Telehealth Practice and the Impact of New Technologies (NTs)

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Abstract

Telehealth aims at delivering healthcare services equally to all citizens whether in rural or urban areas. As delivering healthcare services remotely depends substantially upon technology, and with the ever-increasing improvements of new technologies (NTs), telehealth facilities can be distantly, ubiquitously, more rapidly, and cost-effectively delivered to patients to obtain better quality healthcare services. The objective of the study was to identify the impact of NTs on the contemporary telehealth practice as well as briefly evaluating telehealth practice in several developed countries and attempting to propose a proper strategy for developing nations. In addition, advantages and barriers of telehealth were considered. An online survey was carried out and distributed to a convenience sampling which included 49 participants of healthcare professionals to achieve their attitudes and viewpoints about the impact of NTs to the current telehealth practice. However, results demonstrated that modern smart phones and tablets such as iPhones, iPads and Samsung Galaxy taps are of the most used technologies in telehealth practice and participants reported that these technologies are very important in providing quality services. Additionally, almost all participants believed that the use of technological devices will lead to improvements in the quality of care as well as reducing both clinical and travelling costs. Some advantages of using NTs in telehealth and several barriers, that may bound the development of telehealth process, were also mentioned. A suggested telehealth strategy for developing countries was illustrated in this study. It is recommended that effective steps should be taken to remove the barriers that are hindering the progress of modern telehealth practices. As well as, necessary policy changes should be made to cover the cost of telehealth equipments in the health board budgets.

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Table of Abbreviations

Abbreviation	Definition
NTs	New Technologies
OTs	Old Technologies
ICTs	Information and Communication Technologies
MTs	Mobile Technologies
SF	Store-and-Forward
PDAs	Personal Digital Assistants
RFID	Radio Frequency Identification
USA	United States of America
NZ	New Zealand
NELH	National Electronic Library for Health
NLM	National Library of Medicine
QoS	Quality of Service
WWW	World Wide Web
GDP	Gross Domestic Product
AMA	American Medical Association
ASH	American Society of Hypertension
AHA	American Heart Association
PCNA	Preventative Cardiovascular Nurses' Association
BP	Blood Pressure
BPMC	Blood Pressure Management Centre
BCBSA	Blue Cross Blue Shield Association
EHRs	Electronic Health Records
DoD	Department of Defence
GPs	General Practitioners
TMA	TeleMedicine Australia's website
ViCCU	Virtual Critical Care Unit
HWW	Hospital Without Walls
CSIRO	Commonwealth Scientific and Industrial Research Organization
ABS	Australian Bureau of Statistics
CT	Computed Tomography
MRI	Magnetic Resonance Imaging
FTTN	Fibre To The Node
FTTP	Fibre To The Promises
HFC	Hybrid Fibre-Coaxial
MCPHIE	Mass Customized/ Personalized Health Information and Education
CME	Continuing Medical Education
MSCFA	Multimedia Super Corridor Flagship Application
WAN	Wide Area Network
LAN	Local Area Network
LTE	Long Term Evolution

RTP	Real-time Transport Protocol
SMIL	Synchronized Multimedia Integration Language
RTSP	Real-Time Streaming Protocol
HCI	Human Computer Interface
MUHEC	Massey University Human Ethics Committee
ADHB	Auckland District Health Board
CCDHB	Capital & Coast District Health Board
ODHB	Otago District Health Board
WDHB	Wiakato District Health Board
NHS	National Health Service
VPN	Virtual Private Network
WHO	World Health Organization
GOe	Global Observatory for eHealth
NIH	National Institute of Health
AWS	Amazon Web Services
IDC	International Data Corporation
ATA	American Telemedicine Association

Chapter 1: Introduction

1.1.Background

Governments whether in developed or developing countries have laid considerable emphasis on the planning and delivery of healthcare systems and services. Internationally, the level of healthcare organization is seen as an essential indicator of the development status of a country (Koch, 2006). Increasingly, this status depends upon the utilization of new technologies (NTs), such as PDAs, tablets, smart phones and social networks, across a wide spectrum of activities but especially healthcare to deliver healthcare services to patients everywhere, at anytime. Telehealth is at the forefront of the developments.

In conjunction with the rapid development of technology, healthcare systems have been also quickly improving. This improvement is seen in both the content of healthcare services and the means through which these services are presented (Khan, Qurashi & Hayee, 2007). As a result of the introduction of the NTs, healthcare services and other health-related activities have formalized a new approach to healthcare delivery systems. This approach is often referred to as “telehealth”.

As telehealth has developed over the last few decades, it has been utilized to remotely transport healthcare services to patients in their homes, in rural areas and in urban sites. Its range has enlarged to comprise patients’ education, healthcare providers’ education and direct healthcare to patients (Burgiss, 2006). The term “telehealth” is frequently used to describe the extended purposes and functions obtained by exploiting the NTs to support the delivery of healthcare services and healthcare training remotely. The shift to adopt and use the accessible NTs becomes critical for all patients to have the right to obtain quality healthcare services ubiquitously, more rapidly, and cost-effectively.

1.2.Definition of Telehealth

The prefix “tele” means “at a distance” or “remote”. This signifies that health delivered at a distance. Additionally, this term is used to describe the employment of medical information and services exchanged from one location to another through the use of

NTs to enhance, sustain, or support the patient's status. Therefore, the word "telehealth" can be basically defined as:

"*The use of information and communication technologies to transfer healthcare information for the delivery of clinical, administrative and educational services*" (Norris, 2002, pp 11).

In this definition, the extension to comprise administrative health data signifies the utilization of telematic services to transmit demographic and operational data that might contain little or non-clinical information. Likewise, while distant education courses for healthcare experts are covered by telehealth, elements of such courses might focus on health strategies or other non clinical subjects.

Accordingly, a telehealth system can be regarded as having four key elements. They are: *technology*, such as workstation technologies and peripherals; *telecommunications links*; *users*, such as patients and doctors; and *policies*. Any telehealth system needs to aptly integrate all these four components in order to be successful (Elford, 1998).

1.3.Telehealth Subsets

There are two key subsets of telehealth which are telemedicine and telecare. Whereas telemedicine is focused on clinical and treatment procedures, telecare is mainly about the provision of care to participants in their own place of residence. Each one of such two subsets includes several sub-divisions underneath its area of function. All these segments are carefully and separately described below.

1.3.1. Telemedicine

Telemedicine is one form of telehealth's subsets in which the focus is confined to clinical procedures and services. It is an enhanced function of clinical medicine used to transfer health information via the internet or any other networks for the purpose of consulting or delivering treatment (Ackerman, Craft, Ferrante, Kartz, Mandil & Spaci, 2002). The delivery of healthcare services in earliest via telemedicine started in the mid-1990s (Burgiss, 2006). This function was initially presented as two-way

videoconferencing between two or more healthcare givers. This technique of health delivery can be utilized for several services. One example is teleconsultation. Telemedicine might be – at its simplest form – two health experts conversing about a particular case over the telephone, or – at its most complicated type – utilizing satellite technology and videoconferencing tools to perform a real-time discussion among two or several health professionals in two or more different nations.

Additionally, using Information and Communications Technology (ICT), patients can perform self-testing as needed and collect critical clinical data which can be remotely conveyed and broadcast to the healthcare giver to view and check. This process is identified as "*telemonitoring*" where enhanced intelligent applications are utilized in which clinical decision support is available to warn and remind both the patient and physician when out-of-range outcomes are reported (Lykke, Holzworth, Rosager, Rhoads & Turisco, 2011). Telemonitoring has become a successful method of telemedicine particularly for patients suffering from chronic illnesses such as asthma and diabetes. However, there are another two examples of telemedicine which are: telesurgery and tele-education that are illustrated in details afterward.

1.3.2. Telecare

Another subset of telehealth is called "telecare" in which care is provided to patients and elderly people in the home. Telecare indicates the notion of allowing individuals to stay at their own homes and live independently by allowing person-centred tools to assist the person and their health givers (Ackerman et al., 2002). The function of telecare is not only to treat a patient, but also to monitor and prevent any health issues. Telemonitoring can be considered as a telecare sub-division in addition to being a part of telemedicine sub-divisions. For instance, using self-testing devices can facilitate patients to perform some types of their treatment procedures in their locations.

1.4.The NTs and their Contributions to Telehealth

The NTs do not only impact on the healthcare system, but also contribute to a broad spectrum of industries. However, telehealth has a strong relationship to communication

and computing technologies. Therefore, understanding such technologies is a vital element in research about telehealth.

The NTs are substantially supporting the developments of many techniques of the healthcare system in general. Several of these are likely to cause enormous savings in personal and national expenditure and a growth in health quality (Davidson & Santorelli, 2009). One of the technologies that have enormously facilitated the delivery of telehealth is broadband. Broadband-enabled telehealth services and applications are modifying the general healthcare system by allowing home care and synchronized patient monitoring as well as spotlighting illness prevention by improving personal safety (Davidson & Santorelli, 2009). Such services and applications are also likely to guarantee more consistent and improved care for rural and remote areas as well as assisting more well-timed and accurate diagnoses and managements for chronic illnesses.

It is important in this thesis to identify a distinguishing point that separates NTs and old technologies (OTs). Such a distinction is somewhat arbitrary and necessarily spread over an interval rather than focused at one time. However, a useful separator is provided by the general take-up of Wi-Fi technology which, amongst other advances, has substantially changed the way the internet used and also led to new developments and innovations such as smart phones and computer tablets. Such technology has become popular since 2004, and such year is taken in this research as the distinguishing date between OTs and NTs, where technologies that have been produced before 2004 are considered as OTs and those subsequent to the same year are NTs.

There are many types of NTs available to use in telehealth. Some examples are: mobile technologies (MTs) – such as *computer tablets* and *Personal Digital Assistants (PDAs)* –, store-and-forward (SF) technologies – such as *iCloud* and *Dropbox* –, social networks – such as *Twitter* and *Facebook* –, video streaming websites – such as *YouTube* and *Vimeo* – and videoconferencing technologies such as *Skype* and *VIA3*.

All these various types of technologies are contributing to telehealth practice by providing better quality, easy-to-use, cost-effective, and ubiquitous services to users no

matter where their locations (Guler & Ubeyli, 2002). Utilization of such NTs can truly facilitate the existing and potential services of telehealth practice by making a bridge to conveniently link both the patient and the healthcare provider at anytime and anywhere, or also by linking two or more health professionals (COCIR telemedicine toolkit, 2011). The ever-increasing developments of mobile and communication technologies have formed a superior foundation for telehealth to broadly serve people all over the globe.

1.5.Dissertation Objectives

This thesis aims to identify the impacts of the NTs on telehealth applications and projects. Additionally, it evaluates and investigates the current status of telehealth in several developed countries – the USA, Australia, New Zealand (NZ) and Malaysia – and to what extent the telehealth applications are actually applied in these countries. It also proposes strategies for the optimal development of telehealth NTs. Furthermore, advantages and barriers of telehealth will be taken into consideration.

1.6.Study Importance and Contribution

The importance of this dissertation is its focus on the impacts of the NTs from which it can be learned how to implement them most effectively. In addition, this study contributes to the field by suggesting a suitable strategy for developing countries – through investigating existing strategies used by several developed countries. The findings and conclusions achieved in this study will be constructive and valuable for future research.

1.7.Research Questions

The questions being conducted in this thesis are as follows:

1. What are the clear roles of the NTs in telehealth systems?
2. To what extent have the NTs affected telehealth systems?
3. What are the top NTs used in telehealth systems?
4. What are the critical advantages obtained from using NTs in the current telehealth system?

5. What are the barriers encountered by utilizing the NTs in the current telehealth system?

All the above questions form the core of this dissertation and remain at the foremost attention of the researcher.

1.8.Study Scope and Structure

In this thesis, the emphasis is centred about the roles and contributions of the NTs and how they facilitate the real functions and procedures of the field of telehealth. In addition, the advantages of and barriers to telehealth resulting from using the NTs are taken into account. In addition, careful investigation is conducted into the current status of telehealth and the existing applications in the four selected countries. However, whilst NTs have influenced many aspects of general healthcare, this research focuses on telehealth. Also, ethical issues such as patient confidentiality and trust are taken into consideration.

The second chapter of this thesis is the literature review in which the subsets of telehealth and their benefits and barriers are considered. Also, an evaluation of the current status of the four selected countries is made. The old existing technologies including their limitations and the NTs – including mobile technologies and social networks – and their contributions to telehealth are illustrated and carefully compared. The third chapter demonstrates the research methodology in which a survey was distributed to a group of healthcare professionals to discover their views on telehealth and the NTs. The next chapter – findings and discussions – considers the results obtained from the survey. Rogers' theory of "diffusion of innovation" as well as suggested implications for the developing world – based on the analysis of the four developed countries – are demonstrated in the same chapter. Finally, some conclusions and recommendations are shown in the last chapter of this dissertation.

Chapter 2: Literature Review

2.1.Subsets of Telehealth

Telehealth can be mainly divided into two key subsets. They are: telemedicine and telecare in which several sub-divisions are found. In this section, these subsets and their sub-divisions are demonstrated.

2.1.1. Telemedicine

The word telemedicine implies “medicine delivered at a distance”. This brief statement is insufficient to fully understand the precise meaning of telemedicine as it does not give any sign to the technique of delivering remote medicine. Therefore, a complete definition describing how to deliver medical services at a distance as well as services correlated to telemedicine is demonstrated below:

“*Telemedicine is the use of information and communication technologies to transfer medical information for diagnosis, therapy and education*” (Norris, 2002, pp.11).

This definition illustrates the functions and service of telemedicine which are diagnosis, therapy and education. It is obvious that treatment is one key goal of telemedicine. Although telemedicine is mainly focused on clinical practices, education can be a part of it whereby instructional courses concerning clinical practices can be performed. It thus relates to various types of information broadcast – voice, video, pictures or texts –, communication tools – microwave, telephone lines, digital wireless, or internet – and user interfaces – telephones, smart phones, PDAs, PCs or laptops (Medical profiling and online medicine, 2010). However, there are several sub-divisions of telemedicine and each one of them has particular functions to perform. Such sub-divisions are separately shown in the subsequent paragraphs.

- *Teleconsultation:* it is one of the clearest functions of telemedicine. It is similar to conventional face-to-face medical consultation but uses telecommunication technologies. It occurs when two or more medical professionals distantly discuss a case through some technologies such as a telephone, email or a

videoconferencing tool (Wootton, Craig & Patterson, 2011) . Additionally, such teleconsultation session can include the patient or can be performed between a single physician and a patient for treatment or medical advice.

However, in the last 15 years, telemedicine has invaded many medical specialities and enhanced the overall number of medical consultations. Studies have demonstrated that in the USA – 1998 – 40.000 teleconsultations were carried out in over 35 diverse specialities (Norris, 2002). Furthermore, statistics have indicated that almost 35 percent of telemedicine practice is applied to teleconsultation (Kerr & Norris, 2004). Accordingly, teleconsultation is vital particularly when a remote professional's estimation is required for making a medical decision.

There are two different techniques of teleconsultation:

1- Real-time manner: teleconsultation is completed interactively between two or more healthcare experts – with or without the attendance of the patient – in real-time using one of the teleconsulting techniques such as videoconferencing.
2- SF data manner: teleconsultation is completed through storing the patient's medical information and sending them to different health professionals to view and consult and then forward back their advice and estimations (Khan, Qurashi & Hayee, 2007). This manner is commonly used to transmit large X-ray images in a process called "teleradiology" for the purpose of a second feedback.

- *Telemonitoring:* it is the utilization of a telecommunications tool to collect repeated or regular data about a particular condition. In this mode, the patient – wherever their location – can record their own data and transfer them to their healthcare provider either in real-time or SF manner (NICTA, 2010).

  Telemonitoring, however, concentrates on enabling the patient to participate in their treatment process. This mode of telemedicine is beneficial especially for chronically ill people and disabled persons. For example, patients with diabetes

can use some designed applications or devices – such as iglucose or glucose meter – and measure their blood glucose and then remotely transfer the readings to the healthcare professional, while they are staying in their homes. In addition, they can distantly obtain feedbacks and recommendations of their health professionals about their glucose readings. Another benefit obtained by telemonitoring is the regular reminders issued by the technology used to remind patients of their medications' time. Additionally, telemonitoring can be performed by only healthcare givers without the patient's involvement. For instance, a specialist can remotely assist some surgeons in carrying out a surgery in a different place. This help can be provided through a video or audio link that can expand in another place or can be offered by a satellite connection.

However, as some the above examples imply, telemonitoring is likely to grow in use in telecare especially for old and disabled persons restricted to their homes and nearby communities. An enlarged application for ill travellers is predictable as well. Also, tele-education can be considered as a clear effective component in telemonitoring.

- *Telesurgery:* it is the use of telecommunication devices to either perform or assist in a surgical process. There are two basic ways of telesurgery. The first is – as previously mentioned – when assistance from a remote expert is provided to a surgeon while carrying out a surgical procedure in which a telemonitoring mode can be considered. The other way is called "telepresence surgery" when robotic arms are used to perform a surgery under a remote supervision and direction of an expert (Kerr & Norris, 2004). In such way, the surgeon can remotely operate interfaces linked electronically and mechanically to surgical tools for example needles and scalpels. Such connections can scale down the movements of the surgeon's hands, thus this is very accurate (Norris, 2002). Also, a tremor free cut can be performed through a technique called "*movement scaling*" which can allow surgeons to fix damage in vessels.

However, several studies have shown that robotic surgery is improving due to advancements in system simulation, accuracy and planning (Lobontiu & Loisance, 2007). Additionally, it has been illustrated that telesurgery will become easier due to decreased network latency and the ever-increasing improvements in the surgical robotics.

- *Tele-education:* educational healthcare courses for medical professionals in remote areas have been presented through tools of tele-education. Such a process is carried out using tools such as those used in teleconsultation to transmit a video or audio of the healthcare trainer to all learners in rural regions (Kerr & Norris, 2004). The transmission can be made either in synchronous or asynchronous manner. Tele-education – also known as *teleinformation* – can be divided into four main aspects based on the purpose of transference and the nature of recipients. These four aspects are independently described below:

i. *Medical education from teleconsultation:* whenever teleconsultation procedure occurs between a healthcare giver and an expert, the first can obtain information and learn from the latter's feedback and recommendation about the case discussed. So, it is a sort of educational process in addition to being a consultation procedure.
ii. *Clinical education through the internet:* the internet gives healthcare professionals the opportunity to independently broaden their knowledge and understanding by providing a large variety of online sources (Lobontiu & Loisance, 2007). Such sources can provide them with evidence-based up-to-date information and experiences from all over the world. Instances for such online resources can include national healthcare websites such as the UK's National Electronic Library for Health (NELH) and the USA's National Library of Medicine (NLM) (Norris, 2002). Therefore, health experts can utilize such sites to retrieve evidence-based data from which they can improve their proficiencies and patient's treatments.
iii. *Academic study over the internet:* lately, educational institutions have offered a new approach to the learning process through which learners can remotely

take courses or study a degree. The new approach is called “distance learning” (Norris, 2002). Where health professionals can distantly study further towards postgraduate levels while undertaking their professions. Also, with the clear cooperation between universities and healthcare institutes, periodical courses and lectures can be undertaken in an interactive remote mode between doctors in the university and health givers in the medical organization.

iv. *Public education through telemedicine:* this aspect of tele-education focuses on delivering public health information to communities. Such information may cover general topics such as exercise, hygiene, and diet and may also include more specific information about particular diseases, for example, diabetes or cancer (Merrill, 2009). The information can be delivered to a targeted group of people in a public location or even in their homes via the NTs. Additionally, the health information can be published on the World Wide Web (WWW), and therefore it can be achieved by anybody surfing the internet. Furthermore, text messages that provide general medical advice for the public such as healthy food, beneficial physical exercises as well as some clues to avoid infection provide an example of public education via telemedicine. Other instances include medical lessons and advice presented on televisions through which prevention comes before remedy.

2.1.2. Telecare

Telecare supports the notion of delivering medical services to patients in their locations instead of the physical presence of them in the healthcare place. So, telecare generally signifies home care. There is a formative definition for telecare made by (Norris, 2002, pp.11), which is stated as follows:

“*Telecare is the use of information and communication technologies to transfer medical information for the delivery of clinical services to patients in their place of domicile*”.

As all developed countries have the aging population issue, telecare has received a growing attention from the middle of 1990s (Koch, 2006). In 1998, there were almost 380 million persons aged above 65 years worldwide. Also, it is estimated that there will be over 800

million individuals by 2020 (Norris, 2002). This clear growth in the number of elder people together with changes in lifestyle raises the prevalence of chronic diseases (Koch, 2006). Therefore, the significance of telecare becomes more critical where the majority of old individuals like to survive their lives in their homes as well as healthcare givers can decrease expenditures by affording home care rather than costly hospitalizations.

In addition, it might be achievable to replace the number of home visits by tele-visits whereby home-health nurses can communicate with patients via an audio-video connection and collect current medical information and vital indications or symptoms particularly if the patient lives in a remote region (Wootton, Craig & Patterson, 2011). This method is being used in a renal dialysis project at The Queen Elizabeth Hospital in Adelaide, South Australia (Norris, 2002).

An emerging area within telehealth, which can be defined under telemedicine and also telecare, is *mobile health* (mhealth). In this dissertation, mhealth has been included under the subset of telecare due to its strong correlation to MTs and also its focus on monitoring chronically ill persons. Healthcare services are delivered in a mobile mode, so are not restricted to the healthcare premises, but are more focused on home-based care. Mhealth, however, is the use of mobile tools, such as PDAs and mobile phones, to deliver healthcare services wirelessly to patients no matter where they are located (COCIR telemedicine toolkit, 2011). It has a wide variety of applications starting from SMS drugs reminders, through gathering social and medical health information, to synchronous monitoring of patients, as well as providing direct home care (Wootton, Craig & Patterson, 2011).

There are several significant benefits obtained by mhealth projects through which better-quality and more cost-effective healthcare services can be achieved. Several such benefits, as stated in COCIR telemedicine toolkit (2001), are outlined below:

- Improved access to healthcare along with ease of use and convenience.
- Real-time connection between the patient and the caregiver.
- Ubiquity of MTs, thus easier adoption from both patients and health professions.
- Cost-effectiveness while providing efficiency – a better quality of service (QoS).

2.2.Telehealth Benefits

The entire healthcare sector can obtain advantages from using and applying telehealth services including – but not limited to – patients, physicians, nurses and administrators; generally all stakeholders. Some of the key benefits are:

- *Enhanced access to healthcare services:* one essential motivation for telehealth is increased access to healthcare services for remote areas and under-served communities. Once the access of healthcare is expanded, socio-economic benefits can be seen through decreased costs and time spent travelling for both the patient and the healthcare provider. In addition, time savings for healthcare providers through quicker access can increase productivity and hence reduce costs (Norris, 2002). All such benefits can be demonstrated whether in telemedicine practice or home care approach. Furthermore, health providers can increase their access to specialists' feedback and opinions, reduce the possibility of travel, and obtain additional chances for extra efficient training (Medical profiling and online medicine, 2010).

- *Better communication between providers:* the adoption of digital data provides several advantages to both patients and health providers by electronically and wirelessly transmitting digitalised information such as x-rays, test results or the patient's medical history. Such digitalised data can be transmitted through standard technologies, such as email (Telemedicine: Opportunities and developments, 2010). Additionally, these technologies present health information that is more precise, more well-timed and more comprehensive; aspects of quality that can cause improved access and thus enhanced healthcare. Also, the NTs can offer better and faster communication sessions between a doctor and a specialist to remotely discuss a case and achieve a second opinion, thereby ensuring more efficient quality of care. Also, telehealth can reduce the duplication of medical procedures, such as tests (Darer, 1998). For example, when some medical procedures were already made for a patient in a rural area and the patient must be transferred to another healthcare organization in another

area for treatment, the information can be transferred rather than the procedures being repeated.

- *Cost-effectiveness:* supporters of telehealth believe that it can enhance efficiency and cost-effectiveness by providing improved management for chronic diseases, enhanced access and share of healthcare services and resources, and decreased hospitalizations (Medical profiling and online medicine, 2010). Also, a recent evaluation of telehealth services has demonstrated that telehealth is cost-effective (NICTA, 2010). According to Norris (2002), obvious expenditure savings have been illustrated in teleradiology which has been used for a long time to form a marketable service and enhance its function. In addition, one further financial advantage of telehealth is in home-care and the healthcare services provided to prisoners by reducing travel costs and waiting times. To sum up, telehealth services can enhance medical care by: decreasing unnecessary visits to physicians and emergency rooms, offering early prevention of replicated hospitalizations, and also presenting education to patients on how to manage early symptoms or gain access to essential support at the beginning of health problems (Wamer, 1997).

2.3.Telehealth Barriers

Telehealth has several barriers that are connected to technical, social or economic aspects. Such barriers prevent the adoption and progress of telehealth practice, and therefore, overcoming them is essential to ensure the quality and effectiveness of telehealth practice. Efforts, especially in developed nations, are taking place to overcome potential barriers and advance the services related to telehealth to meet the patient and health provider's needs to ensure better QoS. Some of the barriers include the following:

- *Uncertainty of cost-effectiveness*: while telehealth promises to cut costs in delivering medical care, creating a telehealth system entails substantial outlays on tools, software, training and facilities. These significant financial costs may place a great financial burden on the health organization (Merrill, 2009). Additionally, there are two key reasons why cost is considered as a barrier to

adapt to telehealth. The first is that most of the studies about telehealth considered the technical and medical factors and did not give a sufficient attention in terms of cost-effectiveness. The other reason is that it is somewhat complicated to assess and estimate the cost advantages of a telehealth application (Burgiss, 2006). Thus, it is difficult to estimate the cost benefits for gains such as enhanced convenience, better QoS, and further reasonable access.

Telehealth promoters are attempting to address these financial barriers, but the uncertain cost advantages have prevented business-related companies from participating to the field of telehealth. Unless the studies related to telehealth discover ways to illustrate cost-effectiveness, the uncertainty will stay as a key barrier to adopting extended telehealth services (Norris, 2002).

- *Policy and strategy*: whilst health strategy is considered as a driver for telehealth, its absence can be a barrier (Telemedicine: Opportunities and developments, 2010). Therefore, the existence of an apt national policy is crucial to make certain that the telehealth system is appropriately planned within the general healthcare system. Several developed countries – such as Australia, Malaysia, and the USA – have started to endorse telehealth practices and progress them by developing new laws and policies that promote their improvement. However, it is certain that the coordinated act of the planners will generate faster and successful progress than the uneven scheme approach.
- *Telecommunications infrastructure:* the communication network is vital for telehealth to link patients and physicians and wirelessly deliver services. Typically, this link is established for multi-purposes. That means a broad-spectrum electronic highway is needed to deal with a variety of different services (NICTA, 2010). Low capacities and short load powers of bandwidth prevent the transmission of large amount of telemedical data can be a barrier. However, bandwidth will be short if it is founded on an analogue, rather than digital transmission techniques. Also shared digital bandwidth might be low (Merrill, 2009). Therefore, this bandwidth may not be able to transfer large data such as x-ray images or even launch a video-conferencing session. Additionally,

incompatibility of protocols and standards can create a difficulty. Particularly, this incompatibility can be seen across international borders where transferred data are not received or are incoherent to the reception location (Lykke et al, 2011).

