence of certain functions, such as + and -, on the touch-screen devices may cause older users to become lost within the system. It is hard to find these clues by systematically exploring the device.

Therefore, nurse support and help is required, which removes the benefit of saving the nurse's time while the patient uses the tablet.
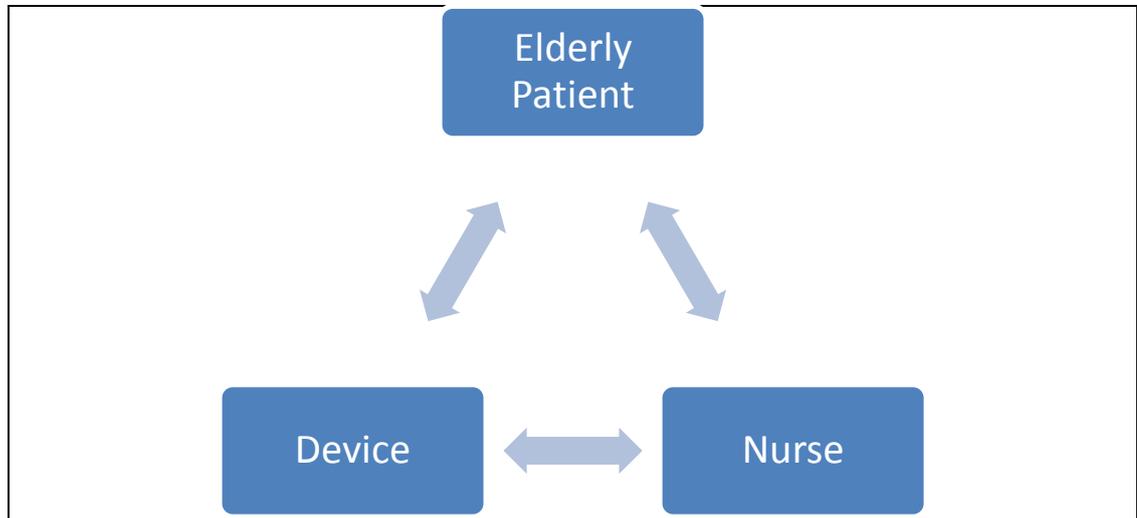
Figure 1 : Study scope

In addition, inadvertent touching is another common challenge facing older patients while using touch- Hscreen devices.Therefore, to understand the challenges of older people interacting with tablet PCs and how they deal with such challenges motion capture technology was emplayed for usability testing of tablet PC applications. Motion capture was adopted in this research as it is considered an effective usability testing method that provides the researcher with all the required information and findings.

The effort by the New Zealand government and the healthcare sector to bring about the use of such devices may be futile if the targeted population is unable to use such devices. This implies that only younger would benefit from tablet PCs as they are well acquainted with mobile phone technology. The introduction of the Tablet PCs, therefore, tends to favor one section of the population and exclude anther (the elderly)

that are highly vulnerable to illness. There is therefore a greater need to address the use of tablet PCs by the elderly patients. It is important to understand the impact of using new technology such as mobile and tablet PCs in a healthcare organization.

1.3 Research Questions

To comprehensively address the above research problem, this research will attempt to answer the following research questions.

Main research question

- How can we study the use of tablet PCs on how it will improve the quality of the consultation services, which are provided to elderly people?

This leads to three sub-questions;

1. How can we perform the usability testing using motion capture?
2. What are the issues of using motion capture?
3. What does motion capture add? What are its advantages?

1.4 Significance of the Study

According to the Ministry of Social Development in New Zealand, the population of older people (65 and over) has increased from 11% in 1992 to 13% in 2009 and is expected to be 18% in 2031 (Ministry of Social Develpment, 2015). A similar report also indicated that the elderly people are highly vulnerable to various illness especially the chronic conditions. This implies that a large number of elderly people visit hospitals more, after when compared to the younger section of the population. The above statistics creates a need to create significant solutions deal with this situation.

This study focuses on the challenges faced by elderly people in using tablet PCs within the healthcare environment. The study will also take into account solutions that can be used to assisting the elderly population improve their use of the tablet PC.

The aim of this study is to find some issues of using motion capture technique as a usability testing method; especially the elderly people. Also, this study intends to help the healthcare a improve the clinical consultation process of elderly patients. Various stakeholders within the healthcare system, to improve the nature and quality of services delivered can use the findings and recommendations of this study. The stakeholders include bodies like the government, the healthcare ministry, private organizations, and the public that have an interest in the research problem.

1.5 Research Structure

This research paper has been divided into five chapters. The first chapter primarily focuses on the introduction of the research problem, statement of the thesis, the significance of the research and the research questions. Chapter 2 involves examination of the existing literature. This entails the population under study in regrad to the research problem. Moreover, the paper will review literature from previous researches on motion capture. The third chapter will be a discussion of the research methodology and the experiment designed for this paper. Chapter four will present pilot studies on how motion capture can be used as a usability testing method for tablet PCs within healthcare environment. Two pilot experiments were planned to be performed, a trial test and the main experiment. The main experiment was planned to be conducted in a hospital setting, but due to logistical issues, it was not performed. However, in this chapter a discussion of the main experiment will be presented based on the pilot test

study. The two researchers planned to undertake the same pilot study as they are linked in their research; the same task script, participants, instrument, and procedure were used. However, the two pieces of research will differ in interview and research' observation. This research concerns the survey pilot study, while, the other concerns the heuristic pilot study. The pilot study protocol for both pieces of research is shown in Chapter 5.

In the final chapter, a discussion and answers to our research questions will be presented. The conclusions and recommended future work will be given.

CHAPTER TWO

2.1 Introduction

This chapter outlines the relevant theoretical background for the main concepts that are used in this study. The literature review provides the most important points and issues concerning this research. Consequently, this chapter discusses older people, who are considered the target users in this research; usability; effects of usability on user interface (UI) designing; usability methods and developments; healthcare informatics; and the impact of usability on healthcare. The main focus is on portable devices (especially tablet PCs) and the impact of using of these devices within the healthcare environment.

2.2 Older People in New Zealand in perspective

According to the Ministry of Social Development in New Zealand, the number of people aged over 65 year will increase to double the present level to around 1.2 million citizens in 2051 (MSD, 2014) as shown in Figure 2.
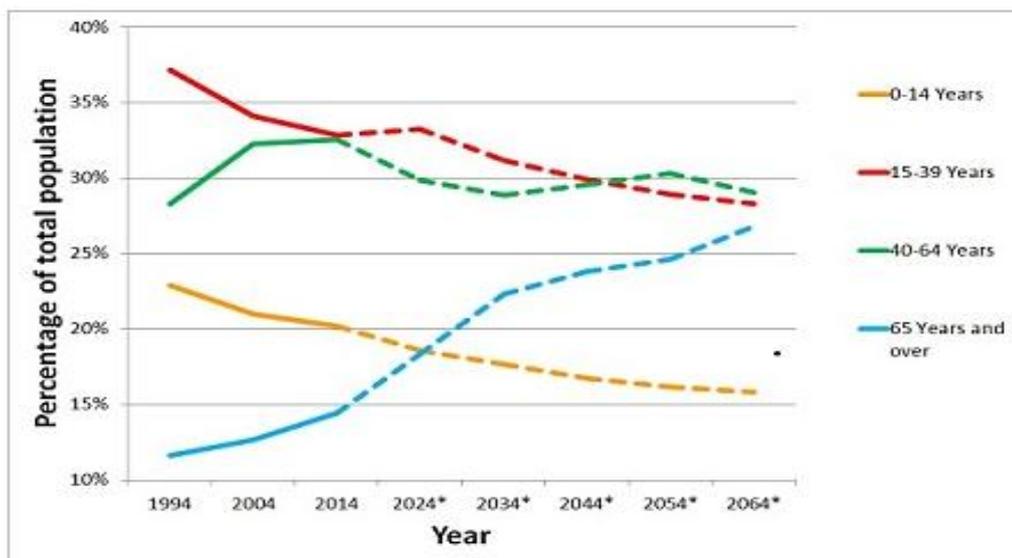
Figure 2: Predicted changes from 1994 until 2064 in the population according to age
source (MSD, 2014)

This growing number of older people within New Zealand will necessitate ensuring the high quality of life they deserve, and this development and improvement can be obtained by introducing the new technologies in areas of basic life requirements. One of these areas is the healthcare where demands increase with aging.

A recent research revealed that out of the entire population aged 65 and above, only 26 percent are in possession of smart phones. In contrast, 85% of teens and young adults aged between 18 to 29 years are in possession of smart phones (NZ research, 2015). The same study revealed that young adults often use cell phones to perform a myriad of tasks, when compared with the older population. The younger population uses mobile phones to not only communicate, but also for social media interactions and relieve boredom. The elderly population, on the other hand, was seen only to use the phones for calling, texting, and emailing. The frequency of use was seen as a key determinant in the amount of operating knowledge of smartphones. The study made the conclusion that, a large number of the elderly population were not in possession of a smartphone, and the few that do own these devices do not use them extensively (Baron et al., 2005). A large number of the elderly population can only operate the most basic functions on the device.

In a related study, Coffey, Holbrook, and Atkinson (1996) observed that most elderly people have developed the perception that technology is complex and therefore only meant for the younger generation. Such stereotyping has led to a large part of the elderly people refusing to adapt to new systems. Most of them have preferred to stay with traditional systems, which they consider simple and convenient.

The current technology calls for people that have a technological education. The current system of education includes technology studies such as social media, which enables students to improve their interactive skills. A large number of the elderly population did not receive this type of education hence making them not to be technologically versatile. The emerging trends such as the introduction of tablets seem to be presenting a highly complex system to this group of people, making it difficult for them to adapt fully (Caprani, O'Connor, & Gurrin,2012).

Tablet PCs come with a smartphone operating system and being Android iPhone, or Windows, among others. Each of these operating systems is often upgraded to newer versions, which may come with a more complex interface. The dynamic changes experienced in the upgrading of the smartphone technology may not allow older members of the population to use the devices comfortably. Given their limited knowledge of current technology, these persons tend to have a poor memory when mastering the use of these devices.

Old age can be characterized by changes in vision, body strength, and presence of chronic diseases. Such changes may impede the ability of the elderly persons to use the available technological devices. Older people may need a different interface design from younger users; as older patient face changes and difficulty related to sensations, perception, cognition and movement control (Fisk, Rogers, Charness, Czaja, & Sharit, 2009).

2.3 Tablet PC use among the elderly population in a healthcare setting

The use of tablet PCs has been seen to have a major influence on the healthcare system (Baron et al., 2005). Nonetheless, as postulated above, research has shown that the elderly adapt to this technology much more slowly. This makes them benefit least from developments that involve technology. Healthcare is highly important, and the elderly require more health care compared to younger sections of the population. Knowledge of the use of these technological devices enables a quick delivery of services.

Accessing information on the state of a patients' health is important to provide immediate consultation services. Healthcare professionals face difficulties in providing consultation services for physically challenged people; as these patients may not be able to express their problems correctly (Jeon and Park ,2015).

Elderly people also experience similar problems. A large number of this population are unable to express themselves freely. Hence, diagnosis of a problem may be difficult. Other research, it was observed that senior citizens constitute the larger part of the population that do not often access the internet regularly. This means that they only use the internet when there is a dire need. According to the study's findings, people that do not frequent use the internet tend to have various problems when it comes to handling technological devices. These individuals may therefore not be well placed to make prescriptions online or use the smartphones to gain medical help online (Mosa, A. S. M., et al. 2012).