- *Privacy issues:* is an international concern where patient's health information and records must not be disclosed unless after obtaining patient's consent, and patients must to have their right to confidentiality. There are some ethical and legal problems correlated to technologies used in telehealth practice through which patient's privacy can be threatened. Certainly, physicians and healthcare professionals obtain a course that guarantees that patient's medical information must be confidential (Wootton, Craig & Patterson, 2011). Concerns regarding privacy in telehealth are not essentially dissimilar form those in the traditional medicine; where the physician has the same obligation of maintaining patients' health data secured. However, in telehealth practice, the challenge is about whom has the authentication to access data, where it is difficult to balance the necessary extension of manpower to administer an electronic system with the growing number of personnel who have the opportunity to access patient's medical information (Privacy, confidentiality and security, n.d.). Authorization of whom can access the information should be limited according to needs, for example, the clinician has the right to access to all medical records, but the nurse should not has the same expansion of accessibility as well as administrators. Every member of healthcare staff should have only the required extension of authentication of accessibility in order to maintain patient's privacy and confidentiality protected.

2.4. International Telehealth

This section investigates the current status of the different telehealth systems of four developed countries. The countries selected for this research, as previously mentioned, are: USA, Australia, NZ and Malaysia. These countries have been selected because of their explicit, constant developments in telehealth, and also because they are amongst the top players and research conductors of telehealth. The existing telehealth systems and their

applications in each country are identified and evaluated based on the literature, along with a particular focus on the impact of the NTs used and value-added, granted benefits.

2.4.1. Telehealth in the USA

USA is commonly regarded as one of the leading players in the area of telehealth. That is due to the early progression made in telecommunications infrastructures during 1986-1996 and the considerable support of the Department of Defence (Norris, 2002). However, the healthcare system in America encounters several challenges. The first one is the continuous increase in healthcare expenditures. Almost 16 percent of the US Gross Domestic Product (GDP) – nearly $2 trillion – represented healthcare expenditures in 2007 (Fife & Pereira, 2008). Correspondingly, costs are anticipated to increase to approximately 20 percent of the GDP by 2020. Another challenge is the expansion of the number of people covered by government-funded healthcare projects. Additionally, the number of un-insured remains high, despite an insignificant decrease from almost 47 million in 2006 to over 45.7 million in 2007 (Davidson, 2009). Furthermore, the aging population issue is likely to double by 2050, laying extra strain on the healthcare organization. Insufficiency of the present healthcare insurance frame is also considered as a further challenge. Therefore, the US healthcare system has started to apply a number of possible services of telehealth as a tentative solution for some of these issues and challenges.

According to the US telehealth website (n.d.), the country's telehealth projects can provide facilities such as telestroke, tele-ICU and telepsychology services to all patients even in remote or rural areas. The strategy used is to apply the concept of a single telehealth specialty and then generally expand it to comprise all specialties. This allows step-by-step customizing of all different types of programs to meet the patients' needs (US telehealth, n.d.). Additionally, telehealth programs enlarge their services to include remote and off-shore people. US telehealth utilizes highly developed technology that allows doctors to remotely perform a comprehensive consultation with a patient providing the following benefits:

- reduced employee downtime;
- treatment of a larger range of diseases on site;

- faster diagnosis and provision of care for common diseases;
- minimized extension of a disease;
- best use of convenience;
- ability to schedule follow-up appointments as needed; and
- encouragement of worker health via education (US telehealth, n.d.).

The benefits of telehealth are identified by influential associations such as the American Medical Association (AMA), the American Society of Hypertension (ASH) and the American Heart Association (AHA). In 2008, the AMA has combined with the ASH and the Preventative Cardiovascular Nurses' Association (PCNA) to release a cooperative scientific announcement that recommends all hypertension sufferers utilize home monitoring devices to consistently trace and follow up their Blood Pressure (BP) (Doty, 2008). In addition, the AMA was developing a Blood Pressure Management Centre (BPMC) through which patients can automatically transfer their BP readings from their own locations to the BPMC via their personal accounts on the BPMC website (Doty, 2008). Also, patients are allowed to share, store or upload any other relevant information.

There are a variety of active telehealth projects today in the US. There are several differences among these programs in terms of administrative formations and complexity of services and plans (US telehealth, n.d.). A number of state-wide telehealth projects are separately demonstrated in Table 2.4.1-1 below as brief case-studies alongside their mechanisms, types of technologies used, coverage and perceived benefits:

Table 2.4.1-1: Summarizing several telehealth projects in the USA	
Project (1)	**WellPoint (CA & GA)**
Supplier	Blue Cross Blue Shield Association (BCBSA)
Mechanism & Coverage	In 2008, 60 sites in California and 55 in Georgia employing real-time videoconferencing technologies. The utilization has arisen to roughly 4.000 encounters for every year in CA alone. Similar rates were in Georgia.

Benefits	Better access to specialties for remote and under-served regions. Early diagnosis and involvement for chronic diseases. Reduction of costs by almost 6 percent in general, but 42 percent for follow-up treatment only (Doty, 2008).
Relevance	Clinical application
Project (2)	**Kaiser Permanente (KP) in CA**
Supplier	
Mechanism & Coverage	Includes 8.7 million health-policy members, 165,000 members of staff, 14,000 doctors, 431 medical workplaces and 35 health centres. There were about 2.3 million members affiliated to its patients' web portal in 2008. Technologies used in KP consist of both real-time consults, such as videoconferences and e-visits, and asynchronous consults such as SF systems (NICTA, 2010).
Benefits	Increased access to healthcare services such as real-time remote consults and personal health data "EHRs"; better efficiency where most test outcomes are accessible online within 24 hours; and reduction of costs through decreasing costly needless visits because of the accessibility of online nursing and consulting services.
Relevance	Clinical application
Project (3)	**Centre for Connected Health (CCH)**
Supplier	Partner healthcare
Mechanism & Coverage	Almost half of Partner Healthcare's congestive heart failure sufferers are engaged in this centre (Doty, 2008). Some chronic disease such as hypertension and diabetes are being remotely managed using monitoring tools connected to the internet. It utilizes several various types of telehealth technologies such as e-visits, real-time videoconferencing with specialists and distant monitoring for chronically ill persons via telemonitoring devices.
Benefits	Enabling more informed decision-making and improved quality of care; creating simpler, more proficient and cost-effective delivery of healthcare; assisting prior and more precise diagnosis; allowing remote specialist treatment for rural areas; providing more efficient administration functions; and ensuring timeliness of treatment and reducing waiting times
Relevance	Clinical application
Project (4)	**Beth Israel Deaconess Medical Centre (BIDMC)**
Supplier	Medical School of Harvard University

Mechanism & Coverage	It has a well-designed system called CareLinke through which an interpreter and a medical encounter can be linked using a live video-conferencing tool (Doty, 2008). Also, it utilizes "simulation and skills lab" for the purpose of education for healthcare interns and experts consultations. BIDMC applies various types of technologies, such as video-conferencing, SF tools and home care monitoring devices. Additionally, it currently utilizes smart phones such as iPhones as the access point for personal medical records (NICTA, 2010).
Benefits	Reduction of waiting times, better access to expert care, and enhanced training and education of health interns (Doty, 2008).
Relevance	Clinical / non-clinical application

The above examples of existing telehealth programs in the US have illustrated the current state of such practice which is continuing to advance. Although these projects have changed the way healthcare services are delivered, much more is yet needed. Several significant barriers still remain such as regulation, acceptance of the utilization of telehealth by conventional medical organizations, reimbursement issues, and absence of a national strategy (Kim, 2004). Additionally, each state has its own regulations regarding reimbursement which limits the provision of telehealth services between different states. For instance, a specialist in Washington cannot deal with or provide telehealth services , such as real-time consultation, to a GP affiliated to a telehealth system in another state due to variances in reimbursement rules between states. Also, the majority of applied telehealth applications are clinical, while the non-clinical and educational telehealth projects are yet insufficient. However, all these obstacles are beginning to disintegrate due to an increasing spectrum of research information indicating how telehealth can enhance patients' results and decrease healthcare expenditures (Kim, 2004). In addition, the Department of Defence (DoD) and NASA have made very significant efforts and attempts to advance the use and exploitation of telehealth opportunities and broaden its services all over the country. Yet, barriers including telecommunication infrastructure problems, patient consent, and a national reimbursement agreement need to be overcome to achieve the best possible outcomes and advantages of telehealth programs around the country.

2.4.2. Telehealth in Australia

Australia is a very large country and has many major cities along coastlines, but almost 33 percent of the population exist outside such major urban areas (Smith, 2012). Typically, most healthcare specialities services are located in the major urban provinces. However, the contemporary utilization of telehealth in the country is: centred about specialities to patient consultations in the remote areas; applied in chosen specialities that are least compromised by the limitations of video conferencing; high quality, but costly video conferencing hardware is predominantly based in hospitals (Smith, 2012). Nonetheless, a system of 85 telehealth videoconference spots were employed in Western Australia along with 19 teleradiology utilities between 1996 and 2003. Telehealth facilities have been increasing progressively in Australia. In 2002, there were more than 30,000 teleradiology communications and around 1250 clinical occurrence of services through videoconference (Dillon & Loermans, 2003). Generally, a survey conducted in 2003 has shown that almost half of the Australian hospitals are applying telehealth applications (Brear, 2006).

Recently, the Australian government has declared that patients in rural provinces will obtain better access to specialities services through recent investments in telehealth online consultations via the internet. Moreover, the government has recently invested more than $400 million in telehealth facilities, including approximately $352 million for Medicare reimbursements for online consultations and incentives for general practitioners (GPs) and specialists to take part in online training, together with nearly $50 million for the GP after hours helpline to incorporate videoconferencing facilities (Barwick, 2010). According to a report published by Access Economics (2010), the need for rapid broadband, especially in remote areas, is one of the major reasons why telehealth practice in the country has been limited.

According to TeleMedicine Australia's website (TMA), which is the first Australian supplier for telemedicine in the primary care, the technologies used in the current Australian telehealth practice can be divided into two key categories: SF and interactive videoconferencing technologies. SF technology includes obtaining health information and then transferring such information at a convenient time to a physician or a

healthcare specialist for evaluation offline. The simultaneous presence of both parties is not necessary. On the other hand, real-time videoconferencing technology necessitates a simultaneous presence of both the patient and the health provider to carry out some medical procedures – such as diagnosis – with no need for a physical presence or face-to-face visit, thus saving money and time. Additionally, the Telemedicine Australia's website provides to its members several telehealth services through some software and capabilities such as "clinician-interactive" and "tConsult software". Several telehealth applications and projects applied in Australia are demonstrated below in Table 2.4.2-1.

Table 2.4.2-1: Summarizing several telehealth projects in Australia

Project (1)	**Virtual Critical Care Unit (ViCCU)**
Supplier	New South Wales Department of Health Metropolitan Hospitals Group
Mechanism & Coverage	The system deals with the issue of lack of critical care personnel in remote and rural provinces. The system is built to have a critical care specialist virtually present at a remote site using ultra-broadband network capabilities (Cregan et al., 2006). Patients who have critical injuries or diseases are now regularly and remotely evaluated and managed by such system. Additionally, this system has caused a better level of transferring patients as well as the availability of high quality medical services.
Benefits	Decreased numbers of needless transfers and reduced healthcare costs.
Relevance	Clinical application
Project (2)	**Health Insite**
Supplier	
Mechanism & Coverage	It is a gateway based on the internet to provide health information presented by a broad variety of official information partners. The main goal is to afford easy access to current and reliable information about healthcare, wellbeing, lifestyle and fitness, in order to have more informed and up to date healthcare decisions or results (NICTA, 2010). It is a 24-hour health advice line that provides a pervasive countrywide access to healthcare triage, medical advice and information. It lists comprehensive, beneficial health information about a wide spectrum of diseases or conditions as well as wellbeing in general, and the user can search for a specific condition or illness and have the access to the information provided regarding such illness (Conditions and diseases, n.d.).

	Generally, it is considered as a form of tele-education.
Benefits	Provision of a quality-controlled medical information resource to both patients and the public, and expansion of access to healthcare information.
Relevance	Non-clinical application
Project (3)	**CSIRO's "Hospital Without Walls" Project(HWW)**
Supplier	Commonwealth Scientific and Industrial Research Organization (CSIRO)
Mechanism & Coverage	This is a system developed to monitor elderly persons by offering them the chance to live in their own homes instead of moving into a hospital or nursing house. It is particularly ideal for those who suffer from one or more chronic conditions. The system consists of a monitored computer in the healthcare provider location, and a belt, developed by the same agency, that should be worn by the patient as well as small patches which indicate some vital signs of the patient's health condition (Wilson et al., 2000). When the patient is wearing the belt, health providers can remotely and continuously monitor their movements and recognize if the patient is walking, sitting, standing or lying down. Most significantly, they can discover if the patient has a fall. In such case, an immediate intervention is performed to assist the patient and carry out the proper medical procedure as soon as possible (Australia advances, 2011). Several vital signs such as heartbeat and BP can be measured which assists in making more accurate health assessment.
Benefits	Ability for patients to live in their own houses; ability for healthcare providers to continuously and remotely monitor their patients conditions; reducing costs of transportation, and reducing costs of hospitalization, as well as time saving for both patients and health providers (Health and wellbeing, 2011). In addition, as falls in old people are very significant cause of mortality and morbidity, they might be decreased through the constant monitoring of HWWs system.
Relevance	Clinical/ non-clinical application

Although the current status of Australian telehealth is somewhat sophisticated, it is yet in need of several enhancements. The most important aspect needed for Australian telehealth is a national strategy that guarantees consistency and compatibility of standards particularly for both public and private sectors; infrastructure; tools; information capture; as well as assessment methods (Dillon & Loermans, 2003). This

development will lead to comparisons among states and districts that will lead to gains in knowledge, thus advancing telehealth nationwide. Additionally, supporting rural and distant regions with quality telecommunication infrastructures is required to overcome all limitations and shortages related to telehealth technologies networks and coverage. Also required are the resolving of various issues such as privacy, social acceptance and the training of healthcare professionals.

However, according to the Australian Bureau of Statistics (ABS) in 2010, 89% of Australians lived in urban regions, which makes Australia one of the most metropolitan countries in the globe. In addition, the majority of Australians reside in coastal areas, particularly in south east of the country. This is one characteristic that makes Australia a proper environment to telehealth. It is accessible to create a national strategy that integrates both public and private health sectors and solves the shortages of healthcare providers in rural areas along with ensuring reimbursement and training healthcare professionals' matters.

2.4.3. Telehealth in NZ

NZ requires a telehealth system to deal with a variety of challenges met in delivering healthcare services. Some of factors that require the presence of a telehealth system are the ageing population and the ever-increasing median age as well as continuous decreases of death rates. NZ's Statistics demonstrate that the median age of New Zealanders has been increasing and it is also likely to increase, as shown in Figure 1 below. In addition, the mortality constantly decreases, as illustrated in Figure 2. This raises the complicated issue of an ageing population with higher demand by these elderly people healthcare services particularly for chronic diseases.

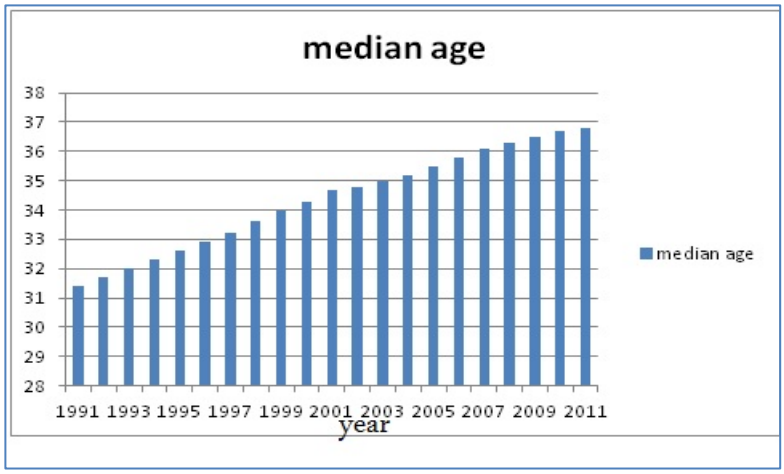


Figure 1: illustrating the median age of New Zealanders. Adapted from (New Zealand Statistics)

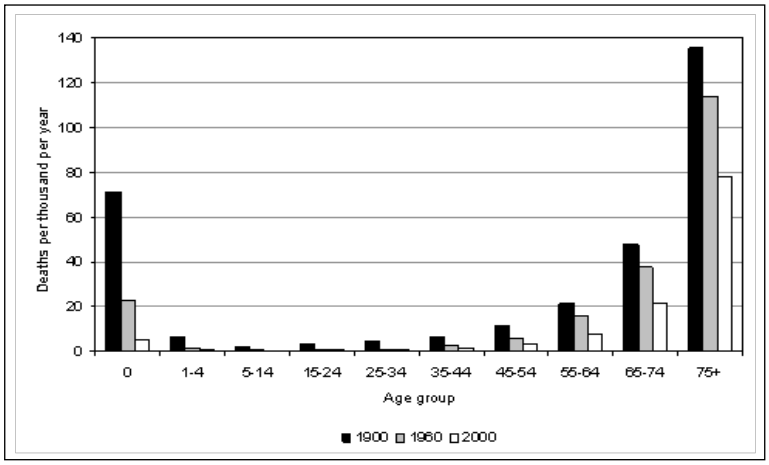


Figure 2: illustrating death rates for each age group for the years 1900, 1960 and 2000. Adapted from (New Zealand Statistics)

A further incentive for a telehealth system in the country is the uneven population distribution. Almost 86 percent of the population reside in metropolitan regions. This makes it one of the most urbanized countries worldwide. According to the NZ's demographic statistics, there are 138 cities and municipalities located near to coastlines, approximately 90 percent of the population is centred within 50 kilometres of the shoreline, and 75 percent resides in the North Island. Thus, large regions with little population density offer considerable opportunity for telehealth advancement.

However, NZ healthcare system has already taken several steps towards developing a telehealth system to overcome the above difficulties and provide the proper care for every citizen at anytime and anywhere. Although a significant improvement is needed to advance the telehealth system in NZ, some useful projects and applications have been

introduced. Several of such applications that have been applied in NZ are briefly described in the next Table 3 besides their mechanism and benefits.

Table 2.4.3-1: Summarizing several telehealth projects in NZ	
Project (1)	**Videoconferencing project- Northland**
Supplier	IT Health Board- Ministry of Health
Mechanism & Coverage	Kaitaia Hospital's renal unit in the Northland has established a videoconferencing technology to instantaneously communicate with specialists in Whangarei and Auckland hospitals. Connection is being executed through two dialysis satellite units founded in Kaitaia and Kawakawa (IT Health Board, 2010). By employing this technique, patients in such rural area can be diagnosed, monitored and treated without the need for travelling long distances to the specialist's region. Digital pictures and medical information such as x-rays or Computed Tomography (CT) scans can also be wirelessly shared with specialists to provide the accurate diagnosis and treatment. Furthermore, healthcare providers in that rural area can directly discuss any case with specialists in either of the above hospitals using a real-time videoconferencing means rather than the previous method of sending emails or written correspondences (Ministry of Health, 2010).
Benefits	It saves time for both patients and healthcare professionals which consequently increases productivity and reduces waiting times. This technique also decreases costs for patients by removing the need of travelling, which causes convenience, and for health providers by reducing costs of transitions whether of patients or medical information (Ministry of Health, 2010). As well as, improving access to healthcare professionals and services.
Relevance	Clinical application
Project (2)	**West Coast case study - Closing the distance**
Supplier	Ministry of Health
Mechanism & Coverage	On the remote West Coast patients used to drive long ways or wait at least six days to see the GP. However, this has changed with the presence of NTs, particularly videoconferencing techniques. High-definition video links have been deployed in eight towns throughout the West Coast to facilitate delivering healthcare services to all patients located in such towns with no need for whether waiting or travelling long distances (Ministry of Health,

	2010). Patients now can reserve a videoconference appointment with a GP or even a specialist in either Greymouth or Westport; and conveniently and directly receive the right care. Additionally, the nurse is involved in this real-time video conversation to perform any required measurements and also to arrange follow-up meetings. Another equipment used in this project is a second handheld camera to enable the healthcare professional of seeing some vital parts of the patient's body such as skin, rashes or eyes in an extreme close-up.
Benefits	It saves time, thus improving productivity. Also, it improves access to healthcare experts and services. As well as, reducing costs of travelling and referring patients. Additionally, convenience for both patients and health professionals. It also gives patients the chance to talk to healthcare professionals more freely and with no hesitation, which might be difficult in some situations with the traditional face-to-face method, and through which healthcare providers can obtain a full picture of the patient's condition and carry out the accurate treatment. Thus, improving quality of care (Ministry of Health, 2010).
Relevance	Clinical application
Project (3)	**Faster access to diagnostics – Auckland**
Supplier	Ministry of Health
Mechanism & Coverage	CT scans, x-rays and ultrasound are sometimes very important in diagnosing what the patient suffering from. Therefore, achieving access to such tools can assist GPs to correctly decide what is needed for the patient ending any uncertainty or doubt. GPs now , in Auckland region as well as in Wellington and Canterbury, are able to straight order complex clinical imaging for their patients via a computerised device (Ministry of Health, 2010). For example, Magnetic Resonance Imaging (MRI) is a vital diagnostic device for patients suffering from headaches, where it is suspected that there might be a severe underlying source. Patients used to be referred to a hospital specialist and listed in the waiting catalogue because only specialists could order a MRI. It was a time-consuming and ponderous way to perform (Ministry of Health, 2010). While now, using this computerised tool, if a patient meets the diagnostic criteria, the MRI diagnosis can be directly and more timely achieved.
Benefits	It decreases waiting times. Also, it reduces patients' referrals to the hospital,

	thus cutting healthcare costs. In addition, this approach provides both GPs and patients with certainty sooner and easier (Ministry of Health, 2010).
Relevance	Clinical application

With the potential broadband strategy in NZ that is planning to enable fibre-based communications and fast broadband services to reach 93 percent of rural areas by 2015, the opportunities for deploying further telehealth initiatives are possible (Chorus, 2012). This is being achieved via promoting the current local broadband networks by expanding fibre optic cables more into rural areas. According to the *final report for internet NZ, published on Network Strategies 2008*, numerous access technologies obtainable that are proper for carrying broadband services now or in the near future such as copper twisted pairs, fibre to the node (FTTN), fibre to the promises (FTTP), WiMAX, Mobile, hybrid fibre-coaxial (HFC) and satellite. There technologies can provide a high-speed connections that are effective for whether individual or commercial use. Therefore, NZ has a sophisticated infrastructure that can allow further telehealth initiatives to be implemented.

The demographic distribution of NZ makes it one of the most urbanized nations and gives it a better chance to implement telehealth initiatives as well as provides healthcare services faster, easier, more cost-effectively and with better quality. Particularly, when most of the country's population lives around coastlines and centred within 50 kilometres of coastlines.

2.4.4. Telehealth in Malaysia

Malaysia is located in South East Asia with a current population of almost 28 million and approximately 44 percent of the total population live in rural regions (Smith & Maeder, 2010). The attempt to exploit the ICTs into the healthcare system has been motivated by the Malaysian government to tackle several diverse challenges encountering the sector such as inflation of healthcare costs, inequality of care, and lack of sources as well as rising patterns of illnesses. Telehealth initiatives in the country aim at enhancing the level of general health facilities which include several services such as medical education, clinical facilities and accessibility of health information (Smith & Maeder, 2010). Despite these challenges, Malaysia is in an enviable status being able to manage its healthcare system expenditures to below 3 percent of the GDP (Hesham,

2005). Numerous telehealth projects that have been established to address at least some of the above mentioned challenges are independently summarized below in Table 2.4.4-1 alongside their mechanism and advantages:

Table 2.4.4-1: Summarizing several telehealth projects in Malaysia	
Project (1)	**Mass Customized/ Personalized Health Information and Education (MCPHIE)**
Supplier	Ministry of Health
Mechanism & Coverage	The objective of this project is to provide quality medical advice and information to persons through available information technologies, especially multimedia and telecommunication tools (Taking charge of our health, 2003). It presents medical and wellness information and advice that is personalized for every individual. It is available for the general public, who can benefit from it by registering on the website (www.telehealth.com.my) and achieve medical updates and information about subjects of their particular concerns and interests. In addition to being accessible interactively on the internet, this information and services are obtainable through healthcare providers and call centres (Taking charge of our health, 2003).
Benefits	Increased access to health information and advice; enabling people to take responsibility of their own health status leading to a new vision of how to obtain a healthy way of life; and accordingly, Malaysians will become more careful of health risks and also more proactive in sustaining their health status and preventing diseases.
Relevance	Non-clinical application
Project (2)	**Teleconsultation Project**
Supplier	Ministry of Health
Mechanism & Coverage	This project is a nationwide network of teleconsultation services. It presents services related to four disciplines which are: radiology, cardiology, neurosurgery and dermatology. The main goal is to provide health consultation services about these four disciplines to under-served and rural areas that lack for such disciplines' consultation (Singh, 2011). In the remote medical centres, physicians can discuss the medical issue cases via teleconsultation techniques with specialists or doctors in the hospital utilizing a videoconferencing system to present a better care in the medical centres with no need to refer the patient

	to the hospital. Merely crucial and essential patients are transferred to the hospital (Yadav & Lin, 2001). Additionally, in 2003, there were 41 locations – whether medical centres or hospitals – connected all over the country and through which doctors can remotely communicate with each other or with patients delivering more accurate and cost-effective medical solutions (Abdullah, 2008).
Benefits	Reduction of unnecessary patients' transfers; cutting down expenditures of the healthcare system; and better QoS.
Relevance	Clinical application
Project (3)	**Continuing Medical Education (CME)**
Supplier	
Mechanism & Coverage	CME provides chances for all healthcare professionals, no matter where they work, to obtain and update their information about healthcare or any health-relevant areas (Taking charge of our health, 2003). It gives the opportunity of attending distant part-time courses without travelling to another location which accordingly saves time and money and promotes productivity. In addition, these courses can be obtained anytime and anywhere as long as an internet connection is found, which means they are convenient. According to a paper published in Flagship website (2003), CME provides three key services which are: the electronic courses, the virtual library and the online professional community services. There are two methods to access the electronic courses: either through the *regular* distance learning or through a *modular* distance learning method. The second service is the virtual library which allows healthcare professionals to access to several medical resources such as journals, databases, governmental reports or medical practice guidelines. In the third service (online professional community services), healthcare providers can communicate through an online means such as e-mail, chat or online audio techniques to share opinions about a case or carry out discussions about a particular topic. All these types of interaction occur electronically and remotely.
Benefits	Expended access to updated medical information and online courses; reduced costs of travelling; and obtainable opportunities to share ideas and improve communications among healthcare providers.
Relevance	Non-clinical application

Malaysia is planning to become a developed country by 2020, and it has created a Multimedia Super Corridor Flagship Application (MSCFA) that ensures development of a wide spectrum of institutions and services such as education, transportation, healthcare, manufacturing and agricultural and livestock. However, Malaysia's telehealth system is not only point-to-point teleconsultation, but also includes the whole spectrum of multimedia technologies to bring advantages to all players in the healthcare sector (Ariff & Chuan, 1998). By benefiting from current multimedia and information technology, and also creating innovative technological solutions, the MSCFA will ensure Malaysians obtain high quality healthcare services. Additionally, it will sustain the advancement of Malaysia into a universal hub for telehealth services, products and education (Ariff & Chuan, 1998). The presence of a national strategy that ensures equality of providing healthcare services to all areas and provinces throughout the country is the most fundamental aspect that makes it developed. The contemporary state of the Malaysian telehealth system is enviable and sophisticated, although it is still developing and growing towards a higher level of success and a greater stage of achievement.

2.5.Older and Existing Technologies

This section explains the older and existing technologies focusing on network broadband and bandwidth. Limitations of the older and existing networks – 2G and 3G – are separately described followed by the contributions.

2.5.1. 2G Networks Limitations

The field of telehealth has gradually become an area of developing and expanding the different aspects of patient care. Professionals have thoroughly considered certain advantages and limitations of various technologies. 2G technologies are widely spread and quite popular to use in the field of telehealth, but they represent a series of limitations. A significant disadvantage of 2G technologies relates to a weaker digital signal. For instance, in less populated areas, the weak digital signals cannot sufficiently reach a cell tower. This limitation regularly appears when 2G systems are placed on

higher frequencies (Batistatos, Tsoulos, & Athanasiadou, 2012). Deploying 2G systems on lower frequencies does not demonstrate such a persistent problem. Another limitation of 2G technologies is identified as an angular decay curve, which implies that in the presence of rather unfavourable conditions, occasional dropouts will deteriorate the digital signal. Other limitations of 2G technologies refer to file size as a consequence of colour depth and resolution of display as well as speed. Moreover, the range of sound that is being transmitted is reduced. In this way, individuals may not adequately hear the tonality of someone in a voice conversation through a specific network.

2.5.2. 3G Networks Limitations

Although 3G technologies have represented greater advantages compared to the older 2G technologies, there are persistent limitations of 3G systems as well. The major problem pertaining to 3G technologies is that of connectivity (Zdravkovic, 2008). It is apparent that 3G technologies are not always available, and thus a substantial number of users have encountered problems with 3G connections in particular areas. For instance, when patients using telehealth are located in an area with low 3G connectivity, then they cannot fully obtain the benefits from this technology's services. Instead, individuals will be more likely reconnected to 2G capabilities that represent a significantly slower speed (Batistatos, Tsoulos, & Athanasiadou, 2012). Another limitation of 3G technologies is associated with hardware and software compatibility. Some internal 3G connection faults may significantly impede the process of communication. It appears that 3G connections are proving difficult, as this technology is beyond the current demands of the average users.

2.5.3. Mobile Technologies

In this part, mobile technologies produced before 2004 are taken into account. Technologies such as laptop computers, cell phones, PDAs and Radio Frequency Identification systems (RFIDs) are illustrated with particular focus on their features and perceived impact on telehealth. Such technologies are separately described below:

i. Laptop Computers

Mobile technologies have emerged as an extremely important tool to facilitate the outcomes of telehealth. The use of laptops and net-books has definitely proved efficient to maintain televisits, teleconsults, and telemonitoring of the health condition of people located in remote areas. Mobile technologies represented through laptops and net-books can serve the essential functions of maintaining remote hospital rounding, remote intensive care units, and remote outpatient care visits (Ozturk, & Sharma, 2011). Healthcare professionals can successfully maintain teleconsults by using laptops and net-books, as in this way, they may include shared access to patient data such as x-rays, images, etc. Likewise, patients can collect and transmit significant clinical statistics through laptops and net-books. The integrated use of mobile technologies can enhance the process of decision-making associated with the health condition of certain groups of the population (Ilie, Slyke, Courtney, & Styne, 2009). Indeed, laptops and net-books demonstrate an innovative technological solution that offers enhanced results in telehealth.

ii. Cell Phones

Cell phones (see section 2.6 for smart phones) have significantly facilitated the process of transmitting important information regarding the health status of patients in remote areas. Cell phones definitely have the potential to turn telehealth into an emerging global initiative that promises relevant outcomes. It is essential to note that the extensive use of cell phones can become an adequate platform for demonstrating health management tools. In an article by Sherwood (2010), the focus was on the innovative development of a cell phone microscope. This microscope is digital, which implies it has the capacity to create images based on the shadows of certain objects. Cell shadows are extensively rich in meaning, as professionals in the field can adequately interpret it (Sherwood, 2010). Smart phones are more powerful regarding facilities that implement algorithm for rendering. In this way, health care professionals can reconstruct the specific image produced as result of the projected shadow for each cell type.

iii. PDAs

PDAs usability for telehealth support has become a subject of persistent interest in telemedicine in recent years. PDAs are quite convenient mobile devices that are perceived as more usable for multimedia data compared to smaller wireless devices such as cell phones (Becker, 2009). Important advantages to use PDAs in telehealth include larger screens, completely functional keyboards, and efficient operating systems that support various desktop features. Moreover, PDAs are portable and mobile especially if compared to desktop computers. An additional feature of PDAs that has been utilized by health care professionals in the field of telehealth is that a PDA has the potential to synchronize with laptops and desktop computers in order to make the process of data sharing quite transparent and efficient (Becker, 2009). Compatibility emerges as an important issue in telehealth considering that patient and medical data stored on a PDA is usually transmitted to a centralized data source.

iv. RFIDs

RFID in the field of telehealth has two major applications that need to be explored. The first application relates to studying supply and demand of specialists, nurses, and patients, whereas the second application is associated with the development of mobile telehealth services (Xiao, Shen, Sun, & Cai, 2006). These technical systems can identify an object or an individual by implementing wireless transmission. RFID systems consist of RFID tags and readers. The attachment of a specific tag to an object or a person through an electromagnetic field can detect a signal from the reader, and thus identifies itself. RFIDs are contention-based, as this implies that a collision may occur if more than one tag respond to the reader at the same time. The mentioned systems employ wireless communications in order to ensure the delivery of appropriate medical information and services. Additionally, tracking objects or individuals is a very important element in the healthcare sector as it can reduce medical errors and ensure that the right patient obtains the right medication in the right time.

2.5.4. Contributions of the Older Technologies

Telehealth technology has existed for many years, making health care accessible and affordable to many patients based in remote areas. It has been shown that a significant number of patients have benefited from older technologies used in telehealth systems. There are two basic types of networks implemented in telehealth: wide area networks (WAN) and local area networks (LAN). The contribution of older technologies reflects in the use of various types of telehealth equipment (Weitzel, Smith, Lee, Deugd & Helal, 2009). In the past, professionals in the field have extensively relied on the fixed network setting using wired telecommunications nets such as digital subscriber lines. Moreover, cellular scheme and proprietary fixed wireless access systems have been implemented for maintaining last-mile connections for telehealth in the past.

In fact, professionals in the field are unanimous that the most reliable way to reform telehealth is to consider essential aspects from the past in order to find a sustainable way back to providing patient-centred care services by using appropriate technologies. The focus on patient-centred care in telehealth, which is facilitated by access to comprehensive health information, shows strong determination to solve many problems in the field (Sherwood, 2010). Adoption of a forward-looking attitude in telehealth is fundamental, as this should occur in the light of employing new technologies that can significantly enhance patient outcomes.

2.6.NTs

In this section, the new and potential broadband networks – 4G and LTE – are demonstrated alongside their expected improvements that can affect telehealth practice and applications. Additionally, some other important technologies such as mobile, SF, video streaming and videoconferencing technologies are described and detailed.

2.6.1. 4G Networks

Although older technologies have significantly influenced developments in telehealth, the urgency of exploring new technologies is evident. The implementation of 4G technologies in telehealth has been considered relevant in the era of immense

technological advances. Major technological characteristics of 4G systems that can facilitate developments in telehealth include the following aspects: higher transmission speed compared to 3G systems; ten times larger system capacity; support for Internet new protocols (IPv6); QoS; ensuring different types of multimedia services; and user-friendly services (Batistatos, Tsoulos, & Athanasiadou, 2012). Undoubtedly, 4G advances can offer mobile patients and citizens a viable opportunity to interact more efficiently obtain the necessary medical attention and advice they need regarding their health condition. Therefore, 4G technologies represent the idea of ensuring high-speed data and other relevant services that are being integrated with voice services (Ozturk, & Sharma, 2011). Wireless 4G networks emerge as an optimal way to deliver medical services to individuals in remote and rural areas.

Similar to wired broadband, 4G systems have sufficient bandwidth to allow the use of live video streams. This bandwidth allows individuals to attain high quality video conferencing and to execute adequate telemetry. The fact that 4G systems are fully IP-based integrated technological solutions is indicative of these systems' huge benefits in the field of telehealth (Ilie et al., 2009). 4G technologies can provide various speeds between 100 Mbit/ s to 1 Gbit/ s, both indoors and outdoors, and thus such systems ensure premium quality and extensive security. The use of 4G technologies in telehealth is at the core of a paradigm shift based on enhancing long-distance diagnostic services.

2.6.2. LTE Networks

Another essential example of the development of new technologies that can be used in telehealth is that of Long Term Evolution (LTE), which indicates a relevant standard for wireless communication aimed at an extremely high speed for data networks. The use of new modulation techniques has the potential to increase the speed and capacity of older network technologies. In fact, LTE represents the promising future of mobile broadband technology (Ozturk, & Sharma, 2011). One of the greatest advantages of LTE as applied to the dynamic requirements of telehealth relates to the provision of a global ecosystem with inherent mobility (Ozturk, & Sharma, 2011). Likewise, this technology offers easier access, as well as a high level of security and privacy. The mentioned

aspects are extremely important in providing a flexible and secure platform of patient care, as patients are quite enthusiastic about the convenient and quality aspects of care.

2.6.3. Videoconferencing Technologies

The use of video conferencing, particularly Skype, has been a subject of proliferation in recent years. For instance, Skype has been utilized as a powerful tool to conduct online therapy or e-counselling services (Sherwood, 2010). Video conferencing, or what is frequently identified as Audio-Visual Technology, emerges as one of the most important forms of communication in contemporary telehealth. Skype is a popular application, which is free and widely available. The concerns about using video conferencing in telehealth mainly focus on the aspects of confidentiality and privacy, as well as HIPAA compliance (Batistatos, Tsoulos, & Athanasiadou, 2012). It is apparent that video conferencing allows real-time views of images related to telehealth, which implies that specialists in the field can present diagnoses faster. High quality video communication can be used for patient care, maintaining investigative research, and other relevant programs. Video conferencing integrates different medical devices with its conferencing infrastructure. An example of the practical application of this technology in telehealth relates to video-assisted surgery (Petr, 2012). This turns video conferencing into a powerful tool to facilitate the structure of telehealth in order to deliver flexible and quality care to patients.

2.6.4. Video Streaming Websites

Relying on various video streaming websites has become quite persistent in the context of telehealth. Some of the mostly utilized video streaming websites include *YouTube*, *Vimeo*, and *MetaCafe*. In fact, video streaming presents a specific method of delivering multimedia data, whether this is video, audio, text, images, or waveform data (Zdravkovic, 2008). During this process of delivering essential data, the mentioned video streaming websites demonstrate a reasonable amount of QoS. In general, the receiving system is represented by displays where the data is being transmitted. It is essential to note that no storage of data takes place in the process of video streaming. In order to achieve data streaming, professionals in the field tend to create the following

important protocols: Real-time Transport Protocol (RTP), Synchronized Multimedia Integration Language (SMIL), and Real-time Streaming Protocol (RTSP). The mentioned video streaming websites demonstrate a higher level of transparency and accountability in the process of delivering medical services within the parameters of telehealth (Becker, 2009).

2.6.5. New Mobile Technologies

I. Smart Phones

The field of telehealth has been persistently developing as result of the implementation of new technologies such as that of smart phones, including iPhone. Contemporary telehealth applications extensively rely on regular phone consultations (Petr, 2012). It is clear that the smart phone applications used in telehealth can produce SMS messages in a format similar to that sent by patients. Sensors implemented in smart phones allow for providing important information about patients' condition and development. These applications use Android Sensor API in order to access the sensors of the phone. In this context, CPU takes control of the API so that the process of data collection can be enabled in cases when the phone is no longer active. In addition, smart phones have relevant features such as plug-ins can schedule tasks for later execution (Petr, 2012). Health care professionals encourage the implementation of user interaction and background tasks.

II. Computer Tablets

Computer tablets such as iPad have found wide application in the field of telehealth (Weitzel et al., 2009). A substantial number of doctors have utilized the iPad, which indicates one of the goals of telehealth, in particular becoming ubiquitous. It is required that doctors embrace the functional capability of iPad for maintaining video conferencing. It has been argued that iPad could definitely change things in telehealth because many physicians and other health care professionals tend to use it for medical tasks (Ballen, 2011). This can be explained by the fact that contemporary telehealth has been persistently gravitating toward the implementation of mobile technologies.

Therefore, leading vendors are more likely to create iPads' applications that correspond to the specific needs and expectations of telehealth physicians.

2.6.6. SF Technologies

A. iCloud

SF technologies are extremely important for the extensive development of telehealth practices. iCloud is a relevant example of a useful mobile platform for health-related applications available to patients in remote areas. This platform allows for the creation of wireless backup and synchronization for various applications, videos, and documents. The files can be accessible from compatible devices such as laptops, desktop computers, iPhone, and iPad (Weitzel et al., 2009). It is important that individuals store data on the cloud in a methodological manner. This storing and forwarding technology ensures a security-based environment. It is clear that such aspects are suitable for health care professionals who access a substantial number of data on a daily basis. They obviously need more space to store additional files in order to maintain their specific operational needs. Therefore, it is important to consider the ramifications of similar storing and forwarding features in the field of telehealth (Weitzel et al., 2009). However, sensitive information should not be stored on iCloud. Such information includes social security numbers, identifiable patient data, etc. It is important to comply with ethical guidelines in telehealth in order to avoid the retrieval of restricted information so that patients can be secure and confident in the process of using certain telehealth platforms.

B. Dropbox

Dropbox represents another innovative technology for storing and forwarding important medical data in telehealth. In the specific architecture of Dropbox, the available medical devices communicate locally through a hub, and thus the hub can contact a server via the Internet. The utmost goal of professionals using Dropbox is to secure message transmissions, as well as to maintain important cryptographic functions (May, Shin, Gunter, & Lee, 2006). It is essential to indicate that only authorized users can retrieve

the stored readings, which implies a high level of security of patient data. In addition, the Dropbox architecture relies on the implementation of various protocols in order to transmit information between parties. The process can be completed by requiring protocols for significant distribution and bootstrapping in a direction of sending messages from patients to physicians (May et al., 2006). An important advantage of Dropbox is that it ensures a reliable and simple access control protocol that can maintain the rights of different physicians and patients.

2.6.7. Social Networks

Progress in telehealth technologies obviously enables health care providers and practitioners with an opportunity to present efficient solutions to improve the quality of patient care. Enabling creative applications, such as the ones maintained in major social networks, can facilitate the delivery of quality care (Weitzel et al., 2009). Social networks, mainly represented by Facebook and Twitter, enhance traditional telehealth systems by the establishment of a virtual care network. In this way, physicians are provided with an opportunity to monitor their patients quite holistically. Undoubtedly, the implementation of social networks in telehealth creates a completely different user experience compared to traditional patient portals. Therefore, health care practitioners tend to incorporate remote monitoring services that support patients, the primary care network, and the extended care network of patients (Ballen, 2011). This implies that such an integrated system has the capacities to leverage various appropriate standards and specifications pertaining to telehealth.

The success of telehealth technologies apparently depends on the population group that is widely available through major social networks. Clearly, social networks demonstrate significant potential to influence behaviour and lead to proper action regarding the health condition of individuals (May et al., 2006). Social networks provide extensive platforms to people to share their important health concerns, support one another, and explore desirable health outcomes in the future (May et al., 2006). The social networking websites of Facebook and Twitter allow users to interact with one another in real time, as well as to monitor behaviour and particular tendencies in the field of telehealth. Social networking facilitates the formation of trust and loyalty in the

relationship between patients and physicians. It is important to note individuals' determination to take an active role in promoting health, especially in remote areas (Weitzel et al., 2009).

2.7.A Comparison Between OTs and NTs

Practical application of new and old technology in telehealth has various differences. Some of the OTs have a number of limitations. Despite their limitations, these technologies are still more effective than the new technologies in some areas such as the price. Therefore, they are still applicable though outdated. On the other hand, the NTs have taken a role of improving and adding benefits to the OTs in telehealth practice. In this subsection, however, a comparison between the OTs and NTs is provided to demonstrate the impact of NTs on the current telehealth practice. Such comparison is categorized into several criteria such as ease of use, speed, ease of access, quality of service and cost model as illustrated below in Table 5.

Table 2.6.8-1: Illustrating a brief comparison between OTs and NTs

Criteria	OTs	NTs
Ease of use	They are easy to use as people have already become customized for them. However, their use may require some complicated skills such as wired connections to transmit data and complications of old human computer interfaces (HCI).	They are easy to use because of some obvious improvements in HCIs as well as supporting touch screen services. Additionally, synchronization of data and configuration process are made easier and faster when a connection between two devices is being performed.
Speed	They have several limitations in terms of speed of uploading and downloading and that is due to the limitations of broadband networks such as 2, 3G. Old networks delays transmission x-ray images and interactive visual connections resulting in poor	New networks broadband such as 4G and LTE provides faster and more effective services, for example, when transferring CT scans or performing videoconferencing. So healthcare professionals can carry out their duties more rapidly and efficiently as well as broadly.

	provision of services.	
Ease of access	Their accessibility is not sufficiently mobile as most of these technologies are fixed and not portable unless otherwise a few inefficient devices such as mobile phones. This certainly defines their accessibility.	They are portable, mobile and handheld which make them usable everywhere and anytime. They are easy to access and pervasive which clarify their usability for both patients and health professionals in various situations such as in home, office or while travelling.
Quality of services	Slow and less effective than the NTs as they mainly cannot be used in some circumstances such as when travelling. Also, their poor processing speed and features may limit them from performing complicated tasks.	More effective due to their mobility and portability which enable both patients and physicians to be more frequently and conveniently in touch. In addition, they are more sophisticated to carry out some complex duties as they have more effective features and capabilities.
Cost model	Less expensive since they are outdated, so their prices have been decreased to increase their demands.	More costly as they are up-to-date and new in the market as well as they contain several innovative capabilities and functions.

Chapter 3: Methodology

This section outlines the research methodology used to identify the impact of NTs on the current telehealth practice. Data was gathered by collecting opinions and attitudes of healthcare providers in New Zealand via a designed questionnaire. This section is categorized as follows: a general overview of quantitative research, an explanation of why quantitative research methodology was selected, followed by sections on the ethics approval process, how the survey questions were structured, and how the sample was selected.

3.1.Type of Research

Alongside a review of the literature, capturing healthcare professionals' opinions is needed in order to discover the impact of NTs on telehealth practice in New Zealand. A survey is designed to capture views and opinions of professionals in work field. Also, as there are no qualitative methods, such as case study, interviews or focus group techniques, used; a quantitative research approach is more appropriate for the present study than a qualitative approach. However, several questions of the survey asked respondents to write some comments, which is considered as "qualitative" approach. Therefore, the type of this research is combination of both qualitative and quantitative approach as the survey included several open-ended questions where participants can write their comments and suggestions.

The concepts and methodology were used to carry out the research and extract the results from the surveys. Additionally, the data for the present study is derived from the surveys and presented in tables and graphs to demonstrate the results in an easy and understandable format (Jackson, 2011).

3.2.Ethics Approval

Due to the involvement of human participants as the sample, the present research had to meet the ethics approval from Massey University. Ethical requirements have become an essential part of research study, similar to a developing understanding of the rights and duties of humans. Massey University has an ethics committee which is essential not

only to deal with ethical standards such as reliability, justice, privacy, and respect for individuals, but also to tackle the developing understanding of how these standards are articulated in society at a particular time (Massey University: Code of ethics, 2012).

An ethics approval for this research was received from the Massey University Human Ethics Committee (MUHEC). The screening questionnaire was concluded to verify the type of procedure to follow to achieve an ethics approval. The questionnaire implied that this research falls under the Low Risk Notification category that is no more hazardous than what is normally met in daily life. Therefore, it was not obligatory to receive a full approval from the MUHEC for a Low Risk Notification project. The notification is used to record the research on the Low Risk Database. The ethics approval process involved producing the documents listed below according to the ethics process order (as provided in appendix A):

- Massey University Screening Questionnaire – to determine the approval procedure.
- Massey University 'Notification of Low Risk / Evaluation Involving Human Participants' application form.
- The ethics approval that was received from MUHEC.
- Invitation letter for participation – to invite healthcare professionals to take part in the survey.
- Information sheet – to provide some important information about the present study including its objectives and importance.

After submission, the documents were assessed and the research was successfully approved as Low Risk research by MUHEC. The paper-based surveys as well as the online version were labelled with the Massey University logo, and contained contact details and the low risk approval note; this was advised by the MUHEC. The letter provided by MUHEC was illustrated to partakers as an authentication of the ethics approval.

3.3.Survey Approach

The questionnaire was designed to capture valuable qualitative and quantitative data. The online version was designed using the Survey Monkey website as it is convenient and simple to use. It was very simple to follow; the participant would add their options and opinions using checkboxes or textboxes. It was designed to take a maximum of 15 minutes to complete. The survey targeted various healthcare providers as well as health strategists who are affiliated to the New Zealand healthcare domain. The survey was available in two formats for convenience: a printed version which could be posted, circulated, or handed out during a personal visit, and an online version that allowed participants to submit their surveys by visiting the URL– https://www.surveymonkey.com/s/XK5NMF3 (as attached in appendix B).

The survey consisted of three key sections as demonstrated below in Table 3.3-1.

Table 3.3-1: Summarizing the survey's main sections

Section 1	Introduction page – providing some information about the study
Section 2	Basic information page – illustrating five basic questions including participant's name, email, age group, health facility name and type.
Section 3	Impact of NTs on telehealth practice – divided into 2 pages, first page included 16 questions and the other page included four.

The first section provided a brief introduction about the research and its objectives and importance. Additionally, a clarification of some terminologies included in the survey was given such as telehealth and NTs. This was provided to ensure participants completely understand all vocabularies and abbreviations included in the survey. Also, this section gave some information about the survey itself such as the number of questions involved, the estimated time to answer all questions and the final date for receiving submissions.

The second section (basic information page) was used to identify the respondent's profile: age group, the name of health facility they work in and its type. Also, an optional space was presented for participants to provide their emails if they would like

to receive an executive summary of the survey's results. In addition, an optional space was given to those who would like to provide their names.

Section three contained questions designed to investigate the impact of NTs on telehealth practice and to what extent such devices and tools have influenced telehealth applications and practices. This section was divided into two parts: the first part included questions that were more focused on the use of devices updated and being used in the health sector as well as tools that have the potential to improve telehealth practice. The second part was concentrated on the importance and advantages, as well as barriers, encountered using NTs in the current telehealth system. Questions about advantages and barriers met by using NTs were given as optional textboxes to allow respondents to add their comments and attitudes based on their experience in this domain. Screenshots of the online version of the survey are provided in Appendix B.

3.4.Sampling

For the results of this study to be meaningful, the individuals who take part in the survey should aptly represent the population under investigation (Jackson, 2011). As the population of the current research consists of all healthcare providers affiliated in the New Zealand healthcare sector, it is not possible to study the entire population. Instead, a sample is selected and given the survey. In order to illustrate reliable and valid conclusions, it is necessary that the sample precisely represents the population which the study is meant to generalize. There are two techniques to sample persons from a population: probability and non-probability sampling (Jacksons, 2011).

In this study, participants were chosen for their relevant knowledge of telehealth and for convenience. As the members of the population of this study do not have the same probability to be selected in the sample and the sample involves participants wherever found and normally wherever convenient, the non-probability convenience sampling technique was used to target the correct population of healthcare providers in New Zealand (Jacksons, 2011). Participants were invited via emails which included an invitation letter and information sheet as well as the web link of the survey. The invitation letter and information sheet are provided in Appendix A.

The online survey was emailed to 25 participants. Several of those participants were affiliated with the National Telehealth Forum in NZ URL http://www.ithealthboard.health.nz/content/new-zealand-telehealth-forum. The rest of those participants were healthcare professionals identified by the researcher where some of them were affiliated to Auckland District Health Board (ADHB), Wiakato District Health Board (WDHB) and the others were associated with Otago District Health Board (ODHB). An invitation letter as well as an information sheet were attached in the email. In addition, the researcher contacted the communication unit in the Capital and Coast District Health Board (CCDHB) and emailed all needed information including ethics approval, information sheet and invitation letter. Accordingly, the communication unit in CCDHB forwarded the email to almost 250 healthcare professionals including specialists, radiologists and GPs. The total number of respondents who eventually took part in the survey was 49 participants. The number of completed surveys was 25, while the rest – 24 – were not completely answered. Accordingly, both complete and incomplete surveys are analyzed in the results section question by question.

3.5.Data Sources

Data included in the literature review was achieved through both primary and secondary sources. Primary data sources essentially comprised academic research and dissertations. Secondary data references contained academic journal articles, reports, governmental issued publications and websites. Both types of sources were accessed and acquired through online journals, databases and academic websites. Valuable insights and notions were achieved from analyzing and reviewing both primary and secondary data sources. These insights and thoughts have been given careful consideration to prepare a high-quality plan for the dissertation. This assisted the researcher to connect key aspects of the topic and also to fill the gap of limitation of information in the area being studied. In addition to this, all collected sources were likely to answer the research questions or lead to some ideas that can be beneficial for answering the thesis questions further to the survey. Also, all accumulated resources were taken into consideration needed to be current and up-to-date references, and thus the year of 2000 was initially selected to be the maximum limit for sources collection,

thus ensuring the topicality of utilized references. However, several quoted sources were published before 2000 – but not before 1997 – and they have been cited in this study because of limitation of information in most aspects of the area, so the researcher had to extend the information search to before 2000.

3.6.Approach of Selecting Used References

After the collection of references, the utilized sources were systematically analyzed by evaluating contents to determine the objectivity, reliability and relevance of the source itself to the current project in conjunction with both author and publisher. Multi-quoted authors were considered the most reliable and trustworthy. The consistency of the collected sources was evaluated by comparing the same information with other references in order to figure out the degree of how reliable this information is. Moreover, relevance of collected information was assessed through analysing the abstract, table of contents and the objectives of the study, so the researcher could effectively determine whether the reference was relevant to the present research or not. Additionally, applicability was taken into account by asking whether each reference was applicable to my research. This was answered by looking initially to the table of contents or the abstract of the reference. Conclusions and discussions of all sources were compared with each other to identify the essential points and eliminate bias. However, the major goal was to understand the context of every source and assess the supporting evidence or inapplicable points.

Chapter 4: Results

The research included 49 online surveys conducted to identify the impact of NTs on telehealth practice in New Zealand healthcare. Questionnaires contributed towards the results of this thesis which are articulated in this chapter. The research methods utilized to collect these results are described in the previous chapter. The next chapter discusses and analyzes in depth these results as well as several important aspects of the current practice of telehealth.

4.1.Survey Results

The survey results are displayed question by question. The original format of the survey is illustrated in Appendix B. The results are demonstrated in both statistical and text formats alongside some graphics showing percentages and number of responses to each option of every question. The questions below are numbered systematically and will be referred to in following sections of the thesis. Additionally, questions are presented in three main parts*: basic information page* which included five questions; *impact of NTs on telehealth practice page 1*, which involved 16 questions; *and impact of NTs on telehealth practice page 2*, which included four questions as mentioned previously in Table 3.3-1(on page 45).

4.1.1.Basic Information Page(Q1 to Q5)

There were five questions posed in this part of the survey, two of which – question 1 and 3 – were "*name of participant*" and "*participant's email*". These two questions were both optional. Since these questions would not affect the results and to protect confidentiality, the answers collected for them are not illustrated. Therefore, only results for questions number two, four and five are separately presented below.

Q2: Age group: the options were: *18-25, 26-35, 36-45, 46-55 and over 55.*

The results include the following:

Table 4.1-1: Illustrating results for question 2		
Options	**Response count**	**Response percentage**
18-25	0	0.0%
26-35	**16**	**33.3%**
36-45	14	29.2%
46-55	8	16.7%
Over 55	10	20.6%
Response calculations	**Answered questions = 48**	**Skipped questions = 1**

The above table demonstrates that the majority – one third – of participants were between the age of 26 and 35 years. In addition, 29.2 percent of respondents were aged between 36 and 45 years. It is obvious that almost half of participants were younger than 45 years, where this could indicate that individuals younger than 45 years of age can be familiar with NTs and they could benefit the most from these NTs in their workplace.

Q4: Name of the health facility:

The results include 48 responses. One participant has skipped this question.