Other studies have related the improper use of tablet PCs among the elderly population to the user interface. The dynamic technological changes have made increasingly complex, thereby making older people develop poor attitudes towards using such devices. Chaffin and Harlow (2005) on the other hand discovered that most people aged 65 and above have a real desire to learn and know about the new technology. Age and health conditions have however been seen as key factors that undermine their ability to learn and interact with advanced technology. Similarly, there is a prevailing belief among people within the American social system that the elderly cannot do much with current technology. Many people in the older population tend to internalize such stereotyping and this inhibits their ability to learn technological concepts.

As stated by Frosch, et al. (2012) effectiveness of the treatment process depends on the time of delivery of the consultation services. Hibbard and Greene (2013) pointed out that health care professionals require a clinical study before taking decisions regarding the treatment of a patient. However, the extensive focus on conducting a clinical study may increase the time needed for making a decision. The effectiveness of the consultation may also be affected by a lack of information. Jeon and Park (2015) opined the complexities of the treatment process might increase if the health care professionals require more time to understand the problems faced by patients. Using the tablet for organizing information is effective in reducing the time needed for accessing information (Zgierska, Miller, & Rabago, 2012).

Portable devices, especially tablet PCs, are one piece of modern technology that has been introduced into the healthcare environment. Despite its advantages and

improvements to healthcare services, users, especially older people, still face challenges using these devices, particularly within the healthcare environment.

Much research has been done on attitudes toward technology (computers and tablet PCs). According to Fisk et al.,2009 and Farage et al.(2012), aging is accompanied by changes in perception, cognition, movement, and psycho-social functioning which are essential in determining an older person's acceptance of technology. The research indicated that the elderly people are therefore not often open to such technological changes.

The above literature review has shown the manner in which the elderly population has been left out of technological advancements. These unfortunate findings point out to the fact that regardless of their propensity for chronic illness that come with age, older people are not ready for the advanced technological developments that are taking place within the healthcare system. Changing user interfaces of smart phones has also been seen to be highly detrimental in making these people person accept the tablet PCs.

2.4 Usability

According to Cronholm, et al. (2006), usability observation is where someone watches a user interact with any system and there are several studies concerned about observation technique (Jääskö & Mattelmäki, 2003). Usability is part of Human-computer interaction (HCI), and, according to information system (IS), the HCI is distributable and responsible for human interaction with information technologies, and tasks

throughout business management organizations; and cultural contexts (Zhang et al., 2002).

Ghaoui (2005) pointed out that the designers of software application interfaces should design a system that is easy and enjoyable to learn. That it has valuable functions that are needed by users in their work. All of this can be accomplished by using suitable design techniques and effective usability evaluation methods to evaluate the task, the context and user behavior and interaction with the computer applications or systems.

Different literature studies are concerned with different aspects of the user interface (UI); such as Shneiderman and Plaisant (2005) who concerned about developing better interfaces. Cranor and Garfinkel (2005) study which focused on analyzing and evaluating the software tools to continue developing interfaces.

2.4.1 Usability and the User Interface

Since the user interfaces are the main way in which the user experiences the computer system, the presented literature study to focus on user interfaces in the setting of interactive products that are used to allow the user to accomplish an aimed task (Stone, Jarrett, Woodroffe, & Minocha, 2005). Juristo, Moreno, and Sanchez-Segura (2007) stated that the interface involves the input and the output devices and their software. So, characterizing an interface is difficult when using, a wide-range of terms to characterize the user interface, which involves everything that informs the user's computer experience, including documentation and human support.

According to Shneiderman and Plaisant (2005), usability will improve the user interface design through assessing the organization, presentation, and interactivity of the interface. The authors also provided a blueprint for user-interface design that discusses the procedure for designing high-quality interactive systems using the syntactic and semantic model of user knowledge. Which will improve any use interface for any system of the designers follow it.

2.4.2 Usability Methods

New technologies have the ability to support people in their everyday activities and this has increased their wide acceptance, Sharp, Rogers, and Preece (2007) identified advanced usability goals in addition to general usability goals. According to them, the main usability goals are: easy to learn, have good utility, safe to use, effective to use, efficient to use, and easy to remember how to re-use. The advanced usability goals (that describe users' experiences when using the system) are satisfying, enjoyable, entertaining, helpful, motivating, aesthetically pleasing, supportive of creativity, rewarding, emotionally fulfilling, and fun.

Researchers (Marcus, 2002; Shneiderman & Plaisant, 2005) continue looking for methods to design interfaces with fewer challenges for the user. Blandford, Blandford, Thimbleby, and Bryan-Kinns (2003) pointed out that the users are facing interaction traps as a result of misunderstanding the user's ability to complete a task because of system failure. This interaction trap arises when the user runs into detours, barriers, or objectives that are difficult to be accomplished. Therefore, a user's interaction with a computer application or system when usability failure arises is essential to determine especially if security controls are associated with an organization's process.

Marcus' (2002) research results were based on interaction with the computer involving the input and the output techniques, status displays, and the local and global level feedback. The local level feedback is associated with the behavior of the computer system's physical side, for example; the visual presentation of a computer screen or peripheral devices, such as the printer, response to the user's printing order. Meanwhile, global level feedback is associated with presenting context issues and task activities within greater scales to the users.

According to Dey and Newberger (2009), the context is collected through an automated method using a combination of sensing and complex rules to permit the application to respond to significant organizational environment changes. Therefore, the context of use and the interaction of the user work as a barometer to measure the effect of the failed task due to usability failure on the influence of the performance. Accordingly Creswell, (2002) put forward three key attributes for "context of use ":

System users who are intended to use the system.

Hardware and software platforms, which are the computer and the interaction devices for the system.

The physical environment where the interaction takes place.

These attributes can be useful in hospital and clinical settings where simple business practices are used. The nature of different tasks as the users differ from patient to healthcare, who decide the system to be used and the environment in which the task is to be accomplished.

Also pointed out by Dey and Newberger (2009), the hospital and clinical settings are often organized to use context-aware applications to precede an action without revealing user input. In addition, the study revealed that the research in the area of context-aware applications suggested that users will be unsatisfied and upset when they do not realize and understand actions that the system performs, which prevent fixing a problem the user is facing.

2.4.3 Usability Development and Design

HCI and the usability domain are primarily concerned with usability development and design. In the area of usability development, the user is the main focus while designing a usable and effective software application depends on basic usability design principles. This, with some notable exceptions, was discussed by Juristo et al. (2007); The inner workings of the system are the basics for software development, whereas usability development concerns about the user. Furthermore, Gould and Lewis, (1985) study found the software development process to contain a user role through eliciting the requirements by the development team. Meanwhile the user is the cause for the design of the system according to the context of usability development which is also known as user-centered development.

There is a strong connection between the challenges in the software development process and the difference in the usability development design viewpoint. On the one hand, the development process provides ways to understand the effect of the various development perspectives on generating an opportunity to state the issues that arise from the development team without connecting with users. For example, some usability

errors such as user's failure are to access a system due of an authentication failure between two systems will not appear as an application development failure.

Instead, the failure will appear as a user's "memorability" or "learnability" problem. An IS security failure is an application accessing problem. So usability-related security failures are reported by users who faced this failure and were addressed through adequate security controls, this enhances and improves the security value to both the usability and information system security communities.

Usability evaluation methods (UEM) are methods used to measure and identify the possible problems affecting the usability attributes of a system or device when considering particular users are performing a particular task in a particular context. The usability attributes are learnability, efficiency, memorability, errors, and satisfaction (Nielsen, 1994).

Applying usability attributes can vary depending on the background knowledge and experience of users, the task for which the system is used, and the context in which it is used (Hilbert & Redmiles, 2000). Usability researchers have proposed several classifications of UEMs. Bobadilla, Ortega, Hernando, and Gutiérrez (2013) observed that UEMs are principally are classified into two different types: empirical methods and inspection methods. According to Fernandez et al., empirical methods are based on capturing and analyzing usage data from end users, while expert evaluators or designers perform inspection methods.

2.4.4 Usability Evaluation

The most common types of UEMs are heuristic Evaluations, cognitive walkthroughs, goals operator methods, and selection. A complete evaluation of usability must consider the user, the task, the computer, and the organization. UEMs are evaluated during the testing or implementation stages of the development process (Winograd & Flores, 1986), which leaves unanswered questions in the usability domain about managing usability-related information security failures once the software is released to the organization.

Literature reported how the development process of the healthcare organizations integrated IT. Integration of IT within healthcare services brought about abundant new terms and definitions that define the software and the hardware technology used within these organizations, such as hospital information system, health care information system, medical information system patient information system, nurse information system, and clinical information system (Boyer, 2014) . Such terms are used to describe both the application and the systems that process the presented data in order to produce the required information of the user to achieve the targeted care for the patients. These users are the physicians and clinicians who are responsible for the direct care and observation for the patients, in addition to the healthcare workers whose contribute to the healthcare process by performing tasks issued by the physicians and the clinicians (Grossmann, Goolsby, Olsen, & McGinnis, 2011).

It is a teamwork process that needs a well -developed and efficient system, to keep all the staff members in contact with each other. Such close contact enables them to achieve the required care and treatment for the patient in a fast and effective manner.

According to Harkke, Alessi, and Collan (2003) healthcare IT (HIT) applications are identified, according to the department levels that each application (subsystems) is developed for, according to each department's needs, beliefs, practices, and expertise into one of the following essential subsystems or by-products: Computerized Order Entry Records (CPOE), Electronic Medical Record (EMR), and Computer-Based Patient Records (CBPR).

Orgun and Vu (2006) found that these subsystems consist of multi-platform and multi-vendor application wrappers, which are constructed around different sources of data that influence the difficulty of the HIT/S.

2.5 Healthcare Informatics Evaluation

Ammenwerth et al. (2004) defined evaluation as the process of measuring or exploring the properties of a health information system, which include the planning, development, operation, and implementation, to produce a decision concerning that system in a particular framework. Meanwhile, Friedman and Wyatt (2006) defined evaluation as the study of the effect of software on users and the wider world.

Kushniruk (2002) stated that the procedures of evaluation in the health informatics should consist of a common and modern methods, Also, and that the evaluation process extend to from project planning to design and implementation.

According to Bürkle, Ammenwerth, Prokosch, and Dudeck (2001), evaluation starts in software development, and it is divided into verification, validation, assessment of human factors and assessment of clinical effects. Verification is the answer to the question: "Did we build the system correctly?" that being asked throughout system design and development to find if this system achieves its specifications and to check its uniformity, completeness, and accuracy. Meanwhile, validation is the answer to the question: "Did we build the right system?" that being asked later to discover whether the system in a real working environment can accomplish the tasks that it has been designed for.

Human factors assessment answers the question: "Will the system be accepted and used?" That led to the appearance of two concepts; usability and usefulness. Ohmann, Boy, and Yang (1996) explained that the concept of usefulness examines the scopes of user's satisfaction, which includes both; the system- independent aspects such as an individual's dislike of computers, and system-dependent aspects such as; content satisfaction, interface satisfaction, and organizational satisfaction. Meanwhile, the concept of usability represents the terms of effectiveness, efficiency, and satisfaction. Bürkle et al. (2001) explained that the appropriate methodology to evaluate a system's usefulness and usability together is by observing the system and the system's main users while they are operating the tasks in their real work environment.

Finally, the assessment of the clinical effect answers question: "What clinical effect does the system have on the patient's outcome?"