Table 4.1-2: Illustrating results for question 4		
Facility name	**Frequency**	**Percentage**
Otago District Health Board (ODHB)	4	8.34%
Capital and Coast District Health Board (CCDHB)	**32**	**66.66%**
Auckland District Health Board (ADHB)	5	10.42%
Wiakato District Health Board (WDHB)	1	2.08%
Telehealth Forum	3	6.26%
Ministry of Health	2	4.16%
University of Auckland	1	2.08%
Response calculations	**48**	**100%**

As illustrated in the table above, two thirds of participants were affiliated to CCDHB. This is because the communication unit in the CCDHB sent the invitation letter and the email to almost 250 healthcare professionals. The predominance of CCDHB may lead to bias (further discussion available in Chapter 5).

Q5: Type of facility:

The options were*: hospital, health centre, health clinic, office, mobile clinic, pharmacy and other (please specify).* The results included 48 responses. One participant has skipped this question.

Table 4.1-3: Illustrating results for question 5		
Type of facility	**Response counts**	**Percentages**
Hospital	**42**	**87.5%**
Health centre	1	2.1%
Health clinic	1	2.1%
Office	4	8.3%
Mobile clinic	0	0.0%
Pharmacy	0	0.0%
Other (please specify)	0	0.0%
Calculations	**48**	**100%**

The majority of respondents – 87.5 percent – were working in hospitals. Only one participant was affiliated to health centre and also one participant was in a health clinic. The rest of the participants – 4 – were working in offices. The predominance of hospital staff may lead to bias (see Chapter 4 discussing findings of Q5).

4.1.2.Impact of NTs on Telehealth Practice Page 1(Q6 to Q15)

Sixteen questions were posed in the second page of the questionnaire, which were designed to survey the impact of NTs on telehealth practice. Responses collected are demonstrated independently for each question. As it is easier to view information from graphics than from tables, results for these questions are demonstrated in a graphical

format. For questions 6-15, 29 participants answered all the questions and 20 skipped them.

Q6: Please indicate below the technological devices you have used in your facility.

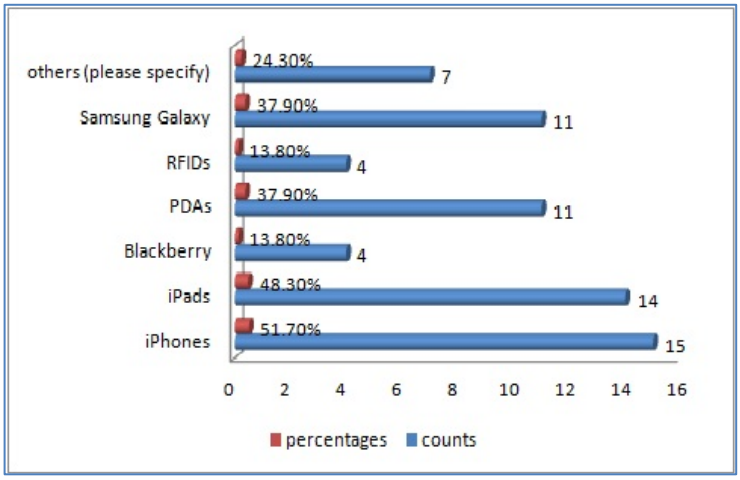


Figure 3: illustrating response counts and percentages for Q6

As demonstrated in the previous graph, iPhones have been used by more than half of participants. Also, iPads were used by 48.3 percent of respondents. 37.9 percent of participants indicated that they have used PDAs and Samsung Galaxy in their health facility. Only 13.8 percent – 4 participants – indicated that they have used RFID in their facility.

Q7: How often do you use technological devices in your facility?

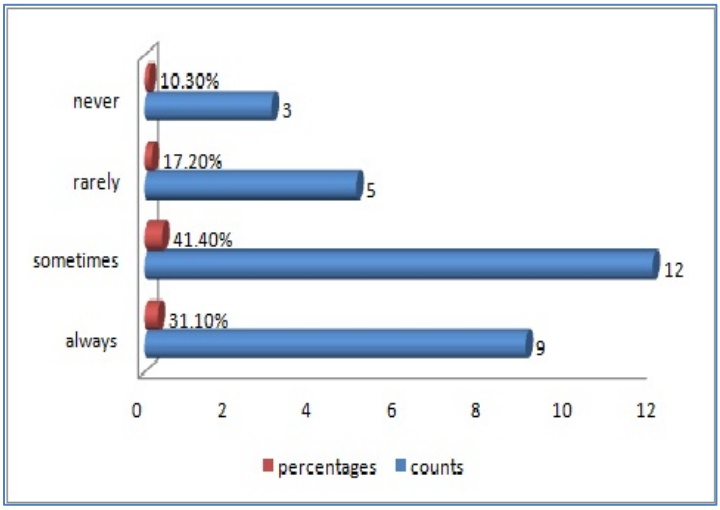


Figure 4: illustrating response counts and percentages for Q7

The majority of participants – 41.4 percent – pointed out that they *sometimes* use technological devices in their facility, while almost one third indicated they *always* use technological devices in their health facility.

Q8: What are the top three technological devices of the following being used in the current telehealth practice?

Participants were asked to identify the top three devices used from the following options: *PDAs, smart phones, cell phones, RFIDs, computer tablets "iPad or Galaxy tap", social networks "Facebook", videoconferencing "Skype" and Dropbox or Cloud*. Results are shown in the following graph.

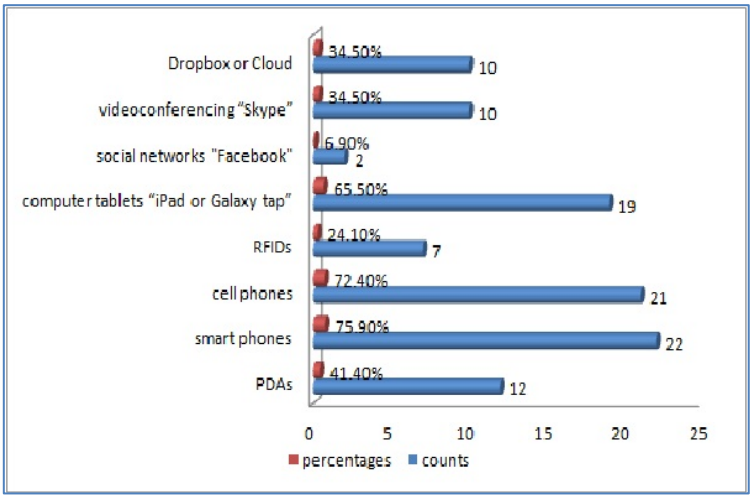


Figure 5: illustrating response counts and percentages for Q8

Participants indicated that the top three technological devices used in the current telehealth are: cell *phones, smart phones and computer tablets "iPads or Galaxy taps"*, as shown in the above chart.

Q9: Which is the most effective one of the above?

Table 4.1-4: Illustrating results for question 9		
Option	**Response counts**	**Percentages**
PDAs	2	6.9%
Smart phones	**8**	**27.5%**
Cell phones	**8**	**27.5%**

RFIDs	1	3.5%
Computer tablets " iPad or Galaxy tap"	4	13.8%
Social networks "Facebook"	1	3.5%
Videoconferencing "Skype"	3	10.4%
Dropbox or Cloud	2	6.9%
Calculations	**29**	**100%**

The above table suggests that *cell phones* and *smart phones* were equivalently indicated as the most effective devices used in the current telehealth practice.

Q10: How important is the use of a smart phone in providing quality services in your facility?

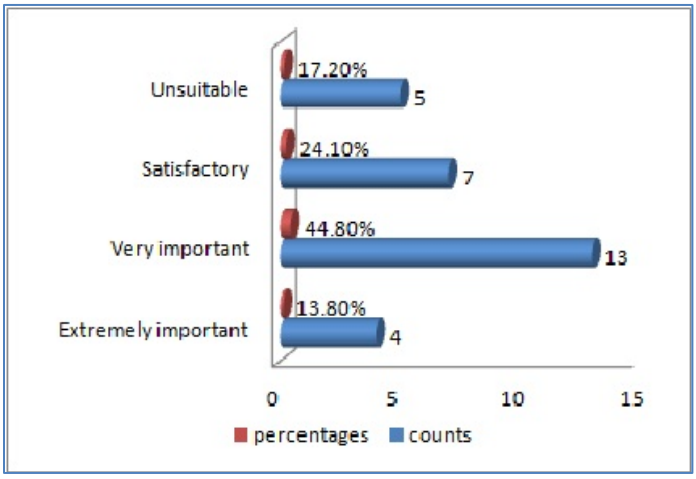


Figure 6: illustrating results for Q10

Almost half – 44.8 percent – of participants pointed out that the smart phone is *very important* in providing quality services in their facility. While almost a quarter of them – 24.1 percent – said that the smart phone is *satisfactory* in providing quality services.

Q11: How important is the tablet (e.g. iPad or Samsung Galaxy) in assisting the healthcare provider in performing medical procedures?

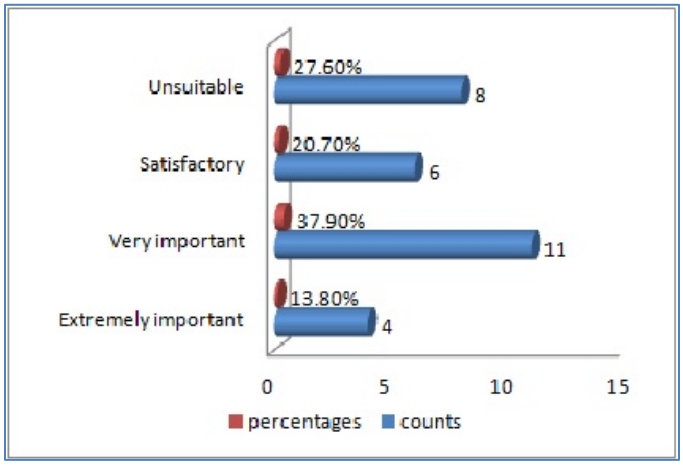


Figure 7: illustrating results for Q11

More than a third – 37.9 percent – of participants indicated that the tablet is *very important* in assisting healthcare providers in performing medical procedures. Also, 13.8 percent of them said that it is *extremely important*. However, more than a quarter – 27.6 – of them pointed out that it is *unsuitable* for performing medical procedures.

Q12: Do you think the applications related to health available on tablets are sufficient enough for healthcare?

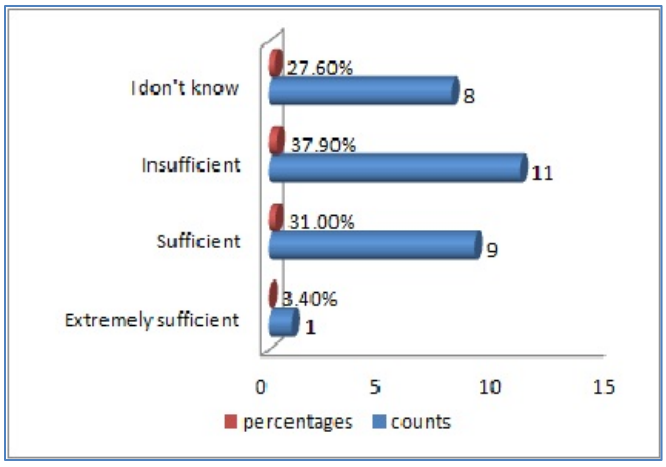


Figure 8: illustrating results for Q12

Majority of participants – 37.9 percent – pointed out that health- related applications available on tablets are *insufficient* for healthcare. While 31 percent of them said these

applications are sufficient enough for healthcare. More than a quarter of respondents – 27.6 percent – stated that they *do not know* whether these applications are sufficient or not.

Q13: Do you think storing patient's data in a computer tablet is safe enough?

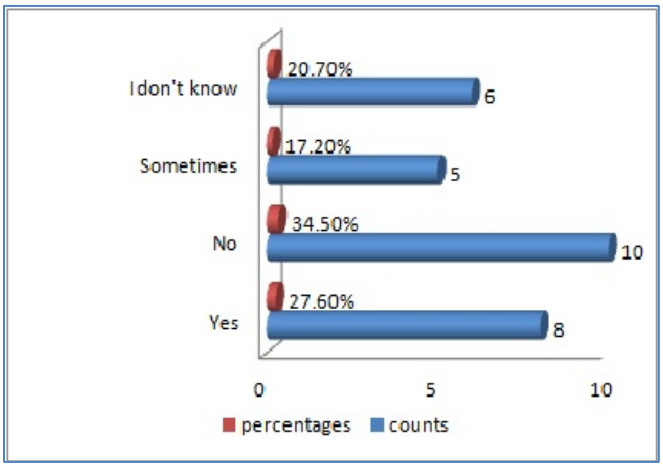


Figure 9: illustrating results for Q13

34.5 percent of the participants indicated that storing patient's data in a computer tablet is *not safe* enough. However, more than a quarter of them – 27.6 percent – stated that it is *safe* enough to store patient's data in a computer tablet. While 17.2 percent of respondents said that it is *sometimes* safe enough to store data in a tablet, 20.7 percent of them stated that they *do not know*.

Q14: Have you ever encountered a challenge while using a smart phone in providing any form of medical care?

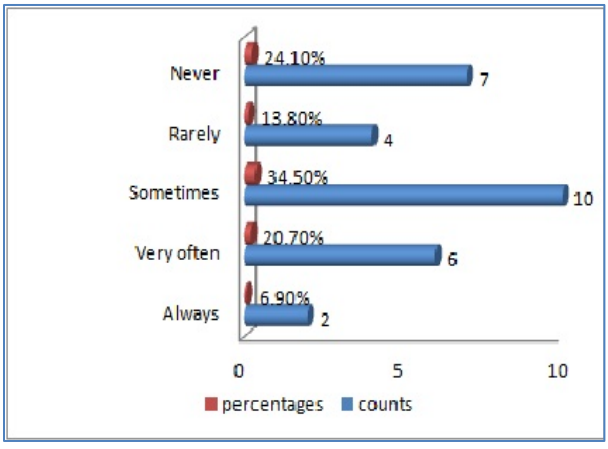


Figure 10: illustrating results for Q14

While more than a third of participants – 34.5 percent – pointed out that they *sometimes* encounter challenges while using a smart phone, more than a quarter – 24.1 percent – said they *never* encountered a challenge. However, small number of participants – 6.9 percent – indicated that they *always* encounter challenges while using smart phones. Almost a fifth – 20.7 percent – of them stated that they *very often* encounter challenges.

Q15: How important is the Dropbox or iCloud in transmitting information (e.g. x-rays or CT scans)?

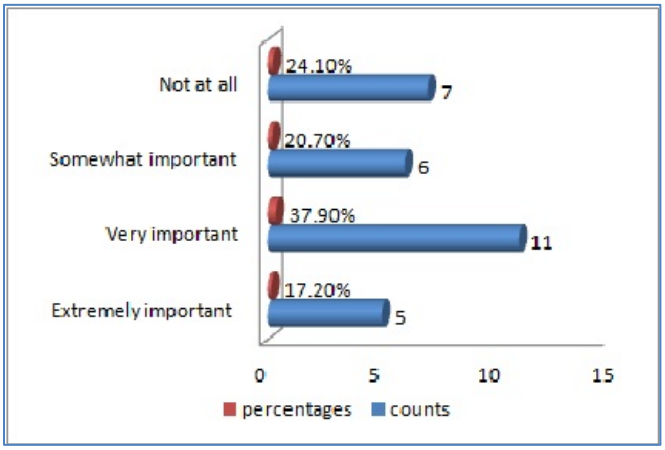


Figure 11: illustrating results for Q15

37.9 percent of the respondents stated that the Dropbox and iCloud are *very important*. Almost a quarter – 24.1 percent – indicated that these applications are *not important at all* in transmitting data.

4.1.3.Impact of NTs on Telehealth Practice Page 2(Q16 to Q25)

This page of the survey is a completion to the previous one investigating the impact of NTs on the current telehealth practice. However, questions included in this page are more open-ended ones where participants can find a space to add their comments and suggestions. In addition, this page included questions about advantages and barriers of using NTs in the current telehealth initiatives.

Q16: Is the use of PDAs or Smartphone the best way of receiving medical alerts for the physicians?

Options provided in this question were: *yes and no*. There was a space for participants to give their reasons for their answers which was optional. Of those who have responded to this question, 13 participants have given their reasons. Table 4.1-5 demonstrates participants' key reasons supporting their answers.

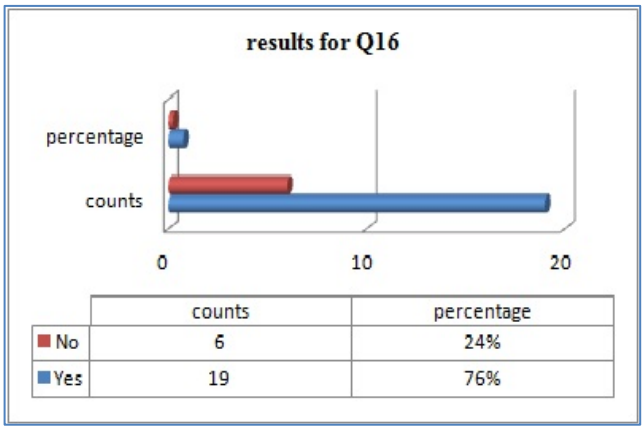


Figure 12: illustrating results for Q16

Table 4.1-5: Summarizing reasons mentioned by respondents for question 16			
Reason	**Answer**	**Reason**	**Answer**
It allows them to keep updated	Yes	Especially transmitting ECGs from ambulance to cardiologists. Such a facility that helps make urgent decisions for heart attack patients in short time	Yes
Always carried	Yes	Accessibility and timeliness is key	Yes
Quicker and more convenient and less paper waste	Yes	Time efficient	Yes
Instant, always-on and always on the person	Yes	Not secure	No

More than three quarters of participants – 76 percent – stated that the use of PDAs or smart phones is the best way of receiving medical alerts for physicians. Some those participants supported their responses with several reasons such as *time efficiency*,

convenience, portability and accessibility. The other quarter of respondents, who responded to this question by "*no*", supported their opinion with one reason, that is *lack of security* of these devices.

Q17: Does the use of RFID tags save time in a hospital setting?

RFIDs are mainly used for asset tracking (see section 2.5.3)

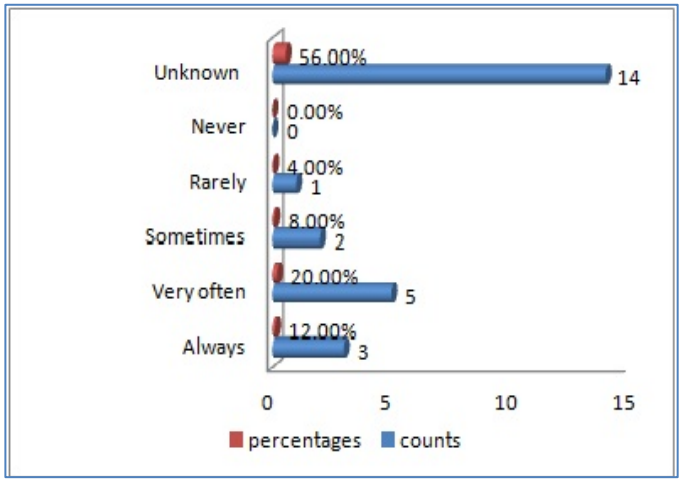


Figure 13: illustrating results for Q17

More than half – 56 percent – of participants indicated that they *do not know* whether RFID tags save time in a hospital setting or no. Only 20 percent of participants stated that RFID tags *very often* save time. Surprisingly, those who answered with unawareness were relatively younger than those who responded affirmatively as illustrated below in Figure 14 (see Chapter 5 for further discussion).

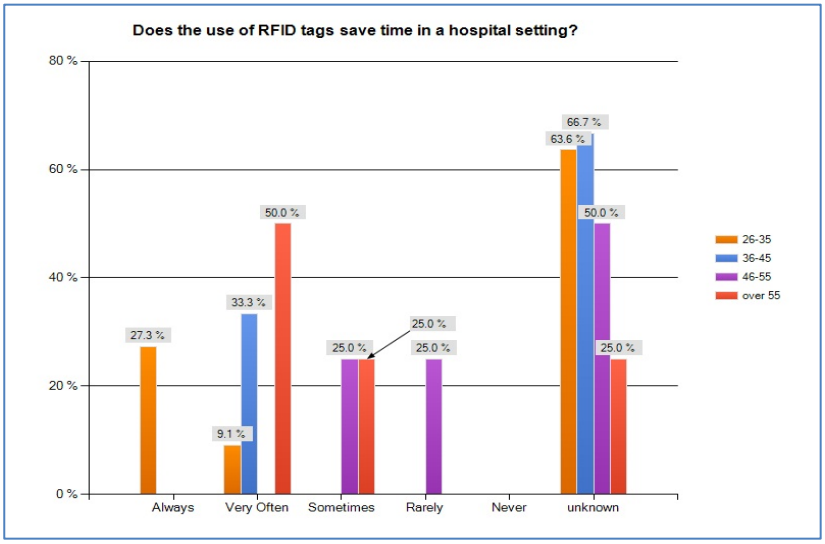


Figure 14: demonstrating answers for Q17 by age groups

Q18: Do you think that the use of technological devices will lead to improvements in the quality of care?

Options provided in this question were: *yes and no*. There was a space for participants to give their reasons for their answers which was optional. Of those who have responded to this question, 10 participants have given their reasons. Table 4.1-6 demonstrates participants' key reasons supporting their answers.

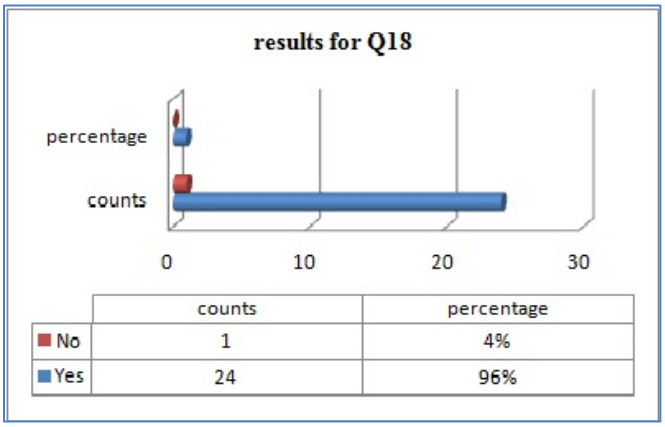


Figure 15: illustrating results for Q18

Table 4.1-6: Summarizing reasons mentioned by participants for question 18			
Reason	**Answer**	**Reason**	**Answer**
It could save the facilities heaps of money	Yes	Better & faster communication & consultation.	Yes
There are issues around privacy	No	Quicker sharing and easier access	Yes
Improves the ability to communicate effectively, reduces duplication	Yes	less missed appointments, quicker access to results and information	Yes
reduce clinical costs, more efficient, supports rural or isolated practice; improves continuity,	Yes	For example, using Skype could benefit patients who would either have a long wait, or who we would normally have a telephone consultation with.	Yes
increased efficiency of communication-eliminating unnecessary travel	Yes	over time they will stop a lot of transcribing and therefore mistakes made that way	Yes

96 percent of participants believed that the use of technological devices will lead to improvements in the quality of care. Key reasons mentioned by participants were: *reduction of costs, waiting times, and travel; better communication and access to health information; and decreasing unnecessary patient referrals and medical errors*. However, only one participant responded to this question with "*no*" and indicated *confidentiality issue*s as a reason.

Q19: To what extent do you think that the use of new technologies (NTs) can reduce the clinical costs?

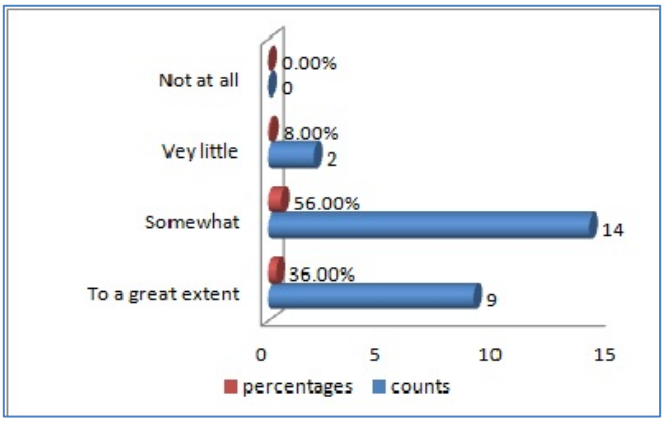


Figure 16: illustrating results for Q19

More than half of participants – 56 percent – believed that the use of NTs can *somewhat* reduce clinical costs. Also, 36 percent of them indicated that the use of NTs can reduce clinical costs *to a great extent.*

Q20: To what extent can the use of telehealth initiatives reduce the travelling costs?

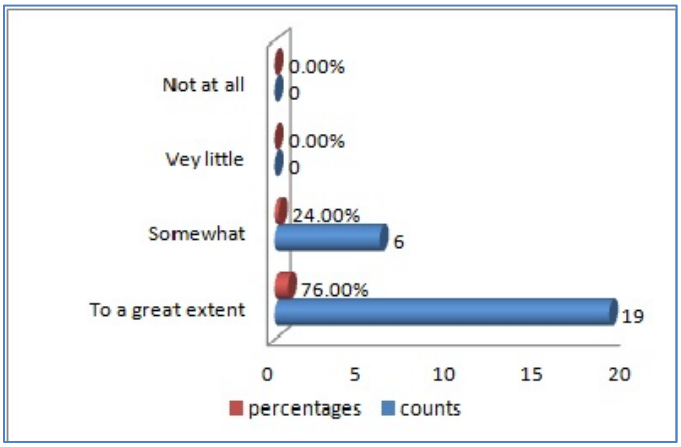


Figure 17: illustrating results for Q20

More than three quarters of participants – 76 percent – believed that the use of NTs can reduce the travelling costs *to a great extent*. The other quarter indicated that it can *somewhat* reduce the travelling costs.

Q21: To what extent can the use of NTs improve quality of services?

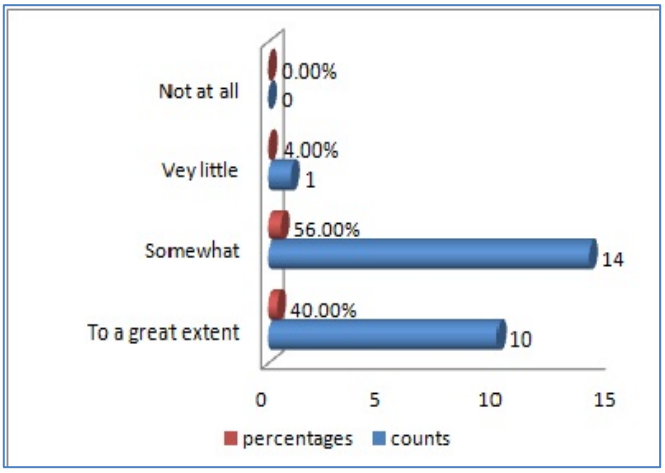


Figure 18: illustrating results for Q21

More than half of respondents – 56 percent – believed that the use of NTs can *somewhat* improve quality of services. In addition, 40 percent pointed out it can improve quality of services *to a great extent*. However, only one participant believed it can improve quality of services to a *very little* extent.

Q22: In general, how would you describe the performance of telehealth in your work.