2.5.1 Usability in Healthcare

In summary, health IT usability evaluation and assessment is achieved by interaction aspects where the interface has high usability; such as, satisfaction; effectiveness; learnability; etc., for its four components that are a user, a task, the health IT, and the environment. Usability is considered a general concept which produces a usable product for the end users. Technology usability has been defined and studied in the management of information system and human-computer interaction fields; these studies using definitions of general technology usability concepts to do research that is mainly concentrated on health IT usability (Dafalla, 2013).
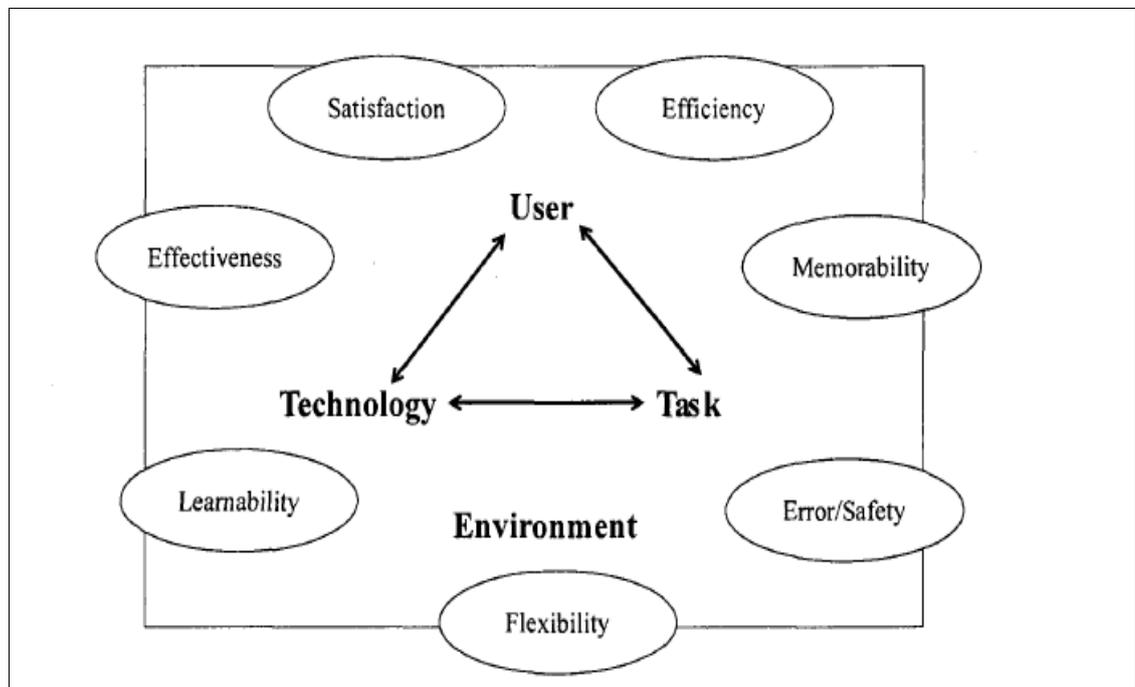
Figure 3: User-centered design framework: (Dafalla, 2013)

One of the fundamental components of usability is user-centered design. Therefore, considering factors such as user's satisfaction is essential to understanding the user's view of usability as shown in Figure 3. The satisfaction is considered the only subjective aspect of defining usability; thus, the health IT acceptance subjectively evaluates the usability of health IT. Meanwhile, health IT adoption concentrates on

health IT diffusion barriers; such as finance, behavioral change resistance, deficient organizational support, system effect, and absence of technical support.

According to Kaplan (2001), there studies found different reasons for the failure of a health IT implementation. The main reasons were summarized in the following points:

- Poorly designed health IT

- Poor use of health IT by the clinicians

- Socio-organizational factors; such as goal conflicts, lack of time, or lack of support from colleagues

Meanwhile, Cain, et al (2013) pointed out that what was being measured in these studies was not clear. So it was difficult to know if the problems were because of health IT usability (health IT itself), health IT acceptance (user resistance), or health IT adoption (social-organizational issues).

According to Davis, Bagozzi, and Warshaw's (1989) research; general technology acceptance is connected with the subjective general technology usability. Also, (Burton-Jones & Hubona, 2005; Davis et al., 1989; Yi, Wu, & TUNG, 2005) studies found that users variances should also be considered in general technology acceptance. User variances such as user experience; age; education; and gender have a significant role on a user's attitude and can be improved and developed by adequate and additional training on computer use (Alquraini, Alhashem, Shah, & Chowdhury, 2007).

However, Pizziferri et al. (2005) pointed out that there should be a good understanding of the differences between user variances that affect user's attitude towards health IT

and the health IT usability itself. It is important to recognize whether there is a need to improve the health IT's usability or to provide adequate system training. Technology adoption is also affected by socio- organizational issues; such as political processes, change management, leadership, commitment, finance, and risk tolerance.

In the relationship between health IT usability, acceptance and health IT adoption usability should be evaluated before moving forward to acceptance and adoption. Statistical methods can be used to control the effect of user variances and any existing socio-organizational factors in order to of concentrate on what is being measured (Yen, 2010).

Healthcare organizations normally provide the standard patient care with maximum efficiency to achieve the required outcomes for the patient. Despite this, organizations face many challenges that may affect the target patient outcomes such as; financial limitation, staff shortages, prolonged waiting times, and complex medical conditions of elderly patients that most healthcare organizations face. Therefore, in the last decade, healthcare technology has been developed and there has been a marked increase in its use within the healthcare environment, changing the way in which healthcare is provided (Johnson, 2008). As Courtney, Demiris, and Alexander (2005, p. 315) emphasized, "it improves the workflows within the healthcare organization."

 The development of technology within healthcare organizations plays a major role in facilitating the process of accessing patient records and ordering medication. It also

encourages knowledge transfer and enhance the quality delivered clinical care through the instant availability of educational resources via the internet or intranet.

Nurses are data and information workers who are responsible for delivering the required patient care within the healthcare organizations. Therefore, they have to employ a combination of their knowledge, skills, and experience\ to provide the required patient care and enhance the outcomes. They may face challenges in accessing online evidence-based resources as computers are usually situated away from the patent's bedside where care occurs, which may cause a delay in providing care and become time consuming.

Today's technology developments have changed our lifestyle remarkably. Computers, laptops, cellular phones, PDAs, smartphones and tablet PCs play an increasingly important role in our daily lives and have to some degree simplified our lives. Di Pietro et al.'s (2008) study confirmed this finding an 18% increase in sales, meaning 13.1 million devices worldwide. Smartphones and tablet PCs have had the highest impact because of their multi-functionality; use as a phone, a camera, an organizer, and being able to directly access the internet; as well as being an anywhere, anytime portable device. Consequently, their use in healthcare environment could affect the process of delivering health care. As such they can be considered a delivery method for point-of-care information, increasing the speed at which the information can be delivered at the point-of-care, a point emphasized by Dale and Le Flore, (2007).

2.5.2 Portable Devices in Healthcare

This literature review found multiple articles regarding projects involving portable devices and nurses within the healthcare environment. The study by, Peterson (2003)

study pointed that many nursing programs expect their students to obtain these devices (PDAs, and tablet PCs, etc.) to download evidence-based resources as textbooks are not always available for all student at the same time.

Furthermore, several studies (Carlton, Dillard, Campbell, & Baker, 2007; Farrell & Rose, 2008; Greenfield, 2007; Kuiper, 2008) were also found concerning the usage of portable devices by the nursing students and the positive feedback on these devices in regards to healthcare professionals.

For example; Carlton et al.'s (2007) study showed that the use of PDAs by nursing students led to improved and increased classroom and clinical student productivity, and also, to eased the transferring of information to students and there by saved time.

2.6 Motion Capture

Motion capture is the process of transferring movement, of a human for example; animals; or objects, from real life into XYZ coordinates on computer. These captured movements are theneither post-processed or applied to a 3-D computerised character to simulate the subject real life movements (Lindequist & Lönnblom, 2004).

Despite while, motion capture is usually connected to the entertainment industry, especially animation movies and video games, this technology is also used in other fields, such as medicine, sports, and the military.

Different methods can be used for motion capture; the most common being optical motion capture systems and electromagnetic systems.

Optical motion capture requires cameras to record the subject's movements. A minimum of four very high-performance cameras (capturing up to 2000 frame/ sec) are used, as shown in the figure. Besides, a suite of markers that is made of reflecting material or LED should be worn to be scanned for the video clip by the cameras that are placed at different angles toward the actor. The cameras order is filmed and then analyzed(Menache, 2000). As well as, the Positions of the markers are also stored on the computer. Accordingly, each camera gives different inputs, which will be combined and process to produce a 3-D demonstration that is known as motion capture data or motion data, which will be analyzed or applied to a 3D- character.

The infrared cameras work by tracking the marker positions in 2D and 3D models. The markers are often made of materials that blink or lighten up to make them easily visible to the infrared cameras. After the motion has been captured, the results are mapped on a virtual frame that suits the needs of the user. The cameras are often positioned in nearly all directions to enable them to capture every movement within the body of the subject. Motion builders are then used to create animations that would depict similar motions as those performed by the actual persons.

In the electromagnetic system, the subject also wears a suit but with 10-20, magnetic sensors attached to it. To record the whole body's movements, an electromagnetic field is produced by a magnetic field generator leading the sensors to return both their position and rotation (Lindequist & Lönnblom, 2004).

In medicine, motion capture is commonly used to do a gait analysis, through which human gesture will be explained and understood in order to detect motion abnormalities and walking changes.

2.6.1 Advantages and disadvantages of motion capture

In regard to dynamic ergonomics, there are advantages and disadvantages to using the motion capture as a user research tool to understand users and the task performance of their tasks.

The accurate capturing and presentation of data by motion capture leads to scientific and credible data analysis, which helps in comparing movements between older and younger participants in order to understand how age affects task performance. This strengthens research findings and raises opportunities for, product development in relation to how to overcome performance task challenges for elderly people (Menache, 2000).

On the other hand, despite the accuracy of motion capture in capturing the real-time data, this advantage is not enough when considering motion capture as an adequate research tool for the research process. The controlled environment for the experiment with the equipment that is not cleafy and understood by the participants, can affect the subject's confidence and focusing while performing the tasks.

Although, wearing a special high tech suit adds some enjoyment for the participants, they may feel uncomfortable in the suit due to its tightness, unusual colors, and the camera's sencors all over their body.

Producing logical results from the scientifically captured data is considered the main challenge of using motion capture as a user research tool. Obviously, motion capture for generating 3D a visualization in animation is different from using it as a research tool. The goal of using it as a research tool in this case is to assist identifying potential product opportunities by better understanding the physical limitations and mobility of the elderly. Even though, until now there is no specific computer program available to produce useful user information for the product design and motivation.On top of all this, students who use motion capture as a research tool should a good understanding of the captured data (Kitagawa & Windsor, 2012).

In conclusion, despite great success that has been achieved in motion capture experiments, a number of scholars have made various recommendations for its use. One such recommendation is to make motion capture more useful as a user dynamic ergonomic research tool through the use of new software that would translate the captured data in a manner that is directly related to dynamic ergonomics. Such software would show directly motion range and speed, or may it automatically recognize problems according to predefined standards or a database comparison, as shown in the following page Figure 4.
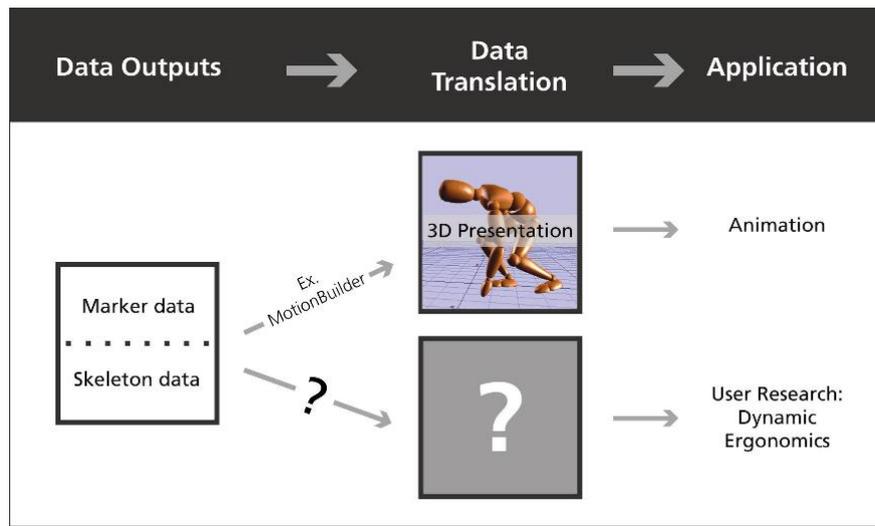
Figure 4: Motion Capture from (Lindequist & Lönnblom, 2004)

2.7 Discussion

The significant and increased intersection between technology and the healthcare environment has led to easier and faster access to healthcare and created chances to create high quality and highly modified healthcare.