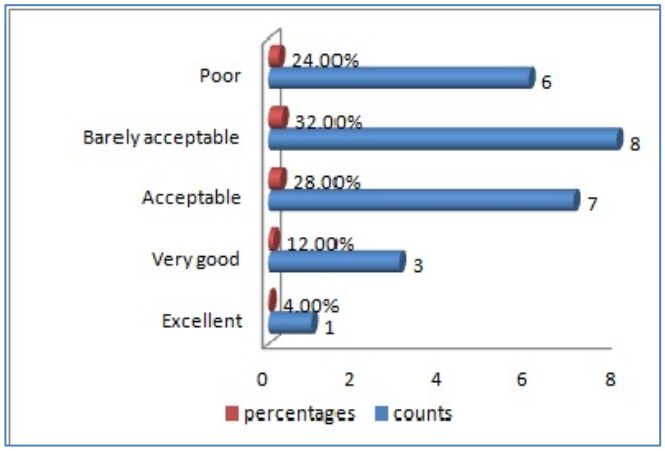


Figure 19: illustrating results for Q22

Almost one third – 32 percent – of participants generally described the performance of telehealth in their work as "*barely acceptable*". While 28 percent of respondents indicated that the performance of telehealth in their work is *acceptable*, 24 percent described it as *poor*. Only one participant described it as *excellent*.

Q23: Do you think that telehealth technologies are an essential part of the future of medical care?

Options provided in this question were: *yes, no and I don't know*. There was a space for participants to give their reasons for their answers which was optional. Of those who have responded to this question, 10 participants have given their reasons. Table 4.1-6 demonstrates participants' key reasons supporting their answers.

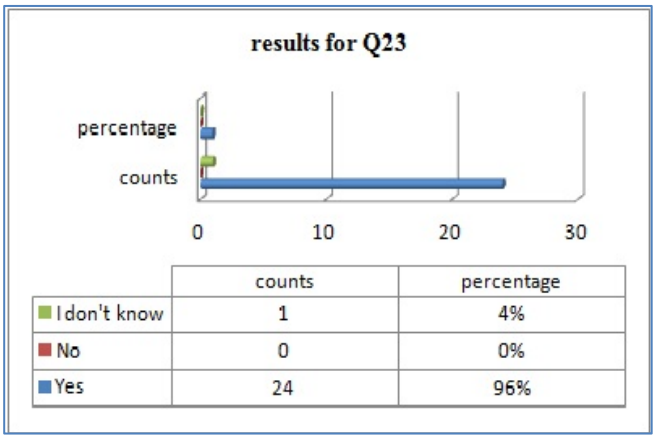


Figure 20: illustrating results for Q23

Table 4.1-7: Summarizing key reasons mentioned by participants for question 23	
age of technology, everything requires the use of technology as a means to facilitate the delivery of services	The context of growing demand, with unmatched growth in resource means new ways of delivering services need to be found.
Technologies always help	saving time, costs, efforts and providing better quality of care, so it is essential
I think they are becoming more and more widespread, so it will be a necessary part of medical more than anything.	Yes. They are inevitable. BYOD continues to be taken up; if hospital IT don't provide it, employees will.

The majority of participants – 96 percent – believed that telehealth technologies are an essential part of the future of medical care. The key reasons mentioned by respondents can be summarized into the following themes: *growing demand for technologies in health, technologies becoming more widespread and their benefits such as saving time, costs and efforts.*

Q24: What are the critical advantages obtained by using NTs in the current telehealth system?

This question was an open-ended one, so participants needed to write down their comments rather than selecting from a list of options. This question was answered by 11 respondents and skipped by 38. Responses and comments made by those 11 participants are separately displayed below in Table 4.1-8.

Table 4.1-8: Reporting advantages of using NTs in telehealth

time saving, reduction of expenditures, and removing the demand for unnecessary referrals	We live in an age when it's almost impossible to keep up to date with new advances: NTs can help
Saves time and duplication	Timeliness and accuracy, best use of scarce resources
Getting a hold of doctors remotely (ie through PDAs).	Portability, instant access to information
Less travel, eco-friendly, more economical, and more patients per hour	save time, cost, and more productivity. Reducing waiting times, easier and faster services.

Several advantages of using NTs in telehealth practice can be summarized in the following themes:

- Saving time and effort
- Reduction of medical costs and waiting times
- Elimination of unnecessary referrals
- Better access to medical information and health providers
- Portability and mobility
- Timeliness and accuracy

Q25: What are the barriers encountered in utilizing NTs in the current telehealth system?

This question also was an open-ended one, so participants needed to write down their comments rather than selecting from a list of options. This question has been answered by 12 respondents and skipped by 37. Responses and comments made by those 12 participants are separately displayed below in Table 4.1-9.

Table 4.1-9: Reporting barriers of using NTs in telehealth

Poor coverage. Unreliability of the network provider.	Infrastructure, the problem with matching schedules for synchronous communication.
budget constraints	Culture and concerns about confidentiality
Funding, usually have to provide your own smart phone and pay for own apps and Internet/data bill. Also the bandwidth in NZ is awful so videos are not yet good enough for diagnosis in either speed or detail	Lack of Wi-Fi as standard in hospitals/ for clinicians. Reliance of 'clunky' slow computers in hospitals. One or other of these needs to change to maximise NT's benefits.
I tried to use Skype to contact a patient and the internet connection was not fast enough. It was a very frustrating experience!	poor design, technical people not understanding the way the users work
Confidentiality & security. iCloud & Dropbox CANNOT be used for the transmission of ANY identifiable data (X-rays, patient notes, lab results etc) as they breach several parts of the privacy act & also the HDC act. There are no comparable secure NZ networks that can be used with such ease other than the limited abilities of some hospital to transmit PACS (radiology) data between certain sites. Storing patient information on personal devices also contravenes several codes & would lead to disciplinary action if it was disclosed to a third party. This is the elephant-in-the-room of BYOD & current IT provision vs. clinician's needs.	

The main barriers of using NTs in the current telehealth practice mentioned by participants are summarized as follows:

- Infrastructure issues – unreliable network coverage
- Confidentiality issues
- Funding and budget constraints

Chapter 5: Findings and Discussion

This chapter includes two main sections. The first section is a discussion of the finding of the survey results with an emphasis on technological features. The following sections considers several of the essential trends and aspects in contemporary telehealth systems. Additionally, several significant factors that play major roles in telehealth systems and strategies such as data, infrastructure and business models "cost-effectiveness" are discussed. Ethical issues regarding confidentiality and privacy are also demonstrated alongside some suggestions and solutions. Also, some proposals and implications for an ideal telehealth strategy for developing countries are illustrated.

5.1.Findings

This study was successful in understanding and elucidating the significance of NTs in the telehealth sector with regards to their current role and emerging prospects. Also, the study was productive in the sense that it contributed to understanding the current technological trends in telehealth systems and the impact of NTs in current telehealth practices. The study also highlighted the most preferred "*new technology*" amongst current telehealth practitioners and offered significant insights into the potential benefits that can be acquired through implementation of NTs in the sector. The study was also instrumental in addressing the potential barriers and deadlocks that are frequently encountered in the field during the practical implementation of NTs in the telehealth sector.

5.1.1. Survey demographics

The combined quantitative and qualitative survey, which was broken down into relevant sections and responded to by a cohort of 49 respondents was highly informative and contributed immensely to fulfilling the research objectives and goals. The first section of the survey focussed on the basic credentials of the cohort subjects and it was interesting to observe that the majority of respondents belonged to a relatively young age group of 26 to 45 years of age. Around one-third of respondents came within the age group of 26 to 35 and they were closely followed by the age group of 36 to 45.

Together they constituted more than 60 percent of the entire cohort strength. This was an interesting find in the sense that young individuals appeared to be open and proactive in accepting and adopting NTs in their daily telehealth practices. The results indicated the popularity of NTs among the younger crowd compared to the other age groups and one reason behind this observation could be their ability to adapt early to new developments and change and their already established orientation towards cutting edge and innovative technology of the 21st century. The younger respondents are less overwhelmed or taken aback when a new technological advancement comes into play compared with the older generation who needs to traverse a wide gap that exist between the old world technology of their generation and 21st century advancements. For them, it is tougher to take the modern day advancements in their stride as casually or smoothly as their younger counterparts primarily because of the significant difference in their thought processes. Many of the NTs that are mundane and basic in the present age appeared only in the realms of science fiction 30 years back.

The study was also successful in penetrating the right institutions as observed in the responses for Question 4 and 5. Telehealth has already become an integral part of western healthcare units and is still in the process of making further inroads. Hospitals are the most prominent establishments where telehealth practice is sometimes a major department itself. In this study, almost all responses came from professionals who were affiliated to hospitals and this clearly indicated the relevance of the research topic to them and also the credibility of the response data that has been acquired. However the results also indicated the predominance of a single health board (CCDHB) in responding to the survey. This might create the impression that diversity in the cohort was not an objective of the study and when considered statistically, the results may seem to lack the vital significance. It is important to note the predominance of a single health board (CCDHB) in the survey responses. This bias arises from an opportunity to reach a larger number of respondents that might otherwise have been expected and a significant sample size was seen as an asset in revealing the spectrum of attitudes. The CCDHB includes both urban and rural areas and the roles represented within the sample population are similar to other DHBs in New Zealand, Consequently, similar results would be expected from other DHBs.

5.1.2. Preferred NTs and Usage

The second section of the survey that attempted to delineate the impact of NTs on telehealth practices was insightful and knowledge generating. Even though all the cohort members did not complete this section of the survey, the participation rate was still around 60 percent, which is considered statistically significant. Question 6 tried to determine the type of technological devices that are used and preferred by telehealth practitioners. The results were overwhelming in favour of modern mobile devices such as smart phones and tablets offered by the highly respected Apple brand. Apart from the Apple iPhones and iPads, respondents also extensively used mobile PDA devices such as BlackBerrys and Samsung Galaxy taps. However, the use of RFIDs appeared to be minimal in modern telehealth practices. The results indicated a significant trend in technology preference amongst the respondents and perhaps RFIDs decreasing in importance due to their drawbacks and lacunas. Earlier studies carried out across the globe highlighted the practicalities of RFID technology in telehealth but many also laid bare the security and privacy issues that plagued the technology (Parks, Chu & Xu, 2010). Furthermore the possibilities that come with modern tablets and smart phones in terms of communication are simply staggering and the more specialised capability of RFID to compete with newer technologies is unknown.

The study also tried to determine the usage patterns of modern devices that incorporated NTs amongst the telehealth practitioners. The results were mixed in the sense that 31.1 percent were regular users and 41.4 percent were occasional users. The remaining 27.5 percent was constituted by rare and non-users. This observation could be interpreted from different angles and several trends could be contemplated. However, the most logical explanation is related to the diversity of the cohort members with regards to age. The responses that were received for Question 2 indicated that 37.3 percent of the respondents belonged to an old age group who are not as comfortable and open to accepting, adopting and using NTs in their telehealth practices, as discussed before. It is anticipated that this age bias has got a role to play in the results of Question 7 that tried to determine the usage patterns. It was already observed that modern sophisticated

devices such as smart phones, tablets and hand-held PDA devices are predominantly popular amongst current telehealth practitioners.

The survey tried to determine the top three most preferred devices. Respondents replied to Question 8 indicated that *smart phones* such as iPhones, *tablets* such as iPads and modern *cell phones* are the most preferred devices. Given the outreach, capability and flexibility of these devices, the results were not surprising. Moreover the other devices that featured in the results included video-conferencing utilities such as Skype, Cloud, social networking sites such as Facebook and RFIDs. The majority of these are third party commercial utilities and the communication through these mediums is not as direct as a cell phone or a tablet. The privacy and security issues associated with RFID technology has already been observed earlier. As the study delved deep and tried to highlight the most effective utility or utilities amongst the top three devices, the results were not surprising once again when *smart phones* and *cell phones* came out as equal winners closely followed by tablets. This preference is undoubtedly because of the smaller size of the cell phones and smart phones compared with the tablets. Furthermore, tablets primarily communicate via the internet while mobile network connectivity is invariably more robust and reliable than the former. The survey went further to illustrate a comparative analysis between smart phones and tablets with regards to the preference in their usage. Although the percentage of respondents who indicated that *tablets* were “extremely important”, “important” and “satisfactory”, were also well-represented categories. The figures for the same question were even higher for *smart phones*. Also worth noting is the fact that 27.6 percent of the participants believed that tablets are unsuitable for telehealth practices compared to 17.2 percent for smart phones. This comparative picture obtained from the responses for Questions 10 and 11 once again demonstrated the stronger orientation of the telehealth practitioners towards smart phones and vindicated the observation derived from the responses for Question 9 earlier, where the preference of the smart and cell phones was clearly observed over the tablets.

The study continued to focus on the practicality and usability of the tablets in telehealth practices and the responses for Question 12 were quite interesting. The majority of the

participants – 37.9 percent – unsurprisingly indicated that the tools and applications that are present in modern tablets are inadequate to meet all telehealth demands. Interestingly, 27.6 percent of respondents pointed out that they are not aware of all the functionalities that are present in a tablet. This observation gives a new dimension or direction to the study and is very important in the sense that the reduced preference of the tablets as compared with smart phones could actually be due to lack of awareness. However, another facet that might be responsible for the bias towards smart phones is that the functionalities in a tablet are perhaps not as convenient to the telehealth practitioners as they are in a smart phone.

5.1.3. Privacy and Security

Protecting the privacy and integrity of sensitive patient data has always been the top priority of health practitioners and administrators across the world. Question 13 sought the opinion of the telehealth practitioners on the safety of storing patient data in tablets. Even though the responses were mixed, the largest segment of the respondents (34.5 percent) was of the opinion that storing patient data in tablets is *unsafe*. While 27.6 percent believed that it is *safe* to use tablets to store patient data and 17.2 percent of the respondents indicated that it is *sometimes safe* to store, it needs to be determined whether their opinion is contextual. In other words it needs to be ascertained if the confidence in using tablets to store patient data is determined by the degree of sensitivity of the patient data. Some forms of data could simply be jargon for ordinary individual and only make sense to a health practitioner. Compromise in the privacy of these types of data, though not acceptable, could be less damaging compared to other forms of data such as medical histories or identity records, which could be a potential source for identity thieves. A significant 20.70 percent also pointed out that they *do not have any idea* if a tablet is safe or not. Robust security capabilities of traditional IT equipments are well-known and well established. Unawareness with regards to the security capabilities of tablets indicates that they are not very well established and well-known. The National Health Service (NHS) in the UK directs its health practitioners not to store identity and medical history revealing sensitive patient data in their tablets (Dolan, 2012). Furthermore, according to NHS guidelines, health practitioners are

strongly advised to avoid free Wi-Fi hotspots and cloud services that could be used by cyber thieves to share patient data between tablets. The NHS believes that the chances of compromising the privacy of patient data are higher when remotely located commercial servers are involved in data sharing (Dolan, 2012). In addition, even in the event of any security breach getting detected, there would be fewer legal options available when the remote server is located in a region which is out of the jurisdiction. It is strongly advised that virtual data sharing should be carried out across trusted closed networks or through utilities such as VPN (Dolan, 2012).

5.1.4. Usability Issues

Given the preference of smart phones and tablets amongst telehealth practitioners, it is also important to highlight any potential issues associated with these devices when it comes to their actual utilization in the field. The survey question 14 tried to find that by asking the practitioners if there are any challenges to using smart phones while delivering care to patients. While 34.5 percent of the respondents expressed that they *sometimes* face some difficulties, 24.1 percent responded by saying that they *never* encountered any problems at all. Here it needs to be determined if these challenges associated with the use of the smart phones emanating from unawareness with regards to the available features in the device or some inherent flaw in the functioning of the device. The results became more critical when 20.7 percent of the respondents expressed that they *very often* encounter challenges while using smart phones. A serious introspective study is required here to accurately determine if the popularity of the smart phones is just because of its portability or whether it actually assists in providing efficient health care to the patients. Another facet that actually needs to be considered is the access of patients to smart phones. A basic principle of telehealth practice is that patients also have access to smart phones that run relevant heath applications. The chance of success in providing telehealth service to patients is also determined by the comfort level of the patients in using the smart phones. A blood pressure monitoring report that is being transmitted to a patient may require authentication at the receiver's end in order to download the report on the device. This could be done by just pressing

some buttons in a menu but such a task could actually be intimidating for an aged patient who is not very technologically oriented.

5.1.5. Cloud Facilities

The survey question 15 tried to gain opinions of telehealth practitioners on the practicality, usability and importance of some utilities such as Dropbox or iCloud in transmitting health data such as x-rays and CT scans. The responses to question number 9 earlier made it very clear that Dropbox and iCloud were considered the second least effective utility for telehealth practices. However, with this information in the background, the responses for question 15 were very interesting. 17.2 percent of the participants mentioned that both Dropbox and iCloud are *extremely important* and 37.9 percent indicated that these utilities are *very important*. So in essence, 55.1 percent of the respondents were of the opinion that the relevance of iCloud or Dropbox in transmitting heath data is actually undisputed. A significant 20.7 percent believed that these technologies are *somewhat important*. The results pointed out the fact that the practicality of these utilities is actually determined by the type of data being transmitted or shared. Dropbox and iCloud services are offered by dedicated servers with excellent bandwidth and data storage capabilities, the two principal requirements to transmit heavy volume data such as high resolution x-rays images and CT scans. Cloud computing is revolutionizing big data sharing and exchange for different health institutes without them investing in big computing assets (Moock, 2011). Similarly, Dropbox is an extremely modern utility that allows hosting and sharing files on the web and is an independent platform. It allows efficient synchronization between connected devices allowing smooth sharing and storing of medical records and files of different sizes (Lieberman, 2012). So it may well be inferred that the segment of the telehealth practitioners, who mentioned that these technologies are "*extremely important*" and "*very important*", might be extensively involved in transmitting and sharing such data. This might also be the reason for those respondents who replied that these technologies are somewhat important. It needs to be determined in what context do they find these technologies important and in what sense they are not that effective.

5.1.6. Impact of NTs

The next segment of the survey comprising questions 16 to 25 was designed to determine the impact of NTs on current telehealth practices. These questions are broader in the sense that the respondents were given the opportunity to express their viewpoints in a free form and more detailed manner instead of choosing one from a given list of options. This helped in gaining a broad and multi-faceted idea on the current trends in modern telehealth practices with regards to the incorporation of NTs.

Question 16 asked the respondents if PDAs and smart phones are the best suited devices for doctors and physicians to receive medical alerts. The response was expected when a majority of 76 percent replied in affirmative. Since these questions were more open-ended as mentioned before, the participants were also asked to give their reasons. The most common and obvious factors were *portability* that facilitated constant access to health practitioners at all times, *efficiency,* with regards to the speed in the transmission of data, *efficiency*, with regards to the response time in case of emergencies such as heart attack and last but not the least, *environmentally friendly* by reducing the use of paper. In case of life threatening medical emergencies, the most critical factor that stands between life and death is time. Smart phones go a long way in bridging this critical gap and making the difference to patient's health. There are numerous document accounts demonstrated that smart phones play a critical role during medical emergencies. One fascinating account came from *Sonoma Valley Hospital* in California, where doctors used smart phones to respond to an emergency case where the patient had an attack of necrotizing fasciitis, a rare and life-threatening disease caused by a flesh eating bacteria (UCDavis, 2012). The doctors used their smart phones to make consultations between themselves and offer the best possible assistance to the patient in a very fast manner (UCDavis, 2012). The doctors believe that without the aid of smart phones, the situation would have been much more difficult for the patient today or even worse, he might not have survived at all (UCDavis, 2012). The only reservation expressed by telehealth practitioners with a smart phone was regarding its security. 24 percent indicated that they are *not confident* with the security measures that are in smart phones (see also section 1.5.3). So the concern is more about the integrity and privacy of patient data that are being managed by a smart phone. However, given the potential of the device in overcoming time constraints and facilitating fast response to

emergencies, the answer would be to implement more robust security features and complex encryption algorithms. Furthermore, it is always a very important matter to encrypt patient data in such a way that it is only understandable to health practitioners and avoid using the device in storing and transmitting the type of data that reveals the identity and medical history of patients.

RFIDs did not generate much enthusiasm amongst the respondents. It has already been observed earlier (question 6) that this technology is not that popular amongst the telehealth practitioners. In spite of its capabilities such as real-time tracking of individuals and equipments in a hospital establishment and improved access to medical records for doctors and health practitioners, the concerns related to patient data privacy remain firmly established (Yao et al. 2010; Parks et al., 2010). Question 17 of the questionnaire asked if the use of RFID tags save time in a hospital setting. Even though the responses were mixed in a true sense, a majority of 56 percent expressed *unawareness* with regards to the contribution of this technology to saving time. 32 percent of the respondents were quite certain that RFIDs *can actually save time* while 8 percent believe that there is *some contribution* of the technology in saving time. The remaining 4 percent believed that the technology *rarely* saves time. The responses for this question indicated that the technology did not catch on in the same way as smart phones and tablets. Even though the significance of RFIDs in a hospital setting is also well documented, it can be anticipated that privacy issues are playing their part in its insignificance amongst the respondents of our questionnaire. Surprisingly, the majority of participants – 56 percent – who demonstrated *unawareness* of RFIDs were aged between 26-55 years (as shown in Figure 14 above). In contrast, those who were over 55 years of age indicated that RFID tags *very often save time* in a hospital setting. This suggests either of two points: the first is that RFIDs' significance is decreasing, so younger health professionals are unaware of them, while older ones are accustomed to them and still applying them. The second point is that RFIDs are being used and applied in health projects that are worked and managed by older professionals. The latter suggestion gains credibility from the observation that RFID is an inherently more specialised application than the ubiquitous smart phone. However, the lack of

familiarity of younger practitioners with the technology is still an interesting topic for further study.

5.1.7. NTs and Quality of Care

Question 18 was very critical in the sense that it tried to understand if the modern technological devices have led to improvements in the quality of healthcare. It did not focus on a single technology but tried to gain a general understanding of whether the telehealth practitioners perceive any benefits in general from modern technologies. This question tried to offer credibility to the whole idea of technical prowess of modern devices in improving health care delivery to patients. The responses, though overwhelmingly in favour of technology, were not surprising. 96 percent of the respondents believed that technological advancements have definitely led to an improvement in healthcare delivery to patients. The answers completely align with the trends of the 21st century where technological advancement in almost every sector is dramatically improving people's quality of life around the globe. The respondents, while answering question 18, also were given the opportunity to add their reasons behind their convictions. It was observed that the agility in the services offered through the aid of modern technological devices was considered as one of its biggest advantage. The respondents also believed that modern technological devices significantly reduce waiting time for patients, reduce travel, increase efficiency in data sharing and decrease communication errors. Furthermore, the respondents also expressed the view that modern technological advancements also make healthcare delivery highly cost-effective for hospital establishments. Modern mobile technologies are growing at an alarming rate and according to a projection by Cisco, there will be around 10 billion mobile devices in operation by the end of the year 2016 (West, 2012). It is widely anticipated that mobile technology will change the way healthcare services are delivered to patients. Mobile technology is already assisting doctors in managing chronic diseases, through timely intervention and efficient follow-ups. It has also come to the aid of senior citizens and expectant mothers by improving their access to healthcare facilities in case of emergencies and increased the outreach of healthcare facilities to rural and remote areas (West, 2012). A congressional report published by Medpac in 2004

indicated that modern information technology has achieved the means and the clout to revolutionize healthcare in the 21st century.

The questions 19 and 20 focussed on the aspect of cost and asked the respondents if telehealth initiatives are actually bringing about a reduction in clinical and transportation costs respectively. 36 percent of the respondents believed that modern telehealth practices *significantly* reduce clinical costs, while 56 percent indicated that there is *some* reduction in costs. The rest – 8 percent – pointed out that there is *no* reduction in cost. Here it needs be determined if the 56 percent of the respondents are fully aware of all sectors of telemedicine where major cost savings are implemented. It may so happen that a telehealth practitioner who responds to emergency alerts on their smart phones may not be very aware of the cost saving prospects through the utilization of utilities such as Cloud, Dropbox etc. So if they were asked whether modern technologies reduce clinical costs, they might not perceive any cost-effectiveness as such, even when they agree that such technologies significantly improve healthcare delivery. While some respondents might somewhat agree and some totally agree, they also perceive reduction in clinical costs. Furthermore, "some cost reduction" is always better than "no cost reduction". Telehealth practices have substantially improved and trends paint a very promising picture for the coming future (West, 2012).

Regarding the contribution of modern telehealth practices to reducing *travel costs*, 76 percent of the respondents believed that there is a *reduction* while 24 percent said that there is *some* reduction. Overall, every respondent appreciated the fact that telehealth reduces transportation cost, which according to some is to a large extent and for some to a lesser extent. The basic philosophy of telehealth practice is agility in providing healthcare and sharing information through modern devices without needing to travel. The amount and quality of data that can be transmitted is now so superior that it substantially reduces the need to travel in person. So the responses were actually not surprising at all. Accounts of reducing travel costs through telehealth practices have been reported by different health boards and institutes and the responses that were received for question 20 fully appreciated the same attitude. Amanda Oakley, who is a clinical associate professor at Waikato hospital, comments that telehealth practices have

significantly improved disease management and reduced unnecessary travel costs (Waikato district health board, 2012).

Question 21 tried to gather opinions of respondents on the extent to which services have been improved by the use NTs in telehealth practices. This question was relatively open-ended and actually summarized what all the earlier more specific questions tried to determine. The information and trends that the survey have revealed until now pointed out the significance of NTs in the modern telehealth practices and the responses to this question reflected a similar orientation. 40 percent of the respondents believed that the improvements in the services have been extensive, where as 56 percent expressed that there has been some improvement. 96 percent in total actually agreed that there have been improvements with varying degrees of conviction. So once again, the single fact that really needs to be appreciated in that "some improvements" is better than "no improvements". The current scale at which modern cutting edge technological devices are becoming available for the healthcare sector is mind boggling and the trends of digitization in the healthcare system confidently forecasts a growth graph that will only increase in the forthcoming years (Farkas & Biesen, 2012).

Question 22 asked the participants to describe the performance of telehealth in their work. This is a very critical question since it tried to measure the actual implementation or the impact of contemporary telehealth practices in their current roles. The responses were also valuable because of the fact that almost all the respondents were from prominent hospitals. These are the establishments where efficient telehealth services are expected the most. The responses were not as flattering as expected, with 32 percent saying that the performance is *barely acceptable*. 24 percent believed that the performances are *poor* while 28 percent believed that the performances are *acceptable*. Just one respondent (4 percent) indicated that the performance was *excellent*. These responses unanimously indicated that the telehealth practices have not yet attained a firm footing in the health establishments that were being surveyed. Even though there have been great improvements in technology and most of the respondents already identified the benefits of modern telehealth practices, it could be observed that telemedicine has not been able to make many inroads into these establishments. The

reasons could be many and varied. Most of the hospitals whose practitioners took part in the survey were affiliated to the CCDHB. It needs to be determined whether this particular board has achieved an open and welcoming policy towards modern telehealth practices or incorporation of NTs in their current telehealth practices. A more rigid policy will invariably highlight a trend that could be similar to the one seen in the responses for question 22.

5.1.8. The Future

The responses to question 23, however, project a very healthy growth of telehealth in the near future. The question asked the respondents if they believe that telehealth technologies are an essential part of the future of medical care. An overwhelming 96 percent responded in *affirmative* and just 4 percent were *unsure* because of unawareness. The reasons given by respondents though reflected the advantages of NTs in telehealth practices; they were also highly practical in nature. Many believed that technology always helps, irrespective of the sector where they are implemented, while some said that this being the age of technology, its surge in the telehealth sector is inevitable and unavoidable. Some also expressed that with the spread of modern telehealth technologies in different health establishments, it will become a vital necessity in providing effective healthcare services, rather than an exclusive speciality. The respondents also appreciated the remarkable benefits of modern telehealth practices in terms of cost-effectiveness and agility in healthcare delivery. Recent studies have already projected that innovations such as distant monitoring and homecare telehealth, e-health and patient portal services, Electronic Health Records (EHRs), robotics and real-time internet tools will revolutionize modern telehealth practices in the very near future (Brennan et. al, 2008).

Question 24 asked the respondent to enumerate the critical advantages obtained by using NTs in the current telehealth system. The advantages cited by the respondents were more or less aligned with the benefits and advantages that appeared in the responses for question 23. Cost-effectives, reduced referral time frames, rapid healthcare delivery and accuracy were the major factors, which according to the respondents brought about the critical advantages. According to West (2012), one of the

major challenges that a healthcare practitioner has to face is efficient chronic disease management. However, sophisticated health status monitoring devices can empower the critically ill patients to transmit their health status to their doctors on a regular basis without the need to travel to the doctor's place. This not only saves travel time and cost, but also provides the patient with the much needed rest and convenience. Studies have also projected that remote monitoring devices alone will save around 197 billion dollars over a period of 25 years in the U.S. (West, 2012). Benefits such as these from the incorporation of NTs in telehealth practices are truly critical.

5.1.9. Barriers

Finally, question 25 summed up the survey by asking the respondents about the potential barriers encountered in utilizing NTs in the current telehealth system. This question, similar to question 24, was entirely open-ended where participants were given full freedom to express their viewpoints in a very thorough manner. In their answer to this question, the respondents expressed that *technical limitations* and *budgetary constraints* are two major obstacles in the current telehealth practices. The respondents took a critical note of the *unreliability of network service providers* and *poor network coverage*, *out-dated IT infrastructure* in the hospital setups, *lack of wireless coverage* in the health establishments and *poor internet speeds*.

Lack of funding was another constraint because of which the IT setup in the health organizations were not modernized and the infrastructure was not able to handle the volume or the quality of data that needs to be transmitted and shared to make telehealth practices effective. Furthermore, the practitioners often had to pay for the network charges that came from sharing data across the network using modern telehealth devices. In addition, participants suggested that technological devices and associated services should be provided by the health sector instead of by the health professional. In other words, health professionals should not need to use their own devices to deliver high-quality and efficient healthcare. This is a key issue where it can be resolved by applying a firm policy that ensures the provision of new technological tools by the healthcare sector to all affiliated practitioners. Finally, privacy and security constraints also played a major role in creating obstacles in telehealth practices. Legal restrictions

ensured that no identifiable patient data could be stored in iCloud, Dropbox and portable telehealth utilities such as smart phones and tablets.

The responses to this question were instrumental in identifying the issues that limit the development of telemedicine today. This will help the concerned government organizations and health boards to direct their effort in the proper direction and deal with the real problems. Modern telehealth technologies are extremely capable and effective in providing patients and healthcare professionals with live, intuitive and user-friendly health management systems that can dramatically improve communication and access between patients and doctors and make healthcare delivery extremely effective (Pryke, 2012). So, the benefits are actually enormous and it is just about time that effective decisions are being taken and policies given a fresh look. It appears that telehealth is achieving its due attention and funding in Europe on a massive scale because the concerned governing bodies were able to identify and appreciate the benefits of technology to human health (Pryke, 2012). It is actually about time then other nations capture the same approach.

5.2.Telehealth and ICTs

ICTs possess the capability of overcoming some of the problems and challenges being faced by the world in dispensing easily accessible, affordable and high-quality medical services and facilities. ICTs are widely used by telehealth to successfully deal with and control the problems arising due to distance and geographical barriers and improve access to better treatment and other medical services. It is mostly helpful and advantageous for people in rural areas particularly in developing countries who suffer due to lack of proper medical facilities and treatment. Due to this potential capability, the WHO set up the Global Observatory for eHealth (GOe) to study and examine the benefits that ICTs can add to healthcare sectors. The task of this Observatory is to determine the validity and calibre of the eHealth results at regional, national and global levels and generation of report with reliable facts and directions and guidance on best routines, procedures, policies and accepted quality in eHealth. Access, standards and affordability are the main concerns of the healthcare industry throughout the world.

Telehealth relies extensively on modern network resources to share and transmit health related data. The significance of telehealth services would be reduced if data could not be disseminated with accuracy and agility. Table 1 below highlights some avenues through which remote health services can exchange information and data (ATA, 2006).

Table 5.2-1: Illustrations of data exchange by remote health services. Adapted from (ATA, 2006)
Centrally located hospitals and health centres are connected to remote health centres located in rural areas through dedicated lease lines of high bandwidth. Patient diagnostic data such as MRI scans or X-Ray images that are collected in the remote health centres could be transmitted to more equipped hospitals in urban areas where specialists can interpret the findings and transmit back the diagnosis. That way patients located in the remote rural regions can have access to excellent diagnosis and treatment without having to wait long times or travel long distances. This could be life changing factor for critically or chronically ill individuals.
Another avenue utilized by healthcare providers is periodic ambulatory care where patients are required to arrive to a dedicated ambulatory site. The ambulatory site is connected to a well-equipped hospital through dedicated networks through which service is rendered to the patients instantly.
A further way by which telehealth professionals increase their outreach to people is through direct video-conferencing interaction with patients. Through a direct phone & video system connection, healthcare professionals can have remote interactive consultation and monitoring sessions with patients.
Another way to disseminate and transmit data involves direct connection of high risk cardiac patients with pacemakers and those in an advanced stage of pregnancy with monitoring healthcare centres. Patients can perform their daily business, while their condition is continuously and remotely monitored by healthcare professionals.
Highly informative and intuitive health web portals can provide excellent information with regards to healthcare services to patients over the internet.

5.2.1. Telehealth and Big Data

The 21st century has witnessed unprecedented growth in data generation, data sharing and information technology. As the globe population increases and businesses continue to increase, the notion of “big data” comes out, which mainly means an explosive increase of data concerning its quantity, kind and rate of generation. However, big data

includes important business value and business logic which can be used to push additional increase of businesses. There are effective implements to completely analyse and use the data. Recent data released by McKinsey & Co. clearly shows the edge that companies, that are efficiently implementing big data solutions, have over their market competitors. What is really fascinating to observe is that big data is not only confined to a specific sector but also relevant to a diverse range of industries. Figure 1 below illustrates the McKinsey & Co. findings (xPatterns, 2012).

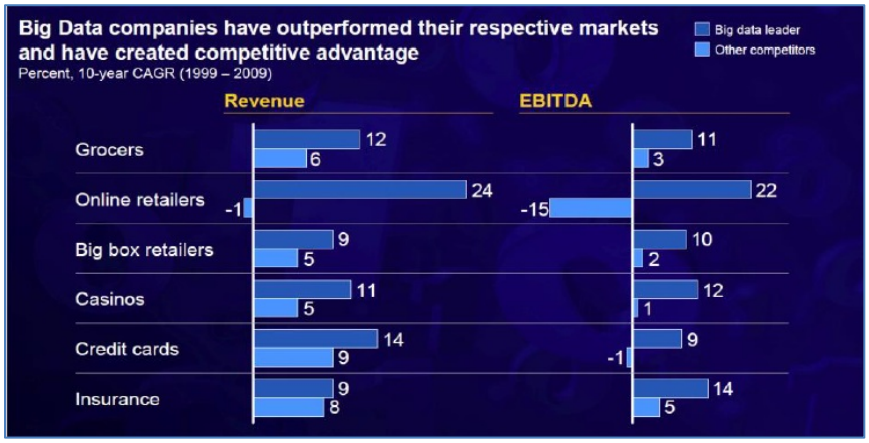


Figure 21: Big data promotes growth. Adapted from (xPatterns, 2012)

In the post genomic era, there has been an explosion in the biological data generation. Cutting edge sequencing experiments that are being carried out across different laboratories are unravelling the secrets of life and throwing tremendous insights into understanding the pathogenesis of different human diseases such as diabetes and multiple sclerosis. So in essence, the role of big data to the healthcare sector in general is tremendously significant. The 1000 Genomes Project of the NIH (National Institute of Health) that has generated the world's largest set of data on human genetic variation is currently being hosted by the Amazon Web Services (AWS) on their cloud. This has been a significant investment of AWS in biological big data, and with the data residing in the cloud, it is accessible by researchers and laboratories across the globe. This will undoubtedly contribute to the progress of science and research since researchers can immediately start their work on the data, without having to worry about issues such as data acquisition, storage, sharing etc. This will also be highly cost-effective, sparing many laboratories the investment on capital IT assets (Federal Telemedicine news, 2012). Another interesting project called Twitter Health initiated by Rochester

University used sophisticated big data mining algorithms to predict flu amongst Twitter users by studying their twit messages (Bertolucci, 2012). These developments will allow researchers dispersed throughout the world to collaborate on genome sequencing and related big data problems using remote (telehealth) links as broadband width increases and infrastructure costs decrease.

Given the importance of big data, the selection of an appropriate big data solution is equally critical. Large corporates such as ORACLE and IBM have released their big data solutions and it is extremely important that new companies and businesses clearly weigh the pros and cons of any solution before adopting the same (O'Mahony, 2012). They need to initially determine whether the solution they are contemplating to adopt is aligned with their specific needs or not. Big data processing technology such as Hadoop is becoming popular according to the International Data Corporation (IDC) report (King, 2011). However, companies must select a technology platform that is least complicated and easiest to adapt. It also needs to be ascertained if the adopted technology has strong and market-relevant analytical skills. Big data is dead weight if they cannot be analysed and utilized for business growth. So, adopting an intelligent big data solution is highly critical. New technology requires new talent and big data solutions will require a new set of software experts who are specifically trained. Companies must determine if it will be more cost-effective to build a pool of internal talent or outsource their projects. The cost of technology is another critical factor and companies need to choose the solution that is cost-effective with regards to their needs. A solution that is based on free open source platform and whose licence is renewable could be a great choice for businesses cost-wise. Oracle and IBM have released their big data solutions and they have taken completely different approaches to dealing with big data (O'Mahony, 2012). It is for businesses to decide what is best for them, and a good way to determine that would be to consider the points discussed above in a very critical manner.

5.2.2. Impact of NTs on Telehealth Practice

The impact of telehealth in providing efficient healthcare has been well recognized in the 21st century, because of the use of cutting edge NTs. Telehealth has truly emerged

from the realms of the telephone and fax and the latest developments in the IT sector such as cloud computing and super-fast wireless data transfer protocols such as 4G are finding increased use in telehealth. Given the increased use of NTs in telehealth, highly agile healthcare delivery, accelerated diagnosis and increased outreach of the super-speciality expertise to remote areas have actually become a reality.

A particular technology that has achieved tremendous promise to facilitate efficient healthcare delivery is mHealth or mobile health information technology (which is considered as one of the most critical applications of telecare as mentioned above). According to Gaur & Jost (2012) pp.1 , mHealth can be defined as the "*emerging mobile communications and network technologies for healthcare systems*". It is widely anticipated that mHealth will revolutionize the way healthcare is delivered in the future and contribute immensely to the progress of knowledge and health research, through increased use of the latest communication gadgets such as smart phones and super-fast wireless data transfer technologies. Modern technologies such as mHealth bring different healthcare departments under the purview of a single healthcare delivery portal and increase cohesiveness in data sharing and exchange of information between different healthcare entities. This way, the patient acquires the attention and focus of the entire healthcare delivery setup. Modern mHealth setups create the avenues to efficiently collect, archive and disseminate health related data in a highly time sensitive manner, resulting in a high degree of efficiency in diagnosis and treatment. This level of agility and efficiency could actually make the difference between life and death for critically ill patients. Rapid data transfer protocols of mHealth information technology enable doctors and telehealth practitioners to efficiently monitor health records such as diagnostic reports and scans in a timely manner, so that proper treatment could be administered immediately when required. Furthermore, minimal human interventions in healthcare record maintenance significantly eliminate record keeping errors and makes healthcare delivery highly cost-effective. It is well evident that mHealth technology can greatly increase the outreach of the excellent healthcare services to remote regions and can greatly improve the healthcare sector in emerging economies.

As technology progresses further and mobile communication devices attain new heights of efficiency, mHealth is getting extensive leverage in improving healthcare delivery through the use of modern wireless devices such as smart phones and handheld PDAs. The IT revolution is practically changing the face of healthcare delivery system and the impact is becoming more and more vivid with every passing day. Application of NTs is not any more limited to some selected sections of healthcare. A very good example of this diversity is the *PE Coach* smart phone application which is designed to manage behavioural health (Reger, 2012). The application facilitates face-to-face psychotherapy of army servicemen who are diagnosed and treated posttraumatic stress disorder (PTSD). Prolonged Exposure or PE is a treatment for PTSD, where the patients are required to re-live the experience of the trauma in their minds. The PE coach application, which could be easily installed in a standard smart phone, help the patients efficiently record their PE sessions on their phones and eliminate the need of a separate voice recorder.

Life moves at a very fast pace today. Given the hectic lifestyle of the modern generation, different social networking platforms have become really popular to facilitate communication and sharing of information in real-time manner. Social networks such as Facebook and Twitter are extremely popular and given their tremendous outreach, they could be just the right medium to broadcast healthcare-related information, create health-related awareness and also advocate good healthcare practices. These social networking platforms could also be paired with mobile communication devices such as smart phones, and patients could receive health alerts such as health check-up appointments or even medicine intake reminders in their phones through Facebook or twitter updates. Additionally, social networking platforms also allow setting up of cohesive groups constituting patients and healthcare professionals to facilitate increased communication and sharing of ideas (Virginia Rural Health Resource Centre, 2011). This will undoubtedly improve the quality of healthcare as doctors and telehealth practitioners can keep themselves abreast with the latest condition of their patients and react fast in real-time when any sort of intervention is required. Another very encouraging example of the role of social networks in telehealth is the blood glucose level monitoring application called *Bant*. Jointly developed by the

Apple Corporation and the University of Toronto, *Bant* is an iPhone application that remotely monitors blood glucose levels and stores the result in a patient Google health account. The application even allows sharing of the experience with Bant through direct updates on Twitter (CommunityManager, 2011).

Cloud computing is one of the latest offering of the IT industry and is all set to revolutionize how different organizations and businesses utilize different IT resources to realize their business dreams and objectives. Cloud computing has removed the shackles of high infrastructure cost pulling down small and medium sized enterprises from executing their brilliantly innovative ideas. Cloud computing is extremely cost-effective as well and have increased the business profitability of both the cloud service providers and their clients. In a cloud computing setup, IT infrastructure such as the central processing unit or the data storage utility is maintained by data centres in distributed locations. Its services are commercially leased to different organizations and service providers over the internet, on an on-demand basis. So, in essence, cloud computing relieves many organizations from investing in expensive IT infrastructure and virtually making computational resources available for use in every geographical locations. This undoubtedly makes the business models of small and medium size corporates highly cost-effective (Zhang et. al., 2010).

The role of cloud computing in telehealth is vast and different healthcare organizations have already benefited tremendously from the services of the cloud. Khan (2011) highlighted that Telepsychiatry first reaped the benefits of a modern cloud when it replaced face-to-face consultation sessions with video-conferencing consultations. This saved great amount of travel time for the patient and facilitated healthcare delivery to the patients, in the comfort of their homes. Modern cloud computing solutions are also being used by many healthcare facilities to store heath records (EHRs) of their patients. These could be prescriptions, diagnostic reports, X-rays and CT scans or even hospital admission records. Since they are on the cloud and can be remotely accessed through internet from any geographical location, data sharing and information dissemination become extremely fast. Due to minimal human intervention, the common errors associated with manual record keeping are significantly reduced as well (Khan, 2011).

One of the biggest incentives of NTs in telehealth is availability of excellent remote healthcare services even in the remote and isolated regions. The Grande Ronde hospital located in the isolated La Grande region of the Oreagon state has put up a magnificent example through an initiative program, where they used *RP-7* robots to provide healthcare to the patients remotely at their facility. The robots were connected to specialists located miles away and the program enabled patients to receive expert care remotely, without having to travel long distances and bear enormous expenses (Pearson, 2012). The RP-7 robots bring together remote control robotic technology and remote presence technologies to allow a doctor, located thousands of miles away, communicate with patients in a manner as if he is physically present near the patient (Intouch Health, 2012).

Figure 22: RP-7i robot illustrates a real-time consultation. Adapted from Intouch Health (2012)

The emergence of ultra-fast broadband networks will revolutionize the way excellent healthcare is delivered to the patients. In fact, most of the NTs depend on a fast broadband network to render excellent health services to patients. Rapid sharing and dissemination of data and information through the cloud will not be feasible with a slow internet connection. Also, high definition videoconferencing requires a fast broadband connection to make high-quality services. This has been well realized by the American Government and they have recently announced the U.S. Ignite Partnership to facilitate rapid development of technologies and user-applications that can benefit from fast

internet networks to provide excellent service such as healthcare to the American people. Networking giants such as *Verizon* have associated themselves with this partnership program and offer ultra-fast broadband connectivity to benefit the healthcare and research organizations located in the Philadelphia area. Similarly, *Comcast* has also decided to sponsor the partnership and cooperate with different universities and research institutes in developing advanced applications and a network system that will significantly improve healthcare delivery in the USA (Executive office of the President, 2012).

So, the possibility of productive application of NTs in modern healthcare delivery is truly immense. The modern healthcare scenario has already changed a great deal, thanks to NTs, and given the trends, it can definitely be safely assumed that the scale of growth is only upwards from here.

5.3.A Great Example of Telehealth Systems, Docobo System

Docobo is a leading British healthcare solution provider that came into existence in 2001. The company's main focus has been conceptualization and development of utilities for the management and monitoring of patients with chronic illness in their homes. The organization provides highly intuitive and effective healthcare solutions such as *doc@Home* and *HealthHub* to manage chronically ill persons and collect patient's health data respectively. The services rendered by the organization in the form of remote health data collection, transmission and analysis are extremely cost-effective for healthcare providers in the UK. Since the Docobo solutions monitor patient health conditions at home and utilize sophisticated health management products or utilities to manage their conditions, patients are able to receive high-quality care from the comfort of their home, while saving money, effort and time (Docobo, 2012).

The NHS of the UK is constantly devoted to improving their health service to the public. Alongside providing excellent services, the NHS also acts to reduce service-related costs. In the given scenario, efficient telehealth services such as those offered by Docobo could be extremely instrumental in maintaining the right balance between excellent healthcare and cost reduction. For some patients, maintaining a certain

lifestyle is vital and they are also fully capable of monitoring some basic physiological conditions such as their blood pressure. Docobo offers such patients the utilities and knowledge to perform self-monitoring of their conditions and helps them cut down travelling time and maintain convenience. Furthermore, doctors and physicians obtain more time to concentrate on patients who need more urgent attention. Utilities such as HealthHub that resemble an average-sized PDA facilitate in-house monitoring of large numbers of patients at any given time (Docobo, 2012). These services are not just improving the quality of healthcare but also reducing the stress of overburdened healthcare professionals by offering perceived and efficient ways to manage patients remotely.

Telehealth service providers such as Docobo are undoubtedly beneficial to the modern healthcare sector in the UK, but its significance is even higher for developing nations. In these countries the penetration of high-quality healthcare is extremely low and the distribution of modest healthcare facilities in the remote areas is relatively poor. People have to travel long distances to cities to receive just the basic healthcare services due to incapability of health centres in their village which are mostly under-equipped (Docobo, 2012). Telehealth solutions provided by consortiums such as Docobo could be extremely instrumental in these scenarios to dramatically increase the outreach of high-quality healthcare services amongst the masses.

5.4.Diffusion of Telehealth

Everett M. Rogers' theory of Diffusion of Innovations throws many insights into how a community or a population responds or reacts to new ideas and innovations (Sahin, 2006). With regards to the emergence of telehealth as a modern paradigm to providing effective healthcare services, the theory could be very helpful to understand how people will react to it. The theory could also help define a roadmap and a strategy to spread the concept of telehealth in the developing world, where the outreach of high-quality medical care is very less compared to the developed world.

Rogers suggests the following four elements, which are inherent to his theory of diffusion (Sahin, 2006).

I. *Innovation:* The theory describes innovation as an element, an idea, an endeavour or even a trait that is accepted or treated as new or unique by a population. The theory literally defines innovation as "*An idea, practice, or project that is perceived as new by an individual or other unit of adoption*" (Rogers, 1983, p. 11). The theory helps identify the traits that lead to a rapid dissemination of an innovation idea amongst the target population and highlights the significance of effective communications. According to Rogers, an innovation might have been conceived long time back in the history, but if it is considered as something new by someone, it could be considered as an innovation for them. The theory highlighted that the major hindrance to an innovation getting embraced with an open mind is the element of uncertainty associated with it. The uncertainty or the reluctance to accept innovation is best dealt with by offering a clear picture to the population with regards to the advantages, the disadvantages and the possible consequences associated with it. When people are made to see the positive aspects of innovation and the trade-offs in a transparent manner, they can evaluate their options and make the best possible decision for themselves. In case of telehealth, the initial high investment in the infrastructure might scare off investors and policy makers in developing nations, but if they are made to perceive the potential cost-effectiveness in the long-term manner, they will be more open to accepting the concept.

II. *Communication channels:* The theory of diffusion considers communication between individuals or units as a key factor in spreading the knowledge of innovation amongst the target population. Rogers describes communication as creation and exchange of ideas and information between individuals or units to arrive upon an agreement (Sahin, 2006). The communication occurs through channels or information exchange pathways that connect the initiator or the creator of information with the benefactor or the receiver of information. Rogers describes the term "*diffusion*" as a form of communication which is constituted by an innovation, two elements who communicates between themselves and a designated communication channel. The theory of diffusion identifies mass

media such as electronic or print media and interpersonal interaction as types of communication channels. According to Rogers, the efficacy of interpersonal communication or interaction far more in changing people's perceptions with regards to innovations and acceptance of the new. In developing countries such as India, the government has implemented different health programs where health workers and educators work in the remote rural regions of the country. They are ones who spread different health related awareness and implement basic health schemes. So their outreach to the villagers is already substantial. In such a scenario, interpersonal communication could be highly effective to educating the population of the advantages of modern telehealth practices.

III. *Time:* The theory of diffusion considers time as a major player and an influencing element that affects the diffusion or communication of the innovation and the rate at which innovation is accepted.

IV. *Social system:* Innovations occur in a social setup or system and the architecture of a social system and its elements in the form of individuals will greatly influence the way innovation is considered or treated. The prevailing social system in a community also shapes its individual's degree of innovation. While some might be more open to innovation, some might show a high degree of reluctance to the same. The theory of diffusion categorizes individuals into the following five categories based on their degree of openness to innovation (Sahin, 2006). According to the theory, "*innovativeness is the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a system*" (Sahin, 2006, pp.18). The theory divided individuals or unites of a systems into five levels according to their degree of innovativeness:

- **Innovators:** They are open to new ideas and do not care much about the benefits. They are pioneers in bringing in and adopting innovations in a given social system (Thinque, 2012).
- **Early adopters:** They operate within the realms of a given social system and have the capability to influence the decision of other social

members. They act as role models or leaders, who analyse innovation and their viewpoint percolates into the social system through interpersonal communication channels or peer-to-peer networks. Their acceptance of an innovation can brighten the prospect of an innovation getting accepted in a social system.

- **Early majority:** They are the intermediates who accept innovations midway. Even though they have excellent communication within a social system, they do not act as leaders. Their role is less important in spreading the awareness on the innovations.
- **Late majority:** They are highly sceptical of the innovations and they also hold many apprehensions. Sheer economic necessity or persuasion by close associates or peers leads them to accepting innovations.
- **Laggards:** They are the most sceptical of innovations. They primarily communicate within their category and percolation of awareness and knowledge is relatively slow in their case. Laggards prefer to wait and watch until an innovation has yielded positive results and its value has been proved beyond doubt. By nature they are most traditional in nature and would prefer to wait until that moment when an innovation actually turns into a tried and tested tradition (Value Based Management, 2012).

The following Figure 22 demonstrates the above five levels with their proportion in a population.

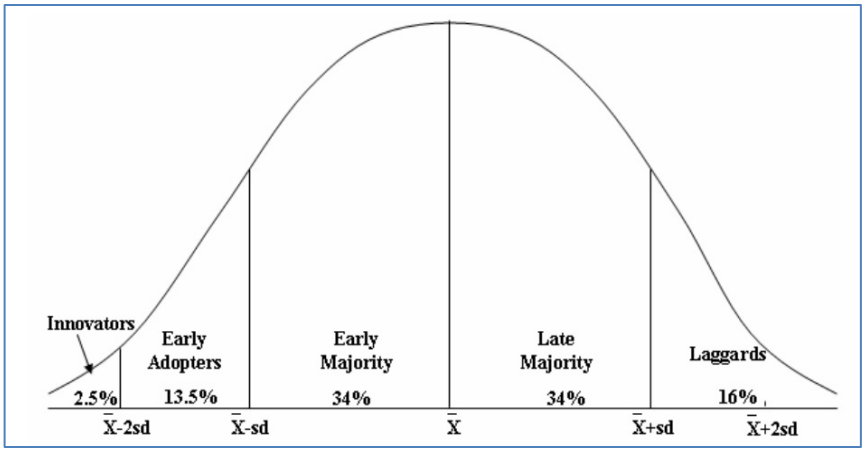


Figure 23: illustrating the adopter levels according to their innovativeness degree. Adapted from (Robinson, 2009)

The theory of diffusion proposed an *Innovation-to-Decision* process and defines it as: "*An information-seeking and information-processing activity, where an individual is motivated to reduce uncertainty about the advantages and disadvantages of an innovation*" (Sahin, 2010).

There are five stages to make a decision about an innovation which are: *knowledge*, *persuasion*, *decision*, *implementation* and *confirmation*. The 5-staged process is illustrated in Figure 23 below.

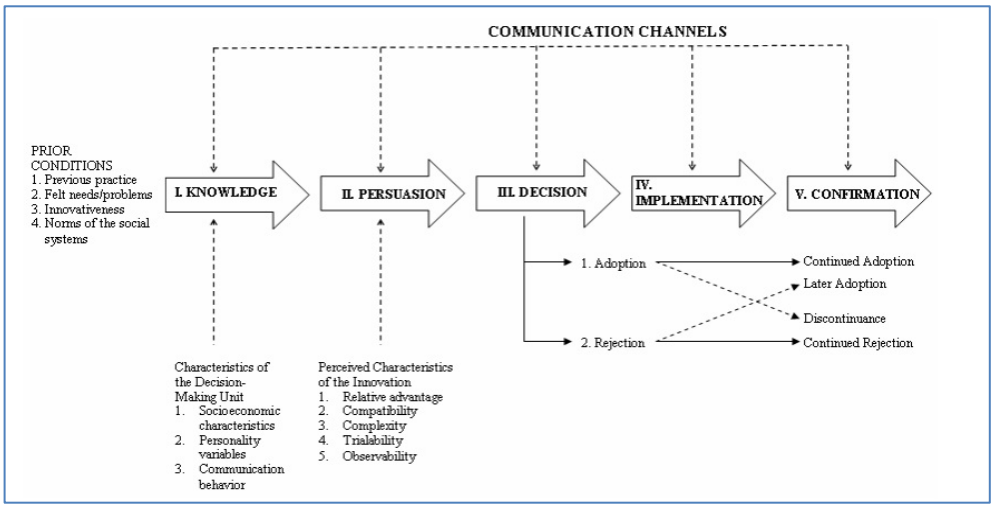


Figure 24: illustrating the Decision-to-Innovation process. Adapted from (Sahin, 2010)

In context of telehealth, the theory could be a constructive roadmap to understanding the spread of awareness of the concept and the diffusion of the idea among the telehealth practitioners leading to a wider acceptance of telehealth as a standard mean of providing healthcare. Amongst the healthcare practitioners, those who are more confident and enlightened about significance of NTs in telehealth practices will embrace change more rapidly. They will act as trendsetters (innovators) in using new technology and demonstrating its effectiveness in imparting excellent healthcare. As the concept percolates further, many will embrace the technology rapidly (early majority), while others will wait and see if telehealth actually brings any improvement. If the results are encouraging they will accept the change as well (late majority). The issue for government and regulatory health providers is whether they should let the 'bottom-up' enthusiasm of innovators determine progress or whether they should provide some guidance or framework by which useful developments can be harnessed and their

potential more fully exploited. The 'market-will-decide' approach may appeal to policy makers because it limits government investment and control but the long-term effects of trial and error may ultimately cost more. To date, very few governments have addressed this issue preferring a hands-off approach.