Courtney et al. (2005) pointed out that nurses, in general, accept and are willing to use and carry technological devices in the workplace if it enhances the care process. On the other hand, many factors affect the involvment of these devices in nursing practice. Therefore, the advantages of involving of portable devices (such as tablet PCs, smartphones, etc.) in the health care environment's daily practice must outweigh the disadvantages or the difficulties in order to be successful and efficient.

Accordingly, the advantages of using portable devices to access electronic resources in the point of care practice are the following:

These devices increase efficiency, reduce error, save time, increase productivity, and provide nurses with the required resources electronically that were designed for these devices (tablet PCs, smartphones, etc.). These devices helped nurses find the required information without the need to look for it in paper resources, manuals, or textbooks as these resource can be electronically available at the bedside when the need arises (Johnson, 2008).

Using motion capture technology in usability testing will be useful to discover the user's actions and feelings about the technology and especially these older people. While motion capture needs special equipment and preparation this study will take place at the AUT MoCap Lab. For the MoCap technology to work the users, nurses and patients, need to be familiar with the environment and the suits.

2.8 Summary

In summary, this study considers health IT usability as a connection between users, system, and task within a well-defined environment (physical). Health IT Usability was measured both subjectively and objectively and, as user variances were expected, the health IT design considered end-user characteristics at the beginning, so that the user variance was minimized and normally distributed.

Rubin and Chisnell (2008) recommended the use of a refined usability evaluation to recognize the problems at the early stage of technology development. This makes the products more and more specific to the user's needs. In addition, Johnson, Johnson, and Zhang (2005) suggested that the concepts of user-centred design and the cognitive model be employed to allow users to be part of the design process, so that designers could identify what the system required in order to accomplish the users' needs.

Usability evaluation is used to appraise the significance, worth, or condition of health IT, usability specification concentrates on the design criteria. Therefore, Stead et al. (1994) believed that performing needs assessment (usability specification) and significance assessment (usability evaluation) from a system development life cycle (SDLC) are parts of the basic requirement to develop a usable and effective health IT system. The usability of a system ensures that the interface developed for the system can be easily used by the prospective users. The usability test ensures that the system components are tailored towards meeting specific user needs enabling them to achieve their goals effortlessly. Performing a usability test on tablet PCs can help the health care system to make recommendations to the manufacturers and developers to come up with special devices that would perfectly suit the needs of the people interacting with the system.

3.0 CHAPTER THREE

This chapter describes the research methodology and approaches that have been used in the study. The key objective of the experiment was to evaluate the benefit of using a tablet PC for clinical consultation of elderly patients. A mixed method model was used in this study to ensure that data collection was done from all the three perspectives, i.e. the patient, the tablet PC, and the nurse. This chapter will also entail a description of the pilot study that was conducted. The original study was meant to be performed at a hospital, with nurses, the Tablet PCs, and patients. This was later moved to the motion capture lab at AUT. The experiment was canceled due to ethics issues and lab maintained. Therefore, only the pilot study was conducted.

3.1 Introduction

In this chapter, we discussed the mixed methods approach that was used to investigate the impact of using tablet PCs in the New Zealand healthcare sector. It addresses the quantitative and qualitative methods ethics, data collections methods and data analysis methods. This chapter will give an overall picture of how the study was designed.

3.2 Methodology of this study

The mixed method model is a popular methods used in research to gather useful data, where the running of qualitative techniques along with quantitative techniques can be helpful in examining the specific isolated components and exploring the complex data (Ritchie, Lewis, Nicholls, & Ormston, 2013). According to Verd (2004), the benefit of using mixed methods is the ability to compare data from different sources in an attempt to validate results by examining the degree of coverage and agreement across methods. Consequently, if both quantitative and qualitative methods are used, the level of

agreement will increase and the findings will with have greater credibility(Fielding & Fielding, 1986).

3.2.1 Mixed methods used

Using the mixed methods, approach enabled us to utilize the strengths of both qualitative and quantitative methods and reduce possible weaknesses. This was emphasized by McDermott (3000) who confirmed that using mixed methods contributes to a reduction in risks of convolution and oversimplification.

Therefore, using the mixed method approach has many benefits on research process, where Bulsara, C. (2015) defined these benefits as the following:

• Validity due to different types of the collected data

• Variety of question answers because of the participants' different viewpoints.

• Reduce the gap between the researcher information and the collected data

• Provide the researcher with all required information which sometimes one methodology cannot provide.

This study used a survey as a quantitative method and interview for the qualitative method, adopting the framework from Creswell (2013, p. 16). The combination of qualitative and quantitative methods provides a comprehensive analysis of our research result; in the following page Figure 5 shows the combined of methods in order to enhance the collection of data to provide us more information.
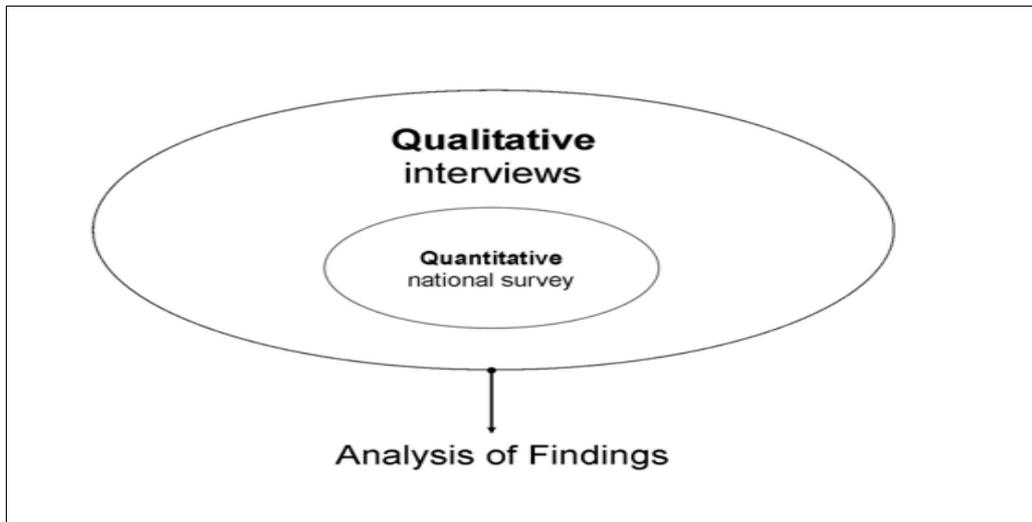
Figure 5: combination of methods

In this study, the survey was used to gather demographic information about user "patients" and other useful data to combine with the interview to understand the triangulate (health staff, patients and technology) as shown in the following Figure 6.
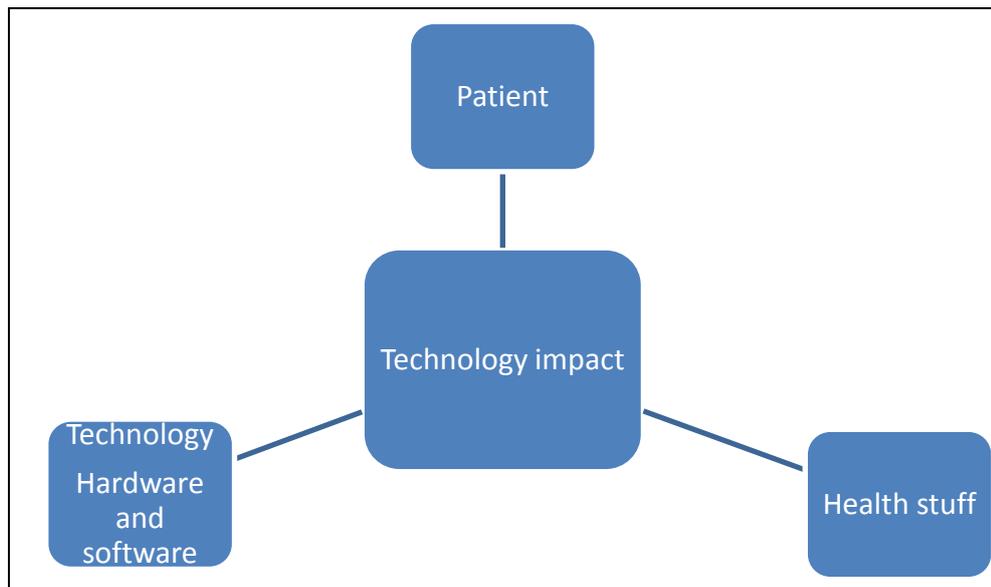
Figure 6: Data triangulation

3.2.2 Ethical Considerations

The research required an ethical approval from AUT University; the form was returned on 14 April 2016. Dealing with human subjects in research requires approves from the

University's Ethic Committee, see (Appendix C). Unfortunately, the delay that occurred in the process of getting the ethical approval prevented the researchers from conducting the experiment.

3.2.3 Data collection methods

Two methods of data collection were used in this study being a questionnaire and interviews with patients and nurses. The first method was used to obtain demographic information of the users. The second method was used to obtain participants' feedback and to understand how they interact with a tablet PC application.

3.2.3.1 Survey

A questionnaire was used to collect useful data about participants, the questionnaire obtained participants' thoughts, feelings, attitudes, beliefs, values, perceptions, personality and behavior (Christensen, Johnson, & Turner, 2011). A researcher can build a picture of different kinds of technology users using questionnaires techniques (Bell, 2014).

The questionnaire as shown in Appendix E is a list of structured questions carefully after complied pilot the study (Collis & Hussey, 2013); the survey could be paper based or electronic via an online website such as SurveyMonkey. Question can be closed or open questions; Oppenheim (2000) defines closed question as questions where response is from a choice of different answers, where participants can tick or choose from specific options. Open or free response questions do not follow any restriction or give options where participants choose a prewritten answer.

Each type has advantages and disadvantages; the closed questions are easier and quicker to answer, the open or free questions provide more information but required a complex method of analysis and require more time. Oppenheim (2000) suggests that closed questions lose spontaneity and expansiveness. Oppenheim adds that a questionnaire may contain checklists, scales, projective techniques, rating scales and a variety of research methods.

There are no specific steps to follow in order to design a questionnaire or any scientific principles that can guarantee a perfect questionnaire (Malhotra, 2008).

The questionnaire design of this study adopted the following steps, defining the research objective, selection of an appropriate format and layout design (Wilson, 2003).

3.2.3.2 Interviews

According to Robson (2002), there are several advantages to using interviews in research, one being that interviews are flexible; the researcher can adapt the interview to each subject. The results could also be more accurate and honest as the interviewer can explain and clarify any questions individually for participants. Brewer and Miller (2003) add that the interviewer can follow up with more questions in order to clarify unclear responses by asking additional questions.

There is three styles interviews; unstructured interviews, semi-structured and structured interviews. The format of question is wide, questions are presented and asked in sequence or in a fixed form, to the open or non-directed (Saunders et al., 2011).

In general, unstructured interview use an open-ended or open questions that the researcher can ask depending open interviewees responses (Naoum, 2012). According to Stewart (2002), unstructured interviews are appropriate when the topic area is extremely broad, giving the researcher the freedom to adapt to different situations. At the same time, the unstructured method needs a high skilled researcher.

In a structured interview all questions are thoroughly planned; answers are stated in words of which the interviewees can pick answers from those provided (Stewart, 2002). Stewart added that structured interviews are easy to use, conduct, record and analyse. However, the interviewer has no chance to explain, qualify or futher questioned the interviewes.

The semi-structured interview has a specific topic. According to the semi-structured interview has four characteristics:

1   Take place with answers known to have been involved in a particular experience.

2   Refer to situations that have been analyzed from the previous interview.

3   The questions and interviewer guide the interviewee specific to topics related to research questions.

4   Are focused on the respondent's experience

In general, the semi-structured interview consists of both structured and un-structured questions, it is used to gather valid and reliable data relevant to the research questions and objectives (Saunders et al., 2011).

3.2.4 Pilot Study

A pilot study was conducted in 8th March 2016. The objective of the pilot study was to refine and clarify whether were any problems in the questions or design of the questionnaire and the interview. The pilot study offered a chance to involve and understand the research questions and objectives before undertaking the actual experimental. Details are given in the next chapter.

4.0 CHAPTER FOUR

This chapter makes a presentation of the pilot study findings. Two pilot studies about motion capture will be given in this chapter, as well as the survey's pilot study. Issues and difficulties faced during this research, will be discussed in this chapter.

4.1 Introduction

This chapter concerns the pilot study into using motion capture as usability evaluation method for the use of tablet PCs in healthcare. It introduces the research's pilot study. A full experiment was planned using motion capture. Due to delay in the ethical approval process and problems in the motion capture lab, the main experiment was canceled. Therefore, the tests and their results will be adopted throughout this chapter.

As mentioned earlier this study was performed by two researchers as both were researching this topic. The researcher of this work was responsible for the interviews and survey, and the other researcher undertook observation and evaluation. The researcher undertook their own data analysis and formulation of their conclusion.

4.2 First Pilot study (Motion capture)

Kurfess (2005) states that in pilot studies, a small trial or pilot study should be undertaken to ensure that the designed plan is practical before conducting the main study. Normally this trial test is conducted to check the procedure, instruments, questionnaires, etc, to ascertain whether find out if they are working correctly and accurately, or they need to be modified.

The aim of this study was usability evaluation for tablet PCs in healthcare clinics. Therefore, to simulate the clinical environment, a motion capture lab was used for the pilot study, and a trial test for this pilot study was done on 8th March, 2016 at the AUT motion capture laboratory. This trial test was conducted to examine the lab environment and equipment.

One staff member from the motion capture studio helped us to prepare the experimental lab instruments. His presence was important to confirm that the lab instruments were working properly, and he instructed us on how to use these instruments to ensure achievement of the desired outcome.

4.2.1 Participants

Three students played as the participants. They were recruited in this trial test; they were all from the Auckland University of Technology. The participants were males with in age range of 26 to 35. English was their second language, see the following page Table 1, and all of the participants were physically fit, with no medical problems.

This small number of participants was enough to conduct the trial tests, and each participant played several roles based on scenarios which were provided to them.

Table 1: Participant's demographic information

Participant	Age	Gender	Ethnicity	Major
P1	28	Male	Arabic	Master student
P2	27	Male	Arabic	Master student
P3	35	Male	Arabic	Secondary Supervisor

4.2.2 Objectives

The objectives of the trial pilot study test were a better understanding of how motion capture can be used as a usability testing procedure and to test our equipment, the tasks' scenario and session procedure plan, to gain answers for the following questions:

- Is the Motion Capture laboratory considered a practical environment to do usability testing?
- What does motion capture add to the research study?
- What are the issues?

4.2.3 The experimental procedure and tasks

The motion capture studio staff member laboratory took 30 minutes to prepare the lab for the experiment. He explained to the researcher and the participants how the lab equipment worked and explained how the raw data would be collected and what its initial form would be.

The researcher and the participants discussed the task's scenario after the information about the experimental equipment had been collected. An initial trial experiment was then performed, it was not recorded into the system, and the participants were not wearing the suits. The idea of doing this initial trial experiment was to make the participants familiar with the task's steps and instruments to avoid making any mistakes while wearing the suits.

After the staff member laboratory had finished preparing the cameras and software, and the participants were ready, the staff member laboratory asked the participants to put on the experimental suits. He spent around one hour helping participants put on the experimental suits, as it was the first time for all of the participants to wear such suits. The staff member gave a brief introduction to the suit and how it should be worn to work properly. The participants reacted positing to the laboratory staff and were happy and excited to wear such a suit.

Three healthcare applications were chosen to be involved in the pilot study. These applications along with the task's scenarios were explained to the laboratory staff. Accordingly, he advised the researcher that for this study, the preferable captured film

recording time was not to exceed five minutes, so longer films need more processing and are time consuming.

As we had three subjects each subject should be identified by the system individually. This mean each subject alone had to do several movements while standing in T position, the movements were given by the statt member and the suytem cameras captured these and they were processed to be special identification marks for the each subject in the system. This process took 10 minutes for each participant, and this was also done for the tablet which was used in this experimental. After this, the suit markers' position could not be changed. If this occured, an error would occur during the experiment recording or there woiuld be a loss of signal from the markers, that were moved.

When all participants were ready, and the lab instruments were prepared, the experimental test started and the time recording started at the sound of the clapperboard. Five experiments were performed; one trial and four main tests, and all were done in the same session.

A Samsung tablet PC was the tablet used. The researcher was the observer who took the notes while the three participants were performing the task. Four different scenarios were adopted for this study and two subjects performed each scenario. The following page Table 2 explains all the experiments that were performed.

Table 2: The experimental setting

Experiment	subject	Scenario	Result	voice Recording
#1	P1(nurse) and P2(patient)	This was a training trial, and no recording was performed.	Participants understand what they should do.	no
#2	P1(nurse) and P2 (patient)	A normal clinical visit was performed as the patient entered the room where a nurse was standing, a conversation was undertaken between both of them and the patient was given the tablet PC in which to fill in his personal information.	The patient was happy with using the tablet PC and felt excited to use it.	no
#3	P2 (nurse) and P1(patient)	A normal environment was simulated. The patient was outside the consnlting room waiting for the nurse to ask him to enter. The nurse did so, and both walked into the room, after welcoming the patient, the nurse give him the tablet on which to fill in some information.	The patient was not familiar with the tablet PC, and was confused while using it.	yes

#4	P1(nurse) and P3 (patient)	A normal clinical examination was done; the nurse measured the patients blood pressure and weight, then give him the tablet to fill in his personal information. The patient was not familiar with the tablet and asked many questions regarding the tablet. For example, he asked how to hold it.	The patient was not familiar with tablet and did not know how to use it. It was his first time for him to use a tablet.	yes
#5	P3 (nurse) and P2 (patient)	A normal clinical visit. However, the nurse was stressed due to the markers, and the patient was a little nervous due to the nurse's reaction while using the tablet.	The nurse and the patient were under stress.	yes

4.2.4 Data analyses

After performing the experiments, multiple data were collected. These data were from two resources: researcher observations and recorded motion capture. Thus, the raw data were in two forms: written (notes) and videos. The raw video data needed to be processed by special software. In this study, two software packages were used, Cortex and Motion Builder.

4.2.4.1 Cortex

Cortex is a single integrated software application that significantly improves outputs. It was the first MoCap tracking software constructed from the Microsoft.NET Framework, which maximizes productivity by translating captured information into features.

In order to record the body movement, markers should be attached to the motion capture suit of the actors, through which the system can recognize the movement performed and record it. Therefore, these markers should always be seen by the camera during the clip recording, and no gap should appear between them in the frame.

The Cortex application involves some tools that can help the programmer find the marker. Each tool has a different purpose and technique. For example, "Rectify" is a tool used to find any missing marker. A missing marker produces a gap in the recording, so "Rectify" can be used to identify the missing markers in the frame as it can scan all the markers to find it. As shown in the following page Figure 7, the system software identified the subjects through the markers which were placed all over the body, and the output of the motion capture was presented by Cortex as skeleton data. The tools are presented on the top of the screen and each tool is used for a specific purpose regarding data interpretation.
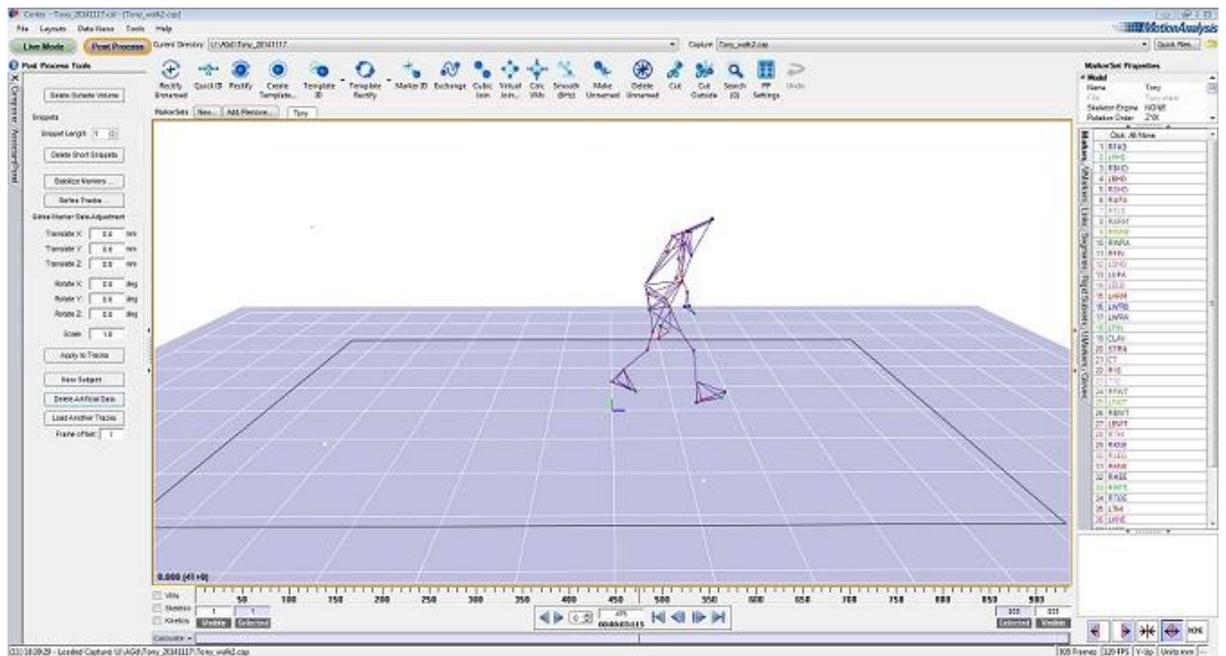
Figure 7: Cortex screen shot

Sometimes identification of a missing marker may be false, and the tools could not find it. If it was deemed to be completely blocked and the software cannot find the missing markers, the mis recorded part will be deleted.

4.2.4.2 Motion Builder

This is a 3D character animation software, which manipulates and refines the collected motion capture data and plays it back as a complex character animation. It has multiple features such as; presenting real-time animation tools, creating facial and skeletal animation, and making a direct connection to other Autodesk digital content creation tools. After having made the markers clearly seen and smooth using Cortex, Motion Builder used to match the markers with characters as animation. We imported the markers into this program then we started with the tablet PC. We created an irritation tablet PC; then we matched the tablet PC with the markers of the tablet PC. After that,

we created a fictitious nurse character then we matched it with the subjects' markers and did the same with the patient. The markers were connected with each part of the body to see clearly the movement. That took around 45 minutes. Finally, it saved it and exported.