5.5.Barriers to Telehealth

5.5.1. Acceptance Barriers

A study carried out by Sanders et. al. (2012) in the UK identified three potential barriers to telehealth. The first reason concerned the technology associated with modern telehealth devices. Many elderly individuals who participated in the study held the view that modern technologies will make them feel more alienated. Most of them already found modern devices such as mobile phones intimidating and do not have much idea about most of their features. The study highlighted the lack of confidence with modern technology as a major barrier to wider acceptance of telehealth. Furthermore, many respondents had pre-held notions of trouble with modern technology-related services such as telehealth because of other difficult experiences they have previously encountered with some other technology. The second barrier to telehealth that was highlighted by the same study emanated from the perceived threat to independence and self-reliance. People were of the opinion that telehealth is only for those who are critically ill. Most of the respondents perceived telehealth as threat to their ability to take care of their own. Many also believed that telehealth will affect their mobility and make them less active leading to laziness. The final barrier to telehealth came from the reluctance of people to embrace something new, which – as they believe – will destabilize an already excellently working fine system of healthcare.

Another study carried out by Moffatt & Eley (2011) in Australia highlighted lack of funding, lack of infrastructure, lack of skills and preference for traditional methods as potential barriers to telehealth. Reginatto (2010) identified similar barriers such as technical issues, costs, aversion to change and lack of benefits to healthcare workers, which are putting road blocks to a wider acceptance of telehealth.

5.5.2. Legal Barriers

Legal issues also present their own share of barriers to effectively implementing telehealth services. The very essence of telehealth is about providing remote services across geographical barriers. Lack of proper legal framework to deal with jurisdiction and privacy issues in different geographical locations and absence of a common and cohesive mechanism to store, share and disseminate patient data and authenticate telehealth practitioner identification have effectively hindered acceptance of modern telehealth in hospitals and health centres. Other challenges include technical issues that can translate to communication disruption and hardware failure. Link failures during a critical stage when a seriously ill patient is waiting for their diagnosis to arrive might actually make a difference between life and death. This might also make a telehealth service provider liable to prosecution in the court of law. Other legal barriers could be due to the absence of a common telehealth policy that is applicable across borders. In the present situation, jurisdiction issues and different national policies on medical data handling could stall the progress of telehealth. Furthermore, jurisdiction issues could also stand as a barrier in providing justice and compensation, if patient data, maintained in a cloud server located in an offshore location is compromised.

5.5.3. Ethical Barriers

Ethical barriers to modern telehealth practices could emanate from the concerns on the privacy and security of patient data when they are transmitted over a network. Ethical concerns related to privacy of patient records data stored on a commercial cloud storage utility could effectively stall the process of acceptance of telehealth as an effective mean of providing healthcare. Other ethical barriers to telehealth could come from issues such as the lack of personal touch between the doctor and the patient when treatment is provided remotely and the pressure, the technology might exert on critically ill patients (Fleming, 2004).

According to O'Reilly (2012), the lack of a face-to-face consultation between the doctor and the patient is not the only ethical concern with regards to telehealth. Patients have may become over dependent on the remote healthcare facility and use the system to

look for doctors who would more readily provide prescription, which perhaps would not have been the case, had there been a physical consultation, given the condition of the patient.

These challenges further emphasize the pertaining need for a more standardized and general telehealth policy applicable and acceptable across the globe. It needs to be ensured that telehealth could fully uphold the promise of significantly increasing the outreach of high-quality healthcare services to the underprivileged and deprived regions and does not get wrangled in a corporate profit making mentality. It also needs to be ensured that modern telehealth practices totally respect the cultural and ethical sentiments and requirements of different culture and nationality and endeavour to maintain the privacy and dignity of each and every individual (WHO, 2010).

5.6.A Suggested Strategy for Developing Countries

The healthcare sector in developing and poor nations is extremely inadequate for the provision of basic healthcare services to its people (Wootton et.al., 2009). The situation is further aggravated in the remote areas where access to even modest healthcare is virtually non-existent. In a situation like this, it is evident that modern telehealth solutions have more to offer here than in developed countries where almost everybody has already achieved access to high-quality healthcare facilities. Even though medical science has made tremendous progress in the past decades, the outreach of high-quality healthcare has remained very low in many communities of the developing world. Given the current volatile economic situation across the globe caused by the recession, many people have been made redundant and they lost their only source of income. The already wide gap that existed between the rich and the poor in the developing nations has grown further. The widening difference is clear in the healthcare sector as well where abstract poverty combined with is fuelling the spread of chronic illness and AIDS at an alarming rate (Wootton et.al., 2009).

In the last two decades information and communication technologies have tremendously developed and their application in the healthcare sector has significantly increased. The effectiveness of this technology in improving healthcare has been realized both in the

developed and the developing worlds and the concept of telehealth is slowly gaining strength even in the developing world.

The following factors could serve as a strategic road map which can help developing nations to build up a workable and effective telehealth service.

A. **Improved access to information**: The first step in setting up an effective healthcare service would be to create awareness. Effort should be made to improve the access to healthcare information, latest research and success stories; so that awareness could be created amongst policy makers and different stakeholders. Improved access to information will also help create awareness amongst the general public and the healthcare community on the advantages of modern telehealth practices and its ability to deal with the prevailing healthcare issues in a highly cost-effective manner.
B. **Increase in collaboration, tie-ups and communication**: Collaboration between different healthcare organizations will dramatically improve the management of health conditions and scarce resources. Effective communication will also help spread the awareness at higher decision making levels of the government.
C. **Continuous monitoring and analysis**: At this stage, information and communication technologies should be used to collect and disseminate health related data and help spread the awareness further. There should be continuous monitoring of trends and their analysis to understand the reaction of the general public to information and knowledge.
D. **Development in the health education sector**: ICT should be used to improve healthcare education so that health professionals have access to the best available resources. ICT could also be instrumental in significantly improving the delivery of the education in a highly effective manner. Development in the health education delivery process can increase the outreach of health education to the vulnerable women population.
E. **Transparency and accountability**: In the developing world, corruption has entrenched deep into the very fabric of the society. So transparency and accountability are paramount to developing a good telehealth setup. There

should be strict monitoring of the schedules and it needs to be ensured that all guidelines are strictly adhered to.

F. **Healthcare facility setup and delivery**: The final stage could be the actual setting up of healthcare facilities and telehealth infrastructure and efficient delivery of healthcare. This might involve the setting up of health information systems, even distribution of healthcare facilities to the remote areas and increased support to rural healthcare professionals to help them achieve a high level of professional competence.

However, despite the promise of modern telehealth services, much more needs to be done to realize their full potential. It has been observed that telehealth still needs to make significant inroads even in the developed western world, let alone the developing third world countries. Telehealth is yet to be thoroughly practiced in routine healthcare centres and hospitals in a major way. Even though a large number of telehealth projects were initiated, very few remained sustainable on their own. Two prominent factors that are acting as hindrances to telehealth are reluctance of the healthcare professionals to forgo their traditional ways of delivering healthcare and embrace change, and lack of expertise in modern ICTs. In addition, there are not many well-documented studies that actually highlight the efficacy and cost-effectiveness of modern telehealth practices. Well documented studies could be extremely instrumental in changing public and government outlook and attracting more interest and funds. Also, worth noting is the fact that a significant difference in outlook exists between modern telehealth professionals and deprived patients which also present barriers in effecting a change.

5.7.Study Limitations

This study was very instrumental to highlight and understand the significance of NTs in modern telehealth practices. However, it also needs to be appreciated that scientific qualitative or quantitative studies in any discipline can invariably attract some kind of bias. Some limitations of this study that could lead to potential bias are identified and discussed below.

Although the study attempted to include a cohort made up of a diverse variety of respondents from different health boards, most of them were affiliated to CCDHB. The other health boards were highly underrepresented and this might give rise to omission bias. The prevailing attitude in CCDHB with regards to the role of NTs in telehealth primarily emerged in this study and this might have skewed the results in the sense that numerous opinions of health professionals belonging to different health boards went unrecorded. So in essence, it may not be entirely correct to consider the results as proper representation of the attitude of telehealth professionals to the significance of NTs in modern telehealth practices.

Another limitation of the study originated from non-participation of all the responds. Even though the request to participate in the study survey was sent to 250 healthcare professionals, only 49 individuals have eventually taken part and only 25 have completely responded to all questions. So, the small cohort size might create bias in the results in the sense that the opinions recorded might be very narrow and largely unrepresentative of many other viewpoints and observations that otherwise could have come from a larger cohort. The full participation of all the respondents were very critical to questions 24 and 25 of the survey which focussed on the critical advantages obtained by using NTs and barriers encountered in utilizing NTs in the current telehealth system, respectively. These questions were designed to highlight the actual significance of NTs in telehealth to understand the reasons behind non-acceptance in the real world. This information was extremely critical from the perspective of future policy decisions to negate the insecurities and apprehensions of telehealth workers and general public towards modern telehealth practices. However, only 11 respondents replied to question 24 and 12 responded to question 25. This will invariably lead to underrepresentation of viewpoints and suppression of information.

Furthermore, there were some questions that might have been formulated in such a way that was either vague or lacked to proper direction with regards to the objective of the study. Questions 10 and 11 that asked the participants about the importance of smart phones in providing quality services and tablets in assisting health providers to perform medical procedures were not specific and lacked direction. In a clearer manner, these

questions were imprecisely stated about telehealth services and they could have been understood in a more general meaning. They should have been more precisely formulated to give a more accurate meaning as intended. Similarly, question 13 wanted to know if storing patient's data in a computer tablet is safe enough. However, there was no clear definition of safety and different respondents might have different ideas on the concept of safety. If the question specifically focussed on the safety of privacy, the responses could have given a more proper direction.

Chapter 6: Conclusions and Recommendations

6.1. Conclusion

With regards to the applicability and potential of different NTs in modern telehealth practices the study highlighted that telehealth practitioners consider mobile devices such as smart phones, hand held PDAs and tablets as ideal in providing excellent telehealth services. The reasons could be the high level of independence, portability and reliability associated with these devices coupled with the natural inclination of today's younger generation to technologies such as this. It needs to be noted that around 60 percent of the respondents belonged to an age group of 26 to 45. The study also brought into light the fact that telehealth practitioners perceive storing sensitive patient data in tablets and smart phones a security risk. A probable solution could be to avoid storing the kinds of data that would reveal patient identity or personal medical history. The results were also in agreement with the established advantages of modern telehealth practices such as reduction in travel times for patients and doctors getting more time to attend to those who need more urgent attention. In other words, the results established that telehealth is extremely cost-effective and the majority of the respondents believed that there is tremendous potential for telehealth in imparting more efficient and agile healthcare to people in the coming future.

The survey also highlighted the potential barriers to telehealth as perceived by the respondents and most of them blamed funding and infrastructure constraints and network limitations as the prominent sources of hindrance to progress. The study revealed that issues related to the privacy of sensitive patient data in mobile telehealth devices is a major concern. While these devices have been very instrumental in increasing the outreach of excellent healthcare, their efficiency in handling sensitive data has remained questionable for many telehealth practitioners. This could have serious implications with regards to telehealth being more widely accepted as standard mean to providing excellent healthcare. Keeping this concern in retrospect, the study has also highlighted that sophisticated remote monitoring devices have got tremendous potential for telehealth and could save around 197 billion dollars over a period of 25 years in the USA alone (West, 2012). Information such as this will definitely have

tremendous implications for telehealth in the future and will undoubtedly help policy makers and health agencies to design a more effective road map for the future.

6.2. Recommendations

Keeping the knowledge and the information gained from this study in retrospect, it is recommended that effective steps should be taken to remove the barriers that are hindering the progress of modern telehealth practices. There is a need for programs to create awareness amongst the general public so that people could be alleviated from their apprehensions with regards to modern telehealth practices. Good publicity programs and extensive promotion of telehealth advantages through different mediums such as the electronic media, health board and hospital websites, health centre notice boards and face-to-face counselling are strongly recommended. People needs to be made aware that telehealth will be extensively cost-effective for them as well the health establishment in the long run and that it will make healthcare delivery more agile and efficient compared to the current system.

Similarly awareness needs to be created amongst those telehealth practitioners who are still reluctant to embrace telehealth. This could be through extensive training programs and workshops highlighting the advantages of telehealth. It is strongly recommended that telehealth practitioners are entitled to equal level of remunerations as that of face-to-face consultations and telehealth practices are considered at par with traditional healthcare delivery mechanisms in a clinic or a hospital. It is recommended that necessary policy changes are made to cover the cost of telehealth equipments in the health board budgets if this has not been done already. Furthermore, it needs to be ensured that patients receiving remote healthcare are entitled to same level of insurance coverage as that of the traditional methods. It is important that government agencies and health boards fully recognize the advantages that come with remote self-monitoring devices that could be used by patients themselves. Another recommendation would be to cover the cost of these devices in the insurance policies of the patients.

6.3. Future Work

Telehealth has tremendous potential to revolutionize healthcare delivery in the future, but there are areas that need rethinking and improvements. In the 21st century, the patient demography is changing at a very fast rate with younger people getting affected by chronic conditions such as hypertension, diabetes and obesity due to their lifestyle and work related pressure (Ghosh & Ahadome, 2012). These patients are more acquainted with the modern technology and would prefer telehealth devices that are extremely portable and adaptable. So, there is pertaining need for the development of mobile but efficient health monitoring devices that will work efficiently on the go and will not affect the life style of the patients. Majority of the remote self-monitoring devices that are currently in use need to be set up at patient homes and are connected to the network physically through a cable. Given the highly mobile lifestyle of the younger patients, development of equally efficient mobile monitoring devices will be in great demand in the future.

The results of this study have shown a significant unawareness of younger healthcare professionals in regards to RFIDs, and this was previously explained in two manners: either RFIDs are deceasing in importance or being used in projects that are worked and managed by older healthcare professionals. Thus, the lack of acquaintance of younger healthcare professionals with the RFID technology is still a motivating subject matter for further research. A study that focuses on FRID use and significance in the current healthcare sector alongside the reasons behind the reduced familiarity of such technology particularly amongst younger health professionals is noteworthy.

This study has highlighted that telehealth practitioners harbour considerable concerns with regards to the security of patient data in mobile telehealth devices such as smart phones and tablets. So, there is considerable scope for future work to design and implement more robust security measures and utilities that will generate enough confidence amongst the health practitioners and the patients alike. Telehealth has been seen as a wonderful mean to ensure high-quality health in general. However, with the progress of technology, a new demand has emerged for telehealth utilities that focus on highly specific aspects of health. So, there is much scope for future work on

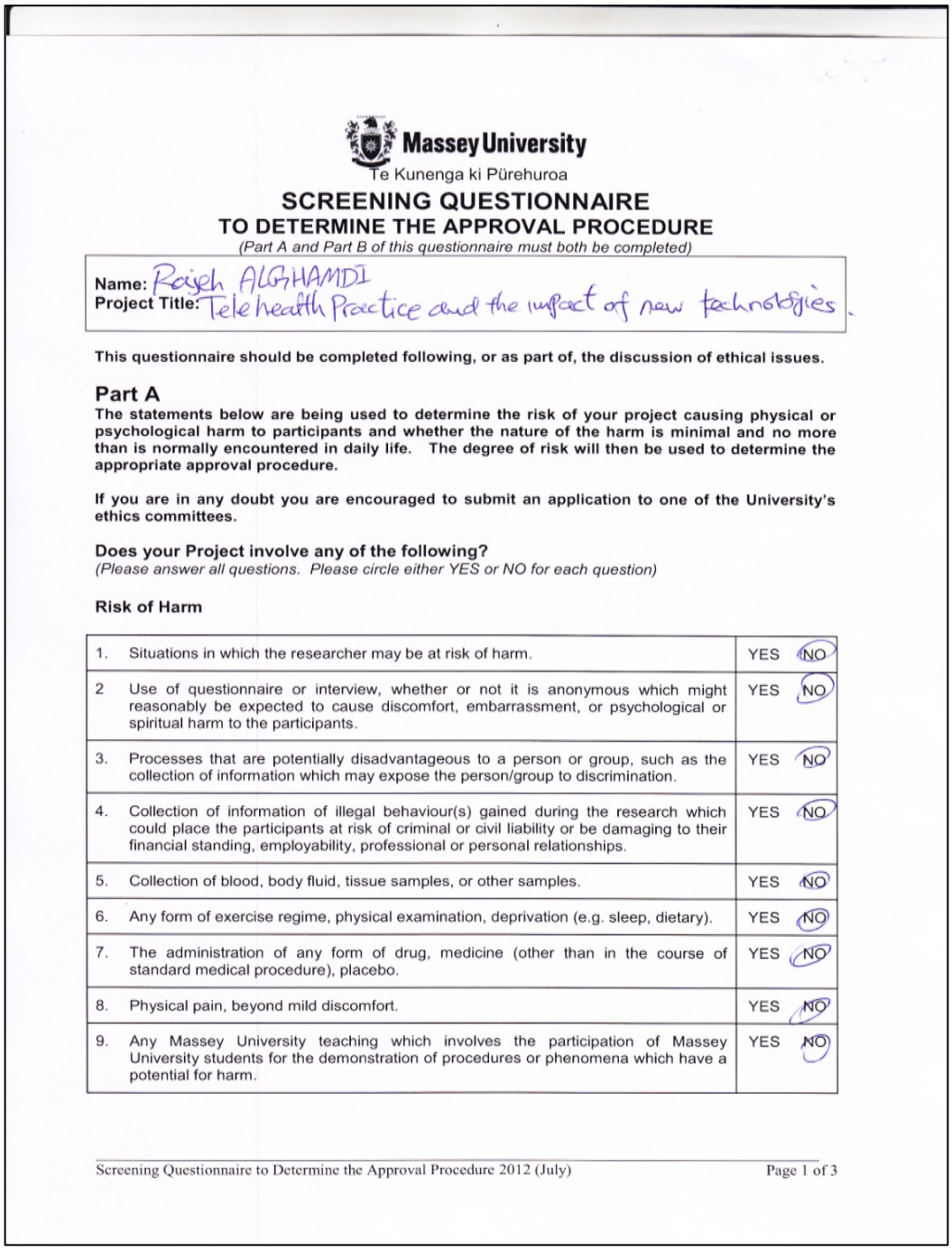
development of highly specific telehealth utilities that focuses on highly specific heath conditions or problems.

Appendixes

Appendix A

The ethics approval

- Massey University Screening Questionnaire – to determine the approval procedure



Massey University
Te Kunenga ki Pūrehuroa

SCREENING QUESTIONNAIRE
TO DETERMINE THE APPROVAL PROCEDURE
(Part A and Part B of this questionnaire must both be completed)

Name: Raiseh ALGHAMDI
Project Title: Telehealth Practice and the impact of new technologies.

This questionnaire should be completed following, or as part of, the discussion of ethical issues.

Part A
The statements below are being used to determine the risk of your project causing physical or psychological harm to participants and whether the nature of the harm is minimal and no more than is normally encountered in daily life. The degree of risk will then be used to determine the appropriate approval procedure.

If you are in any doubt you are encouraged to submit an application to one of the University's ethics committees.

Does your Project involve any of the following?
(Please answer all questions. Please circle either YES or NO for each question)

Risk of Harm

1.	Situations in which the researcher may be at risk of harm.	YES (NO)
2	Use of questionnaire or interview, whether or not it is anonymous which might reasonably be expected to cause discomfort, embarrassment, or psychological or spiritual harm to the participants.	YES (NO)
3.	Processes that are potentially disadvantageous to a person or group, such as the collection of information which may expose the person/group to discrimination.	YES (NO)
4.	Collection of information of illegal behaviour(s) gained during the research which could place the participants at risk of criminal or civil liability or be damaging to their financial standing, employability, professional or personal relationships.	YES (NO)
5.	Collection of blood, body fluid, tissue samples, or other samples.	YES (NO)
6.	Any form of exercise regime, physical examination, deprivation (e.g. sleep, dietary).	YES (NO)
7.	The administration of any form of drug, medicine (other than in the course of standard medical procedure), placebo.	YES (NO)
8.	Physical pain, beyond mild discomfort.	YES (NO)
9.	Any Massey University teaching which involves the participation of Massey University students for the demonstration of procedures or phenomena which have a potential for harm.	YES (NO)

Screening Questionnaire to Determine the Approval Procedure 2012 (July) Page 1 of 3

Informed and Voluntary Consent

10. Participants whose identity is known to the researcher giving oral consent rather than written consent (if participants are anonymous you may answer No).	YES (NO)
11. Participants who are unable to give informed consent.	YES (NO)
12. Research on your own students/pupils.	YES (NO)
13. The participation of children (seven (7) years old or younger).	YES (NO)
14. The participation of children under sixteen (16) years old where active parental consent is not being sought.	YES (NO)
15. Participants who are in a dependent situation, such as people with a disability, or residents of a hospital, nursing home or prison or patients highly dependent on medical care.	YES (NO)
16. Participants who are vulnerable.	YES (NO)
17. The use of previously collected information or biological samples for which there was no explicit consent for this research.	YES (NO)

Privacy/Confidentiality Issue

18. Any evaluation of organisational services or practices where information of a personal nature may be collected and where participants or the organisation may be identified.	YES (NO)

Deception

19. Deception of the participants, including concealment and covert observations.	YES (NO)

Conflict of Interest

20. Conflict of interest situation for the researcher (e.g. is the researcher also the lecturer/teacher/treatment-provider/colleague or employer of the research participants or is there any other power relationship between the researcher and research participants?)	YES (NO)

Compensation to Participants

21. Payments or other financial inducements (other than reasonable reimbursement of travel expenses or time) to participants.	YES (NO)

Procedural

22. A requirement by an outside organisation (e.g. a funding organisation or a journal in which you wish to publish) for Massey University Human Ethics Committee approval.	YES (NO)

Part B

FOR PROPOSED HEALTH AND DISABILITY RESEARCH ONLY

Not all health and disability research requires review by a Health and Disability Ethics Committee (HDEC).

Your study is likely to require HDEC review if it involves:

- **human participants recruited in their capacity as:**
  - **consumers of health or disability support services; or**
  - **relatives or caregivers of such consumers; or**
  - **volunteers in clinical trials; or**
- **human tissue; or**
- **health information.**

In order to establish whether or not HDEC review is required: (i) read the Massey University Digest of the HDEC Scope of Review standard operating procedure; (ii) work through the 'Does your study require HDEC review?' flowchart; and (iii) answer Question 23 below.

If you are still unsure whether your project requires HDEC approval, please email the Ministry of Health for advice (hdecs@moh.govt.nz) and keep a copy of the response for your records.

23. Is HDEC review required for this study?	YES (NO)

Select the appropriate procedure to be used (choose one option):

If you answer **YES** to any of the questions 1 to 22 (Part A) and **NO** to Q23 in Part B	If you answer **YES** to question 23 (Part B)	If you answer **NO** to all of the questions in Parts A and B*
↓	↓	↓
Prepare an application using the MUHEC Application Pack	**Prepare an application using the Health & Disability Ethics Committee Application Form**	**Prepare a Low Risk Notification** * *Note- researchers who are new to the University, new to research with human participants or for whom Committee approval is desirable are welcome to send in a full MUHEC application, even if the Screening Questionnaire questions have all been answered "no".*
↓	↓	↓

GO BACK TO APPROVAL PROCEDURES, STEP 4, AND DOWNLOAD THE INFORMATION REQUIRED.

http://www.massey.ac.nz/massey/research/research-ethics/human-ethics/approval.cfm

- Massey University 'Notification of Low Risk / Evaluation Involving Human Participants' application form

09 443 9389

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NOTIFICATION OF LOW RISK RESEARCH/EVALUATION INVOLVING HUMAN PARTICIPANTS

(All notifications are to be typed)
(Do not modify the content or formatting of this document in any way)

SECTION A:

1. **Project Title** Telehealth practice and the impact of new technologies

Projected start date for data collection 20/07/2012 **Projected end date** 30/07/2012

(Low risk notifications will not be processed if recruitment and/or data collection has already begun.)

2. **Applicant Details** *(Select the appropriate box and complete details)*

ACADEMIC STAFF NOTIFICATION

Full Name of Staff Applicant/s
School/Department/Institute
Region *(mark one only)* **Albany** ☐ **Palmerston North** ☐ **Wellington** ☐
Telephone **Email Address**

STUDENT NOTIFICATION

Full Name of Student Applicant Rajeh Abdullah ALGHAMDI
Postal Address 2/123 Bruce rd, Glenfield, North Shore, Auckland 0629
Telephone 0210753314 **Email Address** Rajah.alghamdi666@gmail.com
Employer (if applicable)
Full Name of Supervisor(s) Professor. Tony Norris
School/Department/Institute Institute of Information and Mathematical Sciences (IIMS)
Region *(mark one only)* **Albany** ☒ **Palmerston North** ☐ **Wellington** ☐
Telephone 09 443 9389 **Email Address** t.norris@massey.ac.nz

GENERAL STAFF NOTIFICATION

Full Name of Applicant
Section
Region *(mark one only)* **Albany** ☐ **Palmerston North** ☐ **Wellington** ☐
Telephone **Email Address**
Full Name of Line Manager
Section
Telephone **Email Address**

3 **Type of Project** *(provide detail as appropriate)*

Staff Research/Evaluation:		**Student Research:**		**If other, please specify:**
Academic Staff		**Name of Qualification**	M	
General Staff		**Credit Value of Research**	120	
Evaluation		**(e.g. 30, 60, 90, 120, 240, 360)**		

4. **Describe the process that has been used to discuss and analyse the ethical issues present in this project.**
(Please refer to the Low Risk Guidelines on the Massey University Human Ethics Committee website)

I have carefully read ethics code and discussed with my supervisor the following points:-
- Roles of the interviewees and concluded that only questions of a techincal nature will be Posted.
- There is no questions about patients or any medical information or history.

we have carefully followed the new flowchart of HDEC and concluded that the present Project does not require a HDEC review.

5. **Summary of Project**

Please outline the following (in no more than 200 words):

1. **The purpose of the research, and**

This thesis aims to identify the impacts of the NTs on telehealth applications and projects. Additionally, barriers encountered and benefits granted by using new technologies in the current telehealth practice are considered.

2. **The methods you will use.**

A questionnaire will be distributed to healthcare professionals including specialists, general practitioners, radiologists, surgeons and nurses affiliated to the New Zealand healthcare sector to collect their attitudes towards current telehealth practice in New Zealand. Such questionnaire will be distributed both online and manually to almost 50 healthcare professionals in different healthcare organizations all over the country. After collecting data, results will be analysed and clearly demonstrated by the researcher. Then, all collected questionnaires will be spoiled and not be used for any other purposes. All information accumulated will be securely dealt with.

(Note: ALL the information provided in the notification is potentially available if a request is made under the Official Information Act. In the event that a request is made, the University, in the first instance, would endeavour to satisfy that request by providing this summary. Please ensure that the language used is comprehensible to all)

Please submit this Low Risk Notification (<u>with the completed Screening Questionnaire</u>) to:

The Ethics Administrator

Research Ethics Office
Sir Geoffrey Peren Building, PN221
Massey University
Private Bag 11 222
Palmerston North

SECTION B: DECLARATION *(Complete appropriate box)*

ACADEMIC STAFF RESEARCH

Declaration for Academic Staff Applicant

I have read the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants. I understand my obligations and the rights of the participants. I agree to undertake the research as set out in the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants. My Head of Department/School/Institute knows that I am undertaking this research. The information contained in this notification is to the very best of my knowledge accurate and not misleading.