These programs helped us to see the data as real animation. However, it took around two hours to build and collect data for only one experiment. The software user cannot see emotion of the characters' faces and cannot see the movements of the fingers as there were no markers for these areas. Thus, while the patient or nurse is touching the tablet PC, the user cannot see real touching or facial expression.

4.3 Survey Pilot Study

The second pilot, which is considered as a simulation focused on the interview section of the research (Pre-questions and Post-questions) as shown in Appendix D, with the interview questions being about using a tablet PC in a motion capture laboratory. The main aim from this pilot study was to avoid any issues or problems with the real participants in the lab while doing the main experiment. It would also show any modifications required for the task script, steps, or the instrument.

 The pilot study was conducted with an undergraduate student who was doing computer science at AUT. The participant was a 20-year-old male of. The student had not been in a motion capture laboratory before.

As a result, I have found some questions needed to be considered. The following tables describe what was discovered. The following page Table 3 shows the answers for the pre experiment -interview questions. The following page Table 4 shows the answers to the questions for post experiment -interview:

Table 3: Pre experiment -interview questions

No	Questions	Participants comment
1	Are you familiar with the use of tablet PC devices?	Easy to answer there is no problem with it.
2	Do you use these devices in clinical care currently?	This question is only for the nurses
3	What benefits do you think these devices can bring?	An open question *Will get a lot of feedback.
4	What are the issues/problems with using these devices?	This question is not necessary, as it will be asked the post interview.

Table 4: Post experiment -interview questions

No	Questions	Participants comment
1	Did you find you were able to behave naturally in the MoCap Environment?	Good question.
2	What advantages were there to performing the usability evaluation in the MoCap environment?	Not clear to the student. Needs to be rewritten to be clear.
3	Did you find the Tablet PC easy to use?	Good question.
4	What issues did you find with the Tablet PC?	This question is in a good place as it is the same as number 4 in the pre experiment - interview.

5	Would you incorporate tablet PC use into clinical practice if you could?	Good question.

4.3.1 The main experiment

As, mentioned before, this research is in connection with other research concerned with clinical consultation. Both researchers cooperated and discussed their objectives; they found they can conduct the same pilot study as their objectives were the same. Therefore, the protocol for the pilot study was designed for both studies, where they share the same scenario and tablet PC application. However, they would differ in observation and experiment before motion capture.

Subsequently, the main purpose of the pilot study was to discover the usability of tablet PC within the healthcare environment. In this research, the main concern was with the older patients, and it was aimed to find out how the portability of a tablet PC could affect older patients' movements while using it within the clinical environment.

The original research was planned to take place at a hospital in New Zealand. However, due to certain ethical approval issues, the experiment was not performed. Therefore, both researchers decided to simulate a clinical environment as a hospital paradigm. The University's motion capture laboratory was the used place to generate a clinical environment, which concerned about the nurse room where the patient basic personal information should be collected, so a disc and two chairs were been presented in the

motion capture lab. The participant who represents the nurse role will seat on the chair behind the desk, while the participant who represents the patient will come in and set on the chair that is front of the desk.

In the trial pilot study experimental tests, participants were required to wear special suits covered with markers. The tablets PCs were also fitted with markers. These markers needed to be identified by the system through the cameras, which record the movement performed by the subjects, in order to measure the movements of the reflecting markers positions.

The experiment was planned to involve a pre experiment-interview, followed by the simulated clinical encounter observation, and then a post experiment interview. The aim of the study for both researchers was to answer the following questions:

1   What are the benefits/ issues that result from using a tablet PC within a clinical environment?

2   How does the motion capture application impact the experience of the usability evaluation?

3   Can a review of the motion capture data offer more information, by the evaluator, and with the participants involved?

4.3.2 The experiment participants

In this experiment, for both pieces of research, our original plan was to recruit AUT student nurses and the AUT staff to act as the participants in the clinical setting simulation.

4.3.3 Objectives

As mentioned above, this study along with the other pieces of research were looking at the same objectives, which are the following:

1. Research on the benefits and issues that may come from the use of tablet PCs within a clinical environment

2. Discover the impact of motion capture while performing usability evaluations.

3. Review the extent to which a review of motion capture data can produce further information about nurses and patients using tablet PCs.

4.3.4 The experimental procedure and tasks

On the due date, it was planned that a lab technician staff member would prepare for the experiments, but due to lab maintenance, these experiments were also canceled. However, it was expected that while the motion capture lab was being prepared, the researcher should explain to the participants the objectives of the experiment. The subjects should be shown how to use the tablets while the markers were on it.

When the lab was prepared and the cameras were ready for the experiments, the participants were encouraged to ask any questions regarding the role. They were expected to play, as they should be comfortable with their role.

During the experiments, the patients (students) were to respond to the supervisor nurses. Each patient was estimated to have at least 40 markers on their body suits, and so there would be some restriction to their movements. They should be within the camera's field

of view to avoid missing marks, which would lead to a gap in the recorded data or erroneous data.

To simulate the clinical environment, it was planned that the nurse's subject would be sitting in the lab, and each of the patient participants was to come in when the sessions were organized. A brief welcome would be done, followed by a conversation between the two subjects, where the 'nurse' ask the 'patient' to use the tablet PC to fill out some information. Various simulated clinical scenarios were expected to be performed, based on a recording of health data.

Similar to the trial pilot study, the recording period in the main experiment was estimated to take 5 minutes for each group. Observations were to be made by the main researcher, and a recorded video was be done via MoCap. A follow-up session was planned to inquire about the patient's' opinions about their experience using the tablet PC within the clinical environment.

The nature of participation was in the experiment voluntary; the participants were not to be subjected to any form of pressure during the experiment. In addition, the observations were to be primarily based on their experience while using the tablet PC. They were able to withdraw at any stage of the experiment if they were uncomfortable.

A little practice was planned to be done for the participant, so they would be familiar with the environment and the task while wearing the suits and to avoid mistakes while recording.

Six experiments were planned to be performed. In all of the experiments, the 'patient' was to be the one who should walk into the lab, where the 'nurse' should be presented. The 'nurse' should give the 'patient' information and ask the patient to use the tablet PC to complete some personal information. During that time, the MoCap system should record all data regarding their movements and responses.

A follow-up interview should be held for each patient participant after his/ her testing sessions to see how he/she found his/her experience with using a tablet PC within simulated clinical environment. The Table 5 below presents a summary of the experiments that were to be performed for both types of research. In addition to the relative expected outcomes:

Table 5: Expected Experimental Result

Experiment	Actors	Scenario
#1	P1 (nurse) and C1 (patient)	The nurse should sit inside the room. The patient should walk in, greet the nurse and takes a seat. The nurse should present the patient with the tablet, which he should take and begin to use. The patient should hold the tablet with one hand and use the other hand to make entries. Though not fast, the patient manages to enter the required information. The cameras record the position and the angle of change in the markers.
#2	P2 (nurse) and C2 (patient)	The patient should walk into the room, asked by the nurse to take a seat, and then be presented with the tablet. At first, the patient was expected to look confused and sit down in a bent posture being unable to read the screen content due to vision problems (short sightedness). Nonetheless, with the bending posture, he managed to use the tablet successfully and fed in the data.
#3		The patient should walk into the room. At first, she

	P3 (nurse) and C3 (patient)	looks a bit nervous. She will be invited to take a seat, and asked if she could use the tablet. The patient admits that she can use it since it bears a resemblance with her cell phone. She should pick the tablet and may sit in a leaning posture on the seat, holds the tablet to one hand, and uses the other hand to enter the information that she was asked to enter.
#4	P1 (nurse) and C4 (patient)	The patient should walk into the room, asked to have a seat and be presented with the tablet. At first, the patient looks uneasy, as he has never been asked to interact with the PC at the health clinic. After listening to the instructions from the nurse, the patient should make entries into the tablet with both hands, while having the tablet placed on his lap. There was no straining an indication that he was comfortable while using the device.
#5	P2 (nurse) and C5 (patient)	The patient should walk into the room and is asked to have a seat after greetings. He is then handed the tablet and should be asked to enter certain data. The patient seemed to be struggling to find the right position to hold the tablet. Finally, he manages to hold it upright, directly opposite his face. From this point, he began entering the information that the nurse wanted. The patient was slow but entered the right information.
#6	P3 (nurse) And C6 (patient)	The nurse should invite the patient to come in. The patient walks in and takes a seat. She should then be presented with a tablet and given instructions on how to use it. The patient holds the tablet with both hands first and looks a bit uneasy. She should then manage to figure out what the nurse wants her to do and enters the required information.

4.4 Data analysis

The aimed of the main study experiment was to replicate human body movements using the tablet PC. As the markers were to be placed on the subjects, their positions need to scanned by the cameras and identified by the lab systems.

Thus, as the experiment concerned the subjects' posture, when the subjects performs the physical movement, the cameras, according to the history of the marker positions, should record this motion. The movements were to be connected into a particular task, to identify and analyse the whole difficulty or ease in which the activity was performed. It should be then represented by the 3D animation.

4.4.1 Cortex analysis

Cortex is software used to process the raw data collected by the lab cameras. It treats all of the captured movements in a single program by adjusting, tracking and processing the raw collected data to achieve the required criteria. Motion data is collected through the makers attached to the participants' suits and the tablet PC. Cortex receives the captured information, and performs sorting according to a set procedure.

Sometimes gaps may occur in the recorded motion capture, tools in Cortex can find the marker that was responsible for this gap and correction will be performed. Indeed, no gap should be presented in the captured motion video.

4.4.2 The Motion Builder

Motion Builder is mainly used to manipulate the processed data from Cortex into a 3D animation. Each of the selected data should be harmonized with the animation character's movement depending on the marker positions.

In this main study as well as the experimental pilot study tests, three animated characters were planned to be established namely, the patient, the nurse, and the Tablet PC. The analog animator should match all the data with the subjects to simplify data analysis. Therefore, when the animators were activated to play, they should perform movements identical to the real actors' movements. Consequently, the motion builder animators should help to understand the actors movements, making it easy to recognize their relative motions and perceptions.

Regardless of the success in data analysis of this method, there are some limitations in the experiment for example; facial expressions were difficult to record.

4.4.3 Expected results

It was expected from this study that the majority of the patients would show comfort and pleasure using a tablet PC within simulated hospital environment. The majority of the research findings should indicate that the patients had the ability to use the tablets, and they made correct entries of information, which should be an indication of the usability of the software interface.

As most of the patient participants had smartphones, it was expected they would operate the tablet PC easily due to daily interactions with touch screen.

The motivation for performing this experiment was to find out the advantages of using tablet PCs in healthcare for older people. It was also to indicate issues that may arise during the use of the Tablet PC within the healthcare environment. The expected response of the patients was to indicate how the use of a tablet PC would be welcomed and could be easily used by older patients.

It was also expected that most of the patient participants would sit in an upright position while performing the experiment. This represents their level of interaction with the interface, which should be effective and easy.

Since the size of tablet, PC is quite a bit bigger than a smartphone it was expected that some patient participants might find it heavy or big. But, it was hoped that most of them could easily handle the tablet PC and feel comfortable. This intornation should be collected by the markers on the participants' suits, which should register their body movements and would show how comfortable and convenient it was for the participants.

Motion capture establishes the body movement about the subjects' body joint physical centers. Each center joint represents an end factor, and its physical position is restricted in distance to the other joint centre of the body, such as hip, knee, and the ankle joints center and their relative distances.

 Body motion represented by the joints center functions could indicate how the tablet PC and the interface were effective and how easy it was to use them. The captured motion should indicate the level of stress or pressure that both the participant patient and nurses experienced. As a result, that level of motion illustrates how easy or difficult it is for older people to use such devices within the healthcare environment.

Body posture should be considered as an indication of the level of user comfort while using the tablet PC and the application. Consequently, the nurse's posture, as well as the

patient's posture, should reveal the level of usability of the tablet PC within the healthcare environment.

In sum, motion captures data's wide range of information about a user's movements while using a tablet PC, can be used to discover several variables within an experiment. With the increased use of mobile phone technology(Smartphone), many users were expected to be able to use a tablet PC easily, since a tablet PC at a certain level is similar to smartphones in design, function, and application interface.

4.5 Summary:

Using motion capture in the consultation setting is quite difficult for patients especially with elderly people. Patients found it hard to wear the suit and use the tablet PC during the consultation. However, some patients find it interesting to use this kind of technology in consultation services, especially in a motion capture lab. Moreover, to improve the quality of the consultation, the movement of the participants will be recorded as data in the motion capture lab. Therefore, the researcher can see the data and see what the effectiveness of the consultation is.

Two programs were to finalize the data of the experiment performed during the studio lab capture, Cortex and Motion Builder. It was interesting to capture and make a 3D animation and be able to see our movements. However, it took us exactly two hours for one experiment (clip), and the laboratory technician assisted this, as the researcher did not have any experience with these kinds of programs. The experiment (clip) length was around 4 minutes. The clip, captured three objects, the nurse, the patient, and the tablet

There were at least 40 markers on the suit from feet to head. The subjects needed to be careful when he/she moved around to avoid the markers touch each other.

The motion capture experiment aimed at measuring human joint motion within a MoCap experience. The animation software should clearly simulate the actor's motion sequence, for example, the stretching motion movement of the patient participants arm to pick up the tablet, and position movements when leaning forward or backward to enter information into the tablet.

Regarding posture, as a tablet PC does not require a lot of movement to perform a task associated with its multi-touch screen applications, it was expected that the required motion to take use the tablet not physically stress an older patient. In other words, the slight movement that is required to use any tablet PC should indicate how easy it is to use this device by older patients, regardless their health.

CHAPTER FIVE

5.0 Introduction

Mobile technology has had a significant impact on the healthcare sector. Nurses alongside other medical practitioners have found the mobile devices to be highly relevant to their practice. The devices allow swift access to patient information, smooth workflow, portability, and remote access among other benefits, which initially were not found in traditional, stationary computers. Based on the above observation, this paper seeks to examine the importance of using tablet PCs in healthcare, and how the usability of the software can be evaluated. The study will be based on the research findings of Richter et al. (2008).

This chapter concerns answers to the research questions. In addition, it will introduce the researcher's conclusion and area for future work.

5.1 The importance of using a Tablet PC on health care

This main research question was **"How can we study the use of tablet PC on how it will improve the quality of the consultation services, which are provided to elderly people?"**

The aim of this question was to find out the benefits of involving tablet PCs the healthcare environment and their role in enhancing healthcare services for elderly people.

According to this research and that of the literature review, the increased use of mobile devices has eliminated portability restrictions that were high in the traditional record keeping system. These devices allow great flexibility and interaction to a large extent. They can be used in data storage, connectivity, and communication within the healthcare institution. Tablet PCs contain all of the above features. The health care

profession involves a lot of data storage, sharing, and communication. Increasing healthcare demands have created the need for a swift and convenient information system. The tablet PC has proven to be ideal within the health care system due to the following reasons.

One of the import reasons for of using a tablet PC in healthcare is its level of efficiency. Richter et al. (2008) in their study observed that self-administered questionnaires accessed through tablet PCs were highly effective, safe, and efficient in collecting patient information. The tablet PCs were seen to be less bulky, and were very portable. In addition, the information uploaded in the tablets was safe and could be easily retrieved.

The ability of the tablets to be used in communication makes them capable of being used for sharing information across the system. This implies that once the patient information has been uploaded to the server, other health practitioners such as doctors can access and use it in administering treatment, patient monitoring, and making relevant decisions regarding patient care.

This study findings indicated that the use of tablet PCs brought about a significant improvement in the speed of service delivery. As patient information can be easily accessed, nurses and the doctors can make prompt decisions regarding patient treatment and can handle many patients within a short period. The use of a tablet PC is therefore highly relevant, and important within the healthcare setting.

5.2 Evaluating usability of the software

In evaluating the usability of the software, Richter et al. (2008) integrated a standardized questionnaire into the tablet PC software. The study involved 153 outpatients, mainly suffering from spondyloarthritis, rheumatoid arthritis, and systemic lupus erythematosus. The patients were then given a paper and pencil version of the questionnaires, and later on the tablet PC version of the questionnaires. The usability results for the tablet were high. The validity and the quality of data obtained from the tablet PC from disabled patients were high, an indication that they were highly convenient. 62.1 percent of the patients preferred the use of tablet PCs in data collection while 4.6 percent of the patients expressed their discomfort in using the Tablet due to their illness. The usability test has therefore proven the viability of tablet PC use within the healthcare system.

In conclusion, the paper has highlighted the significance of tablet PC use within the healthcare system. Its level of effectiveness and efficiency makes it highly recommended in handling patient information. The usability has also indicated the simplicity of the software, and patients expressed their preference for it (Richter et al., 2008).

5.3 Discussion

Motion capture on healthcare is a procedure by which a device can be used to capture data of live developments, which is then transferred to a computer where software displays it applied to a subject actor (Song, et al. 2013. The recorded motion capture is then depicted on a digital model in 3D software such that the digital version matches the actor's recorded movements (Christian, et al. 2010). Healthcare in motion will consider

the range of flexibility structure related to healthcare. It reviews the flexibility in healthcare, which considers both mobility and healthcare as multi-complex political and even cultural procedures. It grants a multi-camera motion capture system is sighting to supply caregivers with timely database software to the patient's health conditions by the use of mobile communication method (Christian et al. 2010).

The basic elements comprise of object detection, video capture, transmission, and video coding, video analysis, and error concealment. Multiple novel ideas are elaborated, e.g., content-aware and adaptive video coding transmission and fast object detection. Secondly, almost all elements are perfectly homogeneous in a combined optimization structure devoted to online data transmission. Motion-capture is the movement of the topic covered on a treadmill with four tripod cameras capturing the video from divergent viewpoints (Song, et al. 2013).

5.3.1 Application of motion capture

Motion capture is mostly used in the healthcare field to treat patients with motor skill disorders. It enables medical practitioners to understand the underlying issue of patients walking disorders (Christian et al. 2010). It enables the healthcare field to combine deferent motion capture technologies and mobile applications to come up with a diagnosis. Motion Capture technology is used to analyze the way patients move and to identify the problem areas. It uses the same concept as are utilized in the film industry.

With the motion capture technology, medical practitioners can track the patient's movements and have it digitally mapped into a screen where the digitally mapped image

is studied, or thus enabling doctors to understand where a problem may be. (Christian et al. 2010).

The need and growth for mobile healthcare applications are related to the willingness of both hospitals and physicians to integrate electronic health records in the very near future. They need to integrate medical records into the pharmacy systems, and there are a significant number of healthcare mobility service providers who are eager to integrate their products into electronic healthcare systems (Chomutare et al, 2011).

Accordingly, the pilot study was concerned with answering the research sub-question about motion capture, and since the main experiment was not performed, our answers will also depend on other research findings, which were reviewed through this research.

5.3.2 How can we perform usability testing using motion capture?

The aim of this question is to find if the researcher can adopt motion capture as a usability testing method and if it accurately and effectively to achieves the research goals.

 Usability factors are primary impediments to adopting health information technology. Medical practitioners and IT experts have been in the forefront in a bid review health IT usability research techniques and to yield actual information on health IT usability evaluation (Song, et al. 2013).

Several health information technologies help physicians provide orderly, standard care, as it provides the healthcare field with convenience in handling their daily operations. Health IT evaluation is difficult to discern as it is often required to perform several functions and is coordinated from of several disciplines. The inability to scrutinize health IT system may result in an inability to meet system satisfaction, efficiency, and effectiveness. The outcome may comprise disruptions in workflow, decreased efficiency and increasing cost increases in health care errors, and frustrated users. In ensuring the best exploitation of health, IT is quite important to be very keen to health IT usability (Song, et al. 2013).

Although motion capture could not in this case indicate the possible opportunities and the success of using tablet PCs within healthcare, it provided the researcher with clear information about the physical challenges that elderly patients may face while using a tablet PC.

However, motion capture is still in the early stages consideration as an adequate usability testing method; The motion capture hardware (suit, cameras, etc,.) and the testing environment need to be developed to be easier to work with and more user-friendly. If, motion capture became physically and psychologically more comfortable and acceptable, and the software and its tools were to be improved to be more useful for processing raw data, it would solve the challenges faced more easily and more quickly.

5.3.3 What are the issues of using motion capture?

In this research, multiple issues were identified regarding using motion capture as a usability testing, and can be summarized as followings:

1. Time-consuming procedure that required a lot of lab and participant preparation. Participants might get bored while waiting for other participants to prepare themselves or be identified by the system.

2. The very sensitivity of the technique, as any change in the markers' position, affects the recorded data and may lead to false information. Therefore, there was some restriction and limitation to participants' movements, which caused inconvenience for the participants.

3. It is quite difficult to recognize a facial reaction and finger movements while using motion capture.

4. There was little freedom in using the tablet PC due to the presence of the markers. Therefore, the user was careful while using it to avoid any change in markers' positions.

5. Long procedure. Data collection took about two hours for each film; it required a lot of training and instruction to avoid errors.

6. Special tools were required to manipulate any wrongly-recorded data, which took time and may not be solved. Thus, sometimes re- recording the problem part was better and preferable.

7. These issues were identified through the trial pilot study; most of them were common issues for the motion capture method.

5.3.3 What does motion capture add/ what are its advantages?

Motion capture, regarding this research and literature review, provided accurate and efficient real time data collection, as its provides precise quantitative information that matches the frequently used qualitative methods of user observation and interviews.

In addition, due to the accuracy of data collection and persentation, it allows scientific and reliable data analysis that helped understand how elderly patient, in comparison with younger patients, can complete a task while using a tablet PC, allowing the researcher to understand how much age is a factor contributing and effecting task performance.

Finally, motion capture can provide exact digital and multiple viewpoints about a participants' interaction with a tablet PC, which allow the researcher to study it in depth without the need for the presence of the participant. It also provides the ability to replay the movement to understand the movement as much as the researcher wishes to collect required data and understand it. Observing digitally animated images provides a level of enjoyment to the research.

5.4 Conclusion and future work:

There are several piece of regading research the predicted future of using the tablet PC in healthcare. These devices can fulfil the purpose of achieving better health outcomes and care systems (Robinson, 2014). Involving mobile technology in healthcare organizations may play a major role in improving services. However, more research is required to see for how far mobile technology can integrate into these services.

Older people usually require special services, which should be easy to use, and handle. In addition, services that require application design such as tablet PC applications should be not complicated and the steps should be clear.

This study is concerned with the use of motion capture as a usability evaluation method. Motion capture can provide accurate information about the movement of the user while using a tablet PC, but it does not provide information about users facial expression or tablet screen activity. However, it is long procedure with a lot of preparation involved, and a sensitive procedure where any changes in the markers position could produce errors.

Therefore, considering motion capture for evaluation of older people is quite difficult as older people's health may limit their ability to withstand the long period of experimentation. Therefore, future research should be done to find out:

How motion capture can be used in an effective way regarding older participants?

How can we perform usability testing using motion capture within a real healthcare environment?

Motion Capture usability protocol:

Table 6: Motion Capture Usability Protocol

Phase	Fawaz	Hussam
Pre- Experiment	Outline scenarios	Identify scenarios
Experiment – before MoCap	Heuristic analysis of software Finalise scenarios	Pre-interview Finalise scenarios

MoCaP	Observe interactions directly	Observe interactions via MoCAP
Post MoCAP	Review MoCAP- compare with direct observation notes	Review scenarios with participents and MoCap and post-interview
Post experiment	Review issues and benefits together	

Rationale:

By having two experimenters involved this study will explore the potential benefits of incorporating MoCap into usability evaluation can be explored. One of the research team will play the part of the "patient" in each scenario.

Scenario's will include:

The health professional using software such as the stroke riskometer on the tablet, asking the questions and demonstrating the results to the "patient"

The "patient" using the tablet for data recording and showing the results to the health professional

Both "patient" and health professional going through a health advice website e.g. health navigator

Indicative questions for Pre- Interview

1. Do you use these devices in clinical care currently ?

2. What benefits do you think these devices can bring ?

3. What are the issues/ problems with using these devices ?

Indicative Questions for post-interview

1. Did you find you were able to behave naturally in the MoCap Environment ?

2. What advantages were there to performing the usability evaluations in the MoCap environment ?

3. Did you find the tablet PC easy to use ?

4. What issues did you find with the Tablet PC ?

5. Would you incorporatestes tablet PC use into clinical practice if you could ?

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Participant Information Sheet

Date Information Sheet Produced:

01/05/2016

Project Title

Tablet PC Usability and Motion Capture in a simulated clinical setting

An Invitation

Hello, we are Fawaz Alsabhen and Hussam Aljamani and we are studying for a Masters in computer and information sciences at AUT

What is the purpose of this research?

We would like to find out if the use of a motion capture (MoCap) tool can help in evaluating the usability of a Tablet PC application in a simulated clinical setting. We would also like to explore what healthcare professionals think about using tablet PC's in clinical environments.

How was I identified and why am I being invited to participate in this research?

You have been chosen because you have a nursing or other clinical background and may be interested in the use of tablet PC's in healthcare. We have asked for people to participate via the networks of Dave Parry our supervisor.

What will happen in this research?

You will be invited to participate based on when the sessions can be organised, we will give a quick welcome and information about the test. then there will be a short interview, and an explanation of what will happen. We will then ask you to go into the lab and go through a number of short simulated clinical scenarios - based around health data recording and advice, with a person pretending to be a patient. This will be observed and recorded via MoCap. After this we will ask some follow up questions and have you look at the moCap recording to comment on what was happening during the experiments.

MoCap involves wearing a suit on top of your normal clothes with small reflectors on it. The lab has a large number of cameras which record the position of these reflectors. A "stick figure" representation of your movements is created in the computer. This is the sort of technology used in "Lord of the Rings" etc. See the picture for an idea of what the MoCap suit is like

You shall be under no pressure throughout the entire session as this research is focusing on your experience of using the software and device, not your individual performance. All data collected will be only accessible for the researcher and his supervisor. Your identity will be anonymous in the written report.

Your participation is fully voluntary. You may withdraw yourself at any time during data collection and all data will be destroyed.

What are the discomforts and risks?

The motion capture suit covers your whole body except your face and feet. People may sometimes get a bit hot although the fabric is very light. Sometimes people feel a bit silly in the suit –although many people enjoy the experience. You may find that some of the set up time is a little boring.

How will these discomforts and risks be alleviated?

The people working in the lab are very used to people wearing the suits and you can take it off at any time. We would not expect you to be wearing the suit for more than 30 minutes' total. The lab is not viewable except by people running the experiment and there will be no video taken – just the stick- figure recording. The scenarios are very short (up to 5 minutes) each.

What are the benefits?

To identify whether MoCap is a practical tool in usability evaluation where multiple people are involved

To identify what benefits may arise from using MoCap in usability evaluation

To explore attitudes and issues associated with the use of Tablet PC's in a clinical environment

What compensation is available for injury or negligence?

None, this study designed to keep you fully comfortable and safe.

How will my privacy be protected?

The researcher and teacher/lecturer will assure the confidentiality of the participants. When writing up the report, real names will not be used. All the data collected will be securely stored and is only accessible for the researcher and his supervisor.

What are the costs of participating in this research?

A session of testing will take around 2 hours total.

How do I agree to participate in this research?

Please complete the consent form and return it within a week.

Will I receive feedback on the results of this research?

The results and discussion sections will be sent to you either electronically or by post upon request. Summary of findings will be shared and disseminated with the participants as they are produced during the research in form of scholarly articles (conference or journal papers and thesis) to the participants wishing to receive such feedback.

What do I do if I have concerns about this research?

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Kate O'Connor, *ethics@aut.ac.nz* , 0064 921 9999 ext 6038.

Figure 8 : The bright lights are actually lightweight reflectors

Whom do I contact for further information about this research?

Project researcher and supervisor contact details*:*

Researcher: Fawaz Alsabhen	Supervisor: Dave Parry
Email <qjt2610@autuni.ac.nz>	dparry@aut.ac.nz
Researcher: Hussam Aljamani	
Email <wxs7855@autuni.ac.nz>	

Appendix B: Consent Form:

Consent Form

Project title: **Tablet PC Usability and Motion Capture in a simulated clinical setting**

Project Supervisor: **Dave Parry**

Researchers: **Fawaz Alsabhen, Hussam Aljamani**

○   I have read and understood the information provided about this research project in the Information Sheet dated 1 /05 /2016.

○   I have had an opportunity to ask questions and to have them answered.

○   I understand that notes will be taken during the interviews.

○   I understand that I may withdraw myself or any information that I have provided for this project at any time prior to completion of data collection, without being disadvantaged in any way.

○   If I withdraw, I understand that all relevant information including tapes and transcripts, or parts thereof, will be destroyed.

○   I agree to take part in this research.

○   I wish to receive a copy of the report from the research (please tick one): Yes○   No○

Participant Signature :   ………………………………………

Participant Name :   ....……………………………………………………

Date :

Appendix C: Approval for AUTEC Ethical Application 16/101

14 April 2016
Dave Parry
Faculty of Design and Creative Technologies
Dear Dave

Ethics Application: 16/101 Tablet PC usability and motion capture in a simulated clinical setting.

Thank you for your ethics application. The Auckland University of Technology Ethics Committee (AUTEC) received your ethics application (16/101) at their meeting on 11 April 2016 and noted it. You are asked to reconsider the ethical aspects of your research, revise your application, and to present it again for consideration. AUTEC has noted the following for your assistance:

1.   This application lacked sufficient information for AUTEC to be able to consider the ethical aspects of the research and is returned to the researcher and the applicant for completion;

2.   A number of times in the application, 'convenience' was referred to in the responses. More clarification is required about what this means in each case and why this is justifiable;

3.   Both the inclusion and exclusion criteria being applied to potential participants need to be reconsidered and clarified and consistently reflected throughout the whole document;

4.   A picture in the Information Sheet of what will be involved would assist participants more that the current explanation;

5.   The reference to interviews in the Consent Form needs further explanation or removal;

6.   The Information Sheet needs to explain the research more adequately to participants.

If there is an issue around timeliness in the consideration of this application, then the completed application may be considered by a subcommittee consisting of the Chair, the Executive Secretary and the AUTEC Faculty Representative for Design and Creative Technologies.

Please provide me with your revised application which will be placed on the agenda for AUTEC's next meeting, where it will be reconsidered. The closing dates for the agenda of the next two AUTEC meetings are Thursdays 21 April and 5 May.

Please note that you are not permitted to commence research until AUTEC approval has been granted. If you do not submit a revised application within six months, your application may be closed and you will need to submit a new application to continue with this research project.

To enable us to provide you with efficient service, we ask that you use the application number and study title in all correspondence with us. If you have any enquiries about this application, or anything else, please do contact us at ethics@aut.ac.nz.

Yours sincerely

Kate O'Connor
Executive Secretary
Auckland University of Technology Ethics Committee

Cc: Fawaz Alsabhen & Hussam Aljamani git2610@autuni.ac.nz; wxs7855@autuni.ac.nz

Appendix D: Pre- interview and Post-interview:

Indicative questions for Pre- interview:

1) Are you familiar with the use of tablet PC devices?

2) Do you use these devices in clinical care currently?\

3) What benefits do you think these devices can bring?

4) What are the issues/problems with using these devices?

Indicative questions for Post-interview:

1) Did you find you were able to behave naturally in the MoCap environment?

2) What advantages were there to performing the usability evaluation in the MoCap environment?

3) Did you find the tablet PC easy to use?

4) What issues did you find with the tablet PC?

5) Would you incorporate tablet PC use into clinical practice if you could?

Appendix E: Survey questions:

USEFULNESS:

1) It helps me to be more effective.
   - o Strongly Agree
   - o Agree
   - o Disagree
   - o Strongly Disagree
   - o Don't Know
2) It helps me to be more productive.
   - o Strongly Agree
   - o Agree
   - o Disagree
   - o Strongly Disagree
   - o Don't Know

3) It saves me time when I use it.
   - o Strongly Agree
   - o Agree
   - o Disagree
   - o Strongly Disagree
   - o Don't Know

4) It meets my needs
   - o Strongly Agree
   - o Agree
   - o Disagree
   - o Strongly Disagree
   - o Don't Know

5) It does everything I would expect it to do.
   - o Strongly Agree
   - o Agree
   - o Disagree
   - o Strongly Disagree
   - o Don't Know

EASE OF USE:

6) It is easy to use.
   - o Strongly Agree
   - o Agree
   - o Disagree
   - o Strongly Disagree
   - o Don't Know

7) It is flexible.
   - o Strongly Agree
   - o Agree

- o   Disagree
- o   Strongly Disagree
- o   Don't Know

8) It requires the fewest steps possible to accomplish what I want to do with it.
   - o   Strongly Agree
   - o   Agree
   - o   Disagree
   - o   Strongly Disagree
   - o   Don't Know

9) I can use it without written instructions.
   - o   Strongly Agree
   - o   Agree
   - o   Disagree
   - o   Strongly Disagree
   - o   Don't Know

10) I do not notice any inconsistencies as I use it.
   - o   Strongly Agree
   - o   Agree
   - o   Disagree
   - o   Strongly Disagree
   - o   Don't Know

11) Both occasional and regular users would like it.
   - o   Strongly Agree
   - o   Agree
   - o   Disagree
   - o   Strongly Disagree
   - o   Don't Know

12) I can use it successfully every time.
   - o   Strongly Agree
   - o   Agree
   - o   Disagree
   - o   Strongly Disagree
   - o   Don't Know

EASE OF LEARNING:

13) I learned to use it quickly.
   - o   Strongly Agree
   - o   Agree
   - o   Disagree
   - o   Strongly Disagree
   - o   Don't Know

14) I easily remembered how to use it.

- o Strongly Agree
- o Agree
- o Disagree
- o Strongly Disagree
- o Don't Know

15) I quickly became skillful with it.
- o Strongly Agree
- o Agree
- o Disagree
- o Strongly Disagree
- o Don't Know

SATISFACTION :

16) I am satisfied with it.
- o Strongly Agree
- o Agree
- o Disagree
- o Strongly Disagree
- o Don't Know

17) I would recommend it to a friend.
- o Strongly Agree
- o Agree
- o Disagree
- o Strongly Disagree
- o Don't Know

18) It is fun to use.
- o Strongly Agree
- o Agree
- o Disagree
- o Strongly Disagree
- o Don't Know

19) It works the way I want it to work.
- o Strongly Agree
- o Agree
- o Disagree
- o Strongly Disagree
- o Don't Know

20) It is pleasant to use.
- o Strongly Agree
- o Agree
- o Disagree
- o Strongly Disagree
- o Don't Know