Staff Applicant's Signature ..... Date: .....

STUDENT RESEARCH

Declaration for Student Applicant

I have read the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants and discussed the ethical analysis with my Supervisor. I understand my obligations and the rights of the participants. I agree to undertake the research as set out in the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants. The information contained in this notification is to the very best of my knowledge accurate and not misleading.

Student Applicant's Signature ..... Date: 16/7/12

Declaration for Supervisor

I have assisted the student in the ethical analysis of this project. As supervisor of this research I will ensure that the research is carried out according to the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants.

Supervisor's Signature Anthony C Norris Date: 16/7/12

Print Name PROF TONY NORRIS

GENERAL STAFF RESEARCH/EVALUATIONS

Declaration for General Staff Applicant

I have read the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants and discussed the ethical analysis with my Supervisor. I understand my obligations and the rights of the participants. I agree to undertake the research as set out in the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants. The information contained in this notification is to the very best of my knowledge accurate and not misleading.

General Staff Applicant's Signature ..... Date: .....

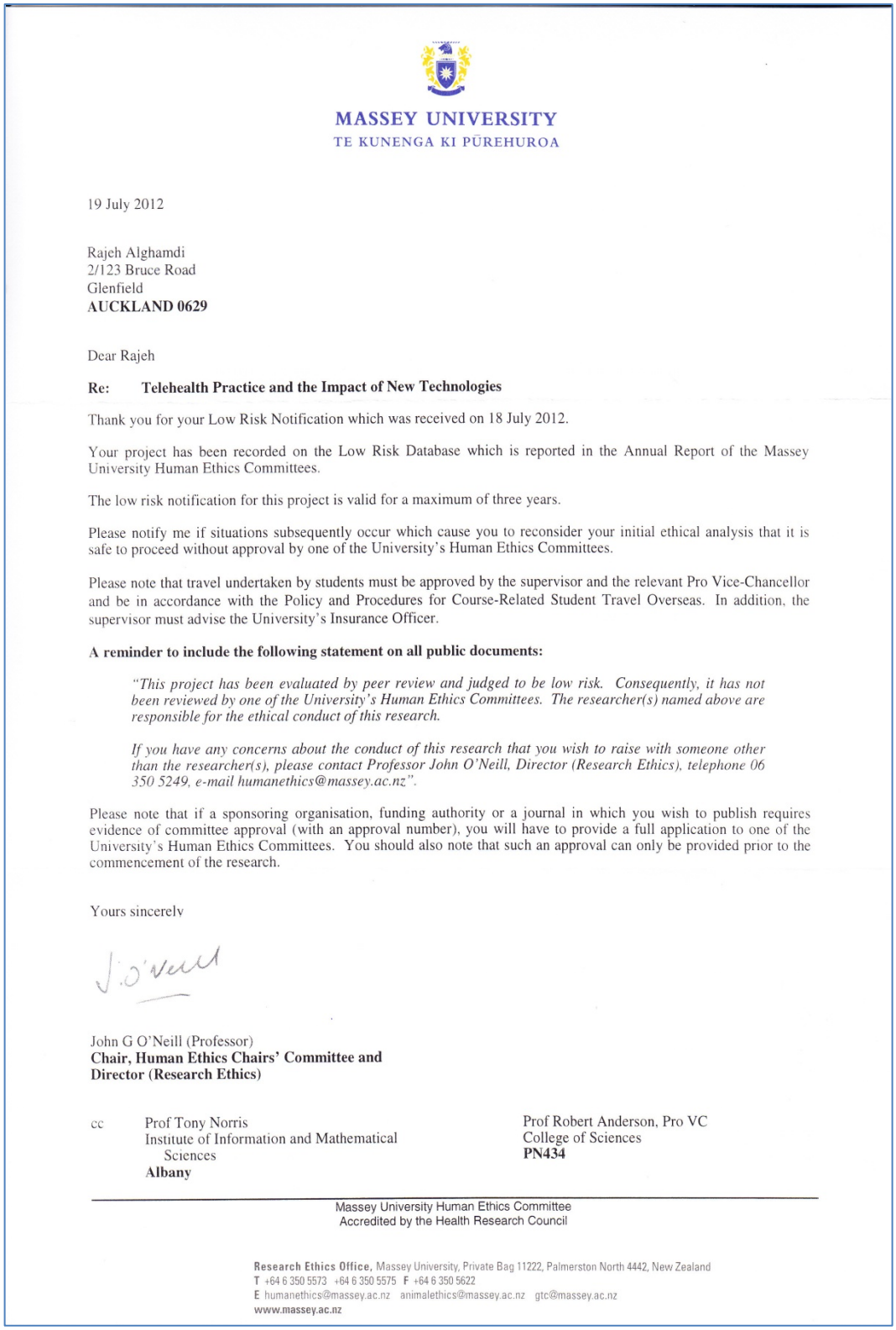
Declaration for Line Manager

I declare that to the best of my knowledge, this notification complies with the Code of Ethical Conduct for Research, Teaching and Evaluations involving Human Participants and that I have approved its content and agreed that it can be submitted.

Line Manager's Signature ..... Date: .....

Print Name .....

- The ethics approval received from MUHEC



MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA

19 July 2012

Rajeh Alghamdi
2/123 Bruce Road
Glenfield
AUCKLAND 0629

Dear Rajeh

Re: Telehealth Practice and the Impact of New Technologies

Thank you for your Low Risk Notification which was received on 18 July 2012.

Your project has been recorded on the Low Risk Database which is reported in the Annual Report of the Massey University Human Ethics Committees.

The low risk notification for this project is valid for a maximum of three years.

Please notify me if situations subsequently occur which cause you to reconsider your initial ethical analysis that it is safe to proceed without approval by one of the University's Human Ethics Committees.

Please note that travel undertaken by students must be approved by the supervisor and the relevant Pro Vice-Chancellor and be in accordance with the Policy and Procedures for Course-Related Student Travel Overseas. In addition, the supervisor must advise the University's Insurance Officer.

A reminder to include the following statement on all public documents:

> *"This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named above are responsible for the ethical conduct of this research.*
>
> *If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher(s), please contact Professor John O'Neill, Director (Research Ethics), telephone 06 350 5249, e-mail humanethics@massey.ac.nz".*

Please note that if a sponsoring organisation, funding authority or a journal in which you wish to publish requires evidence of committee approval (with an approval number), you will have to provide a full application to one of the University's Human Ethics Committees. You should also note that such an approval can only be provided prior to the commencement of the research.

Yours sincerely

J. O'Neill

John G O'Neill (Professor)
Chair, Human Ethics Chairs' Committee and
Director (Research Ethics)

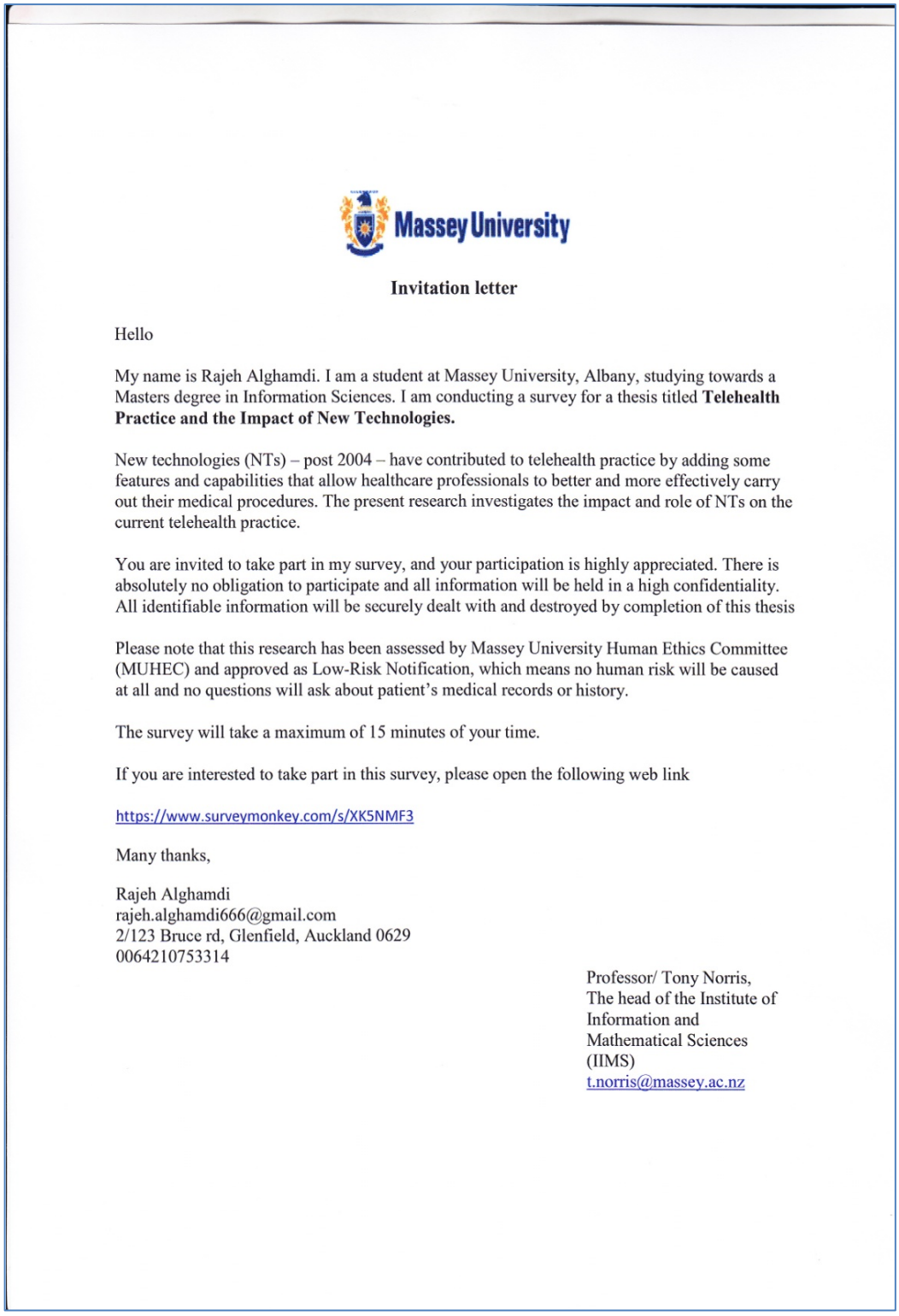
cc Prof Tony Norris
Institute of Information and Mathematical Sciences
Albany

Prof Robert Anderson, Pro VC
College of Sciences
PN434

Massey University Human Ethics Committee
Accredited by the Health Research Council

Research Ethics Office, Massey University, Private Bag 11222, Palmerston North 4442, New Zealand
T +64 6 350 5573 +64 6 350 5575 F +64 6 350 5622
E humanethics@massey.ac.nz animalethics@massey.ac.nz gtc@massey.ac.nz
www.massey.ac.nz

- Invitation letter for participation



Massey University

Invitation letter

Hello

My name is Rajeh Alghamdi. I am a student at Massey University, Albany, studying towards a Masters degree in Information Sciences. I am conducting a survey for a thesis titled **Telehealth Practice and the Impact of New Technologies.**

New technologies (NTs) – post 2004 – have contributed to telehealth practice by adding some features and capabilities that allow healthcare professionals to better and more effectively carry out their medical procedures. The present research investigates the impact and role of NTs on the current telehealth practice.

You are invited to take part in my survey, and your participation is highly appreciated. There is absolutely no obligation to participate and all information will be held in a high confidentiality. All identifiable information will be securely dealt with and destroyed by completion of this thesis

Please note that this research has been assessed by Massey University Human Ethics Committee (MUHEC) and approved as Low-Risk Notification, which means no human risk will be caused at all and no questions will ask about patient's medical records or history.

The survey will take a maximum of 15 minutes of your time.

If you are interested to take part in this survey, please open the following web link

https://www.surveymonkey.com/s/XK5NMF3

Many thanks,

Rajeh Alghamdi
rajeh.alghamdi666@gmail.com
2/123 Bruce rd, Glenfield, Auckland 0629
0064210753314

Professor/ Tony Norris,
The head of the Institute of Information and Mathematical Sciences (IIMS)
t.norris@massey.ac.nz

- Information sheet

Massey University

Information sheet

Telehealth practice and the impact of new technologies

My name is Rajeh Alghamdi. I am a student at Massey University, Albany, studying towards a Masters degree in Information Sciences. I am conducting a survey for a thesis titled "Telehealth Practice and the Impact of New Technologies".

Telehealth is becoming a very important element in healthcare sector. It can be a good way of delivering healthcare services to rural areas with a reduced cost and a faster time as well as a better quality of care. In order to obtain effective outcomes of deploying telehealth initiatives, high-quality communication technologies are needed. Communication technologies are improving very rapidly and providing more effective services and features which can affect on current telehealth practice. New technologies (NTs) – post 2004 – have contributed to telehealth practice by adding some features and capabilities that allow healthcare professionals to better and more effectively carry out their medical procedures. The present research investigates the impact and role of NTs on the current telehealth practice by surveying healthcare professionals in New Zealand. Questions included in the survey are all of a technical nature and do not ask about patient's medical information or history. They are all about technologies used in healthcare sector and ask about how these technologies contribute to telehealth practice and to what extent.

Please note that this research has been assessed by Massey University Human Ethics Committee (MUHEC) and approved as Low-Risk Notification, which means no human risk will be caused at all and no questions will ask about patient's medical records or history.

You are invited to take part in my survey, and your participation is highly appreciated. There is absolutely no obligation to participate and all information will be held in a high confidentiality. All identifiable information will be securely dealt with and destroyed by completion of this thesis. The survey has 25 questions and will take a maximum of 15 minutes of your time.

If you are interested to take part in this survey, please open the following web link:

https://www.surveymonkey.com/s/XK5NMF3

yours sincerely,

Rajeh Alghamdi
rajeh.alghamdi666@gmail.com

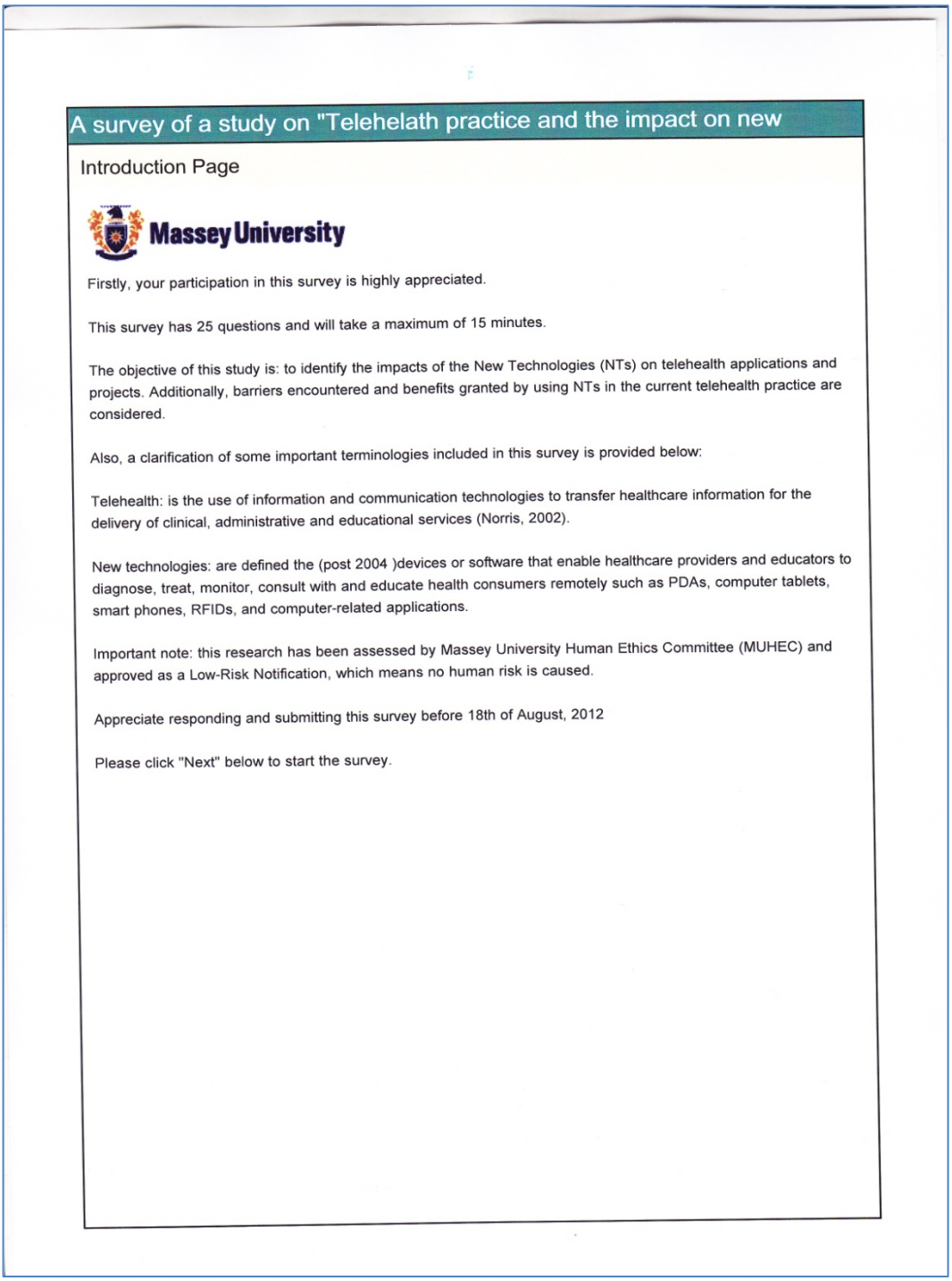
2/123 Bruce rd, Glenfield, Auckland 0629
0064210753314

Professor/ Tony Norris,
the head of the Institute of Information and Mathematical Sciences (IIMS)
t.norris@massey.ac.nz
09 443 9389

Appendix B

Online survey scans

Section 1- introduction page



A survey of a study on "Telehelath practice and the impact on new

Introduction Page

Massey University

Firstly, your participation in this survey is highly appreciated.

This survey has 25 questions and will take a maximum of 15 minutes.

The objective of this study is: to identify the impacts of the New Technologies (NTs) on telehealth applications and projects. Additionally, barriers encountered and benefits granted by using NTs in the current telehealth practice are considered.

Also, a clarification of some important terminologies included in this survey is provided below:

Telehealth: is the use of information and communication technologies to transfer healthcare information for the delivery of clinical, administrative and educational services (Norris, 2002).

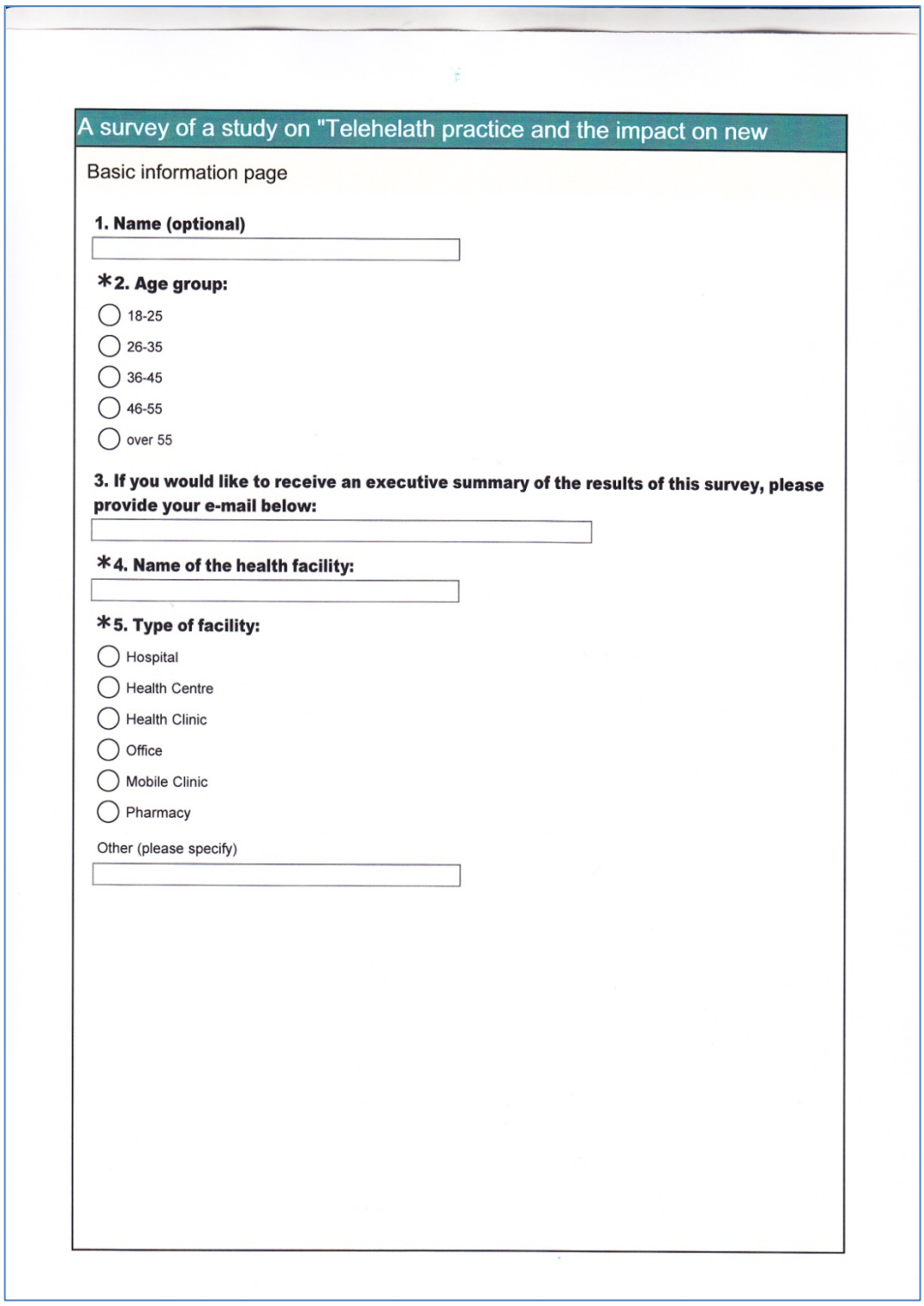
New technologies: are defined the (post 2004)devices or software that enable healthcare providers and educators to diagnose, treat, monitor, consult with and educate health consumers remotely such as PDAs, computer tablets, smart phones, RFIDs, and computer-related applications.

Important note: this research has been assessed by Massey University Human Ethics Committee (MUHEC) and approved as a Low-Risk Notification, which means no human risk is caused.

Appreciate responding and submitting this survey before 18th of August, 2012

Please click "Next" below to start the survey.

Section 2- basic information page (questions 1-5)



A survey of a study on "Telehelath practice and the impact on new

Basic information page

1. Name (optional)

***2. Age group:**

- ◯ 18-25
- ◯ 26-35
- ◯ 36-45
- ◯ 46-55
- ◯ over 55

3. If you would like to receive an executive summary of the results of this survey, please provide your e-mail below:

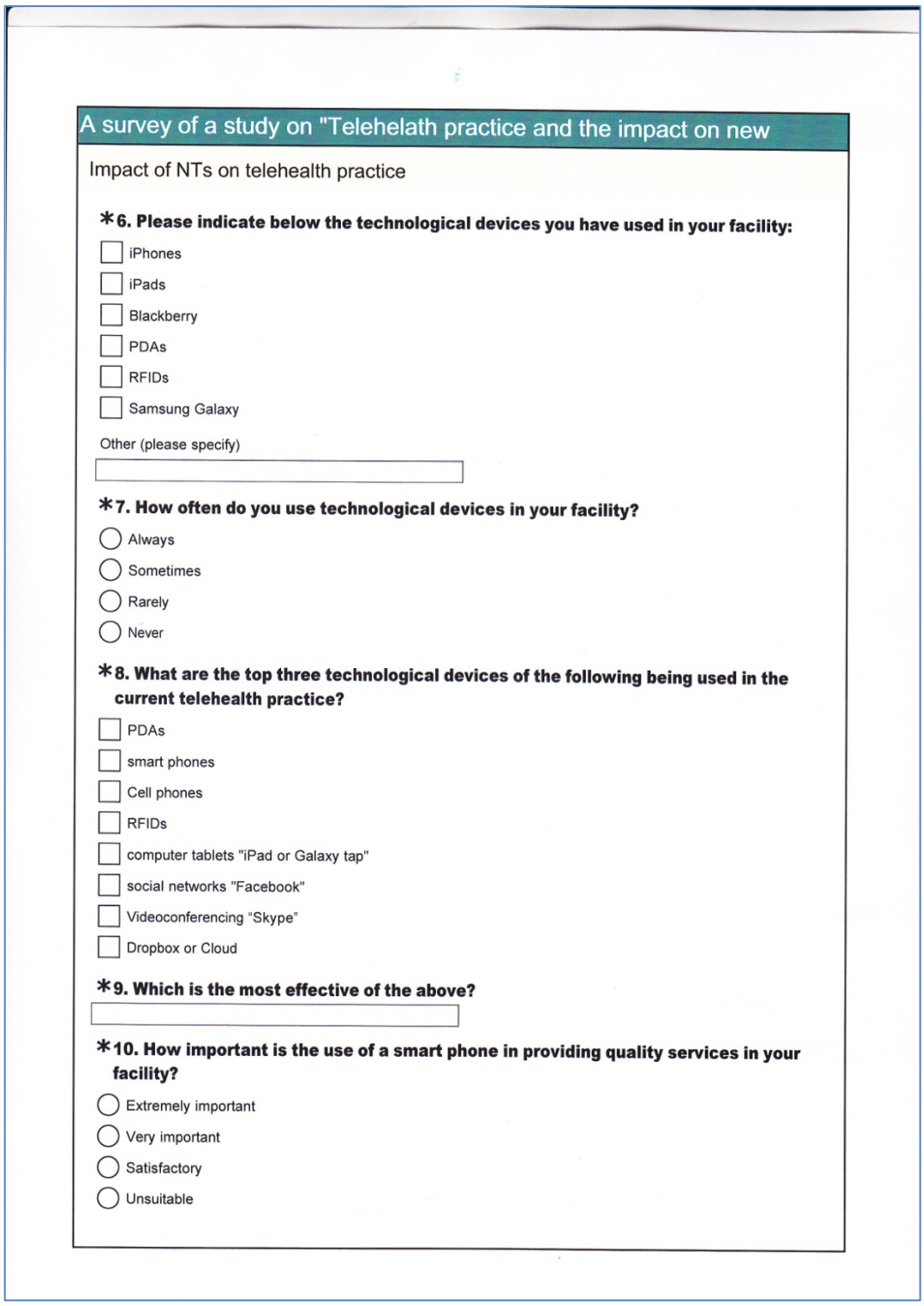
***4. Name of the health facility:**

***5. Type of facility:**

- ◯ Hospital
- ◯ Health Centre
- ◯ Health Clinic
- ◯ Office
- ◯ Mobile Clinic
- ◯ Pharmacy

Other (please specify)

Section 3- impact of NTs on telehealth, part 1 (questions 6-10)



A survey of a study on "Telehelath practice and the impact on new

Impact of NTs on telehealth practice

***6. Please indicate below the technological devices you have used in your facility:**

- [ ] iPhones
- [ ] iPads
- [ ] Blackberry
- [ ] PDAs
- [ ] RFIDs
- [ ] Samsung Galaxy

Other (please specify)

***7. How often do you use technological devices in your facility?**

- ◯ Always
- ◯ Sometimes
- ◯ Rarely
- ◯ Never

***8. What are the top three technological devices of the following being used in the current telehealth practice?**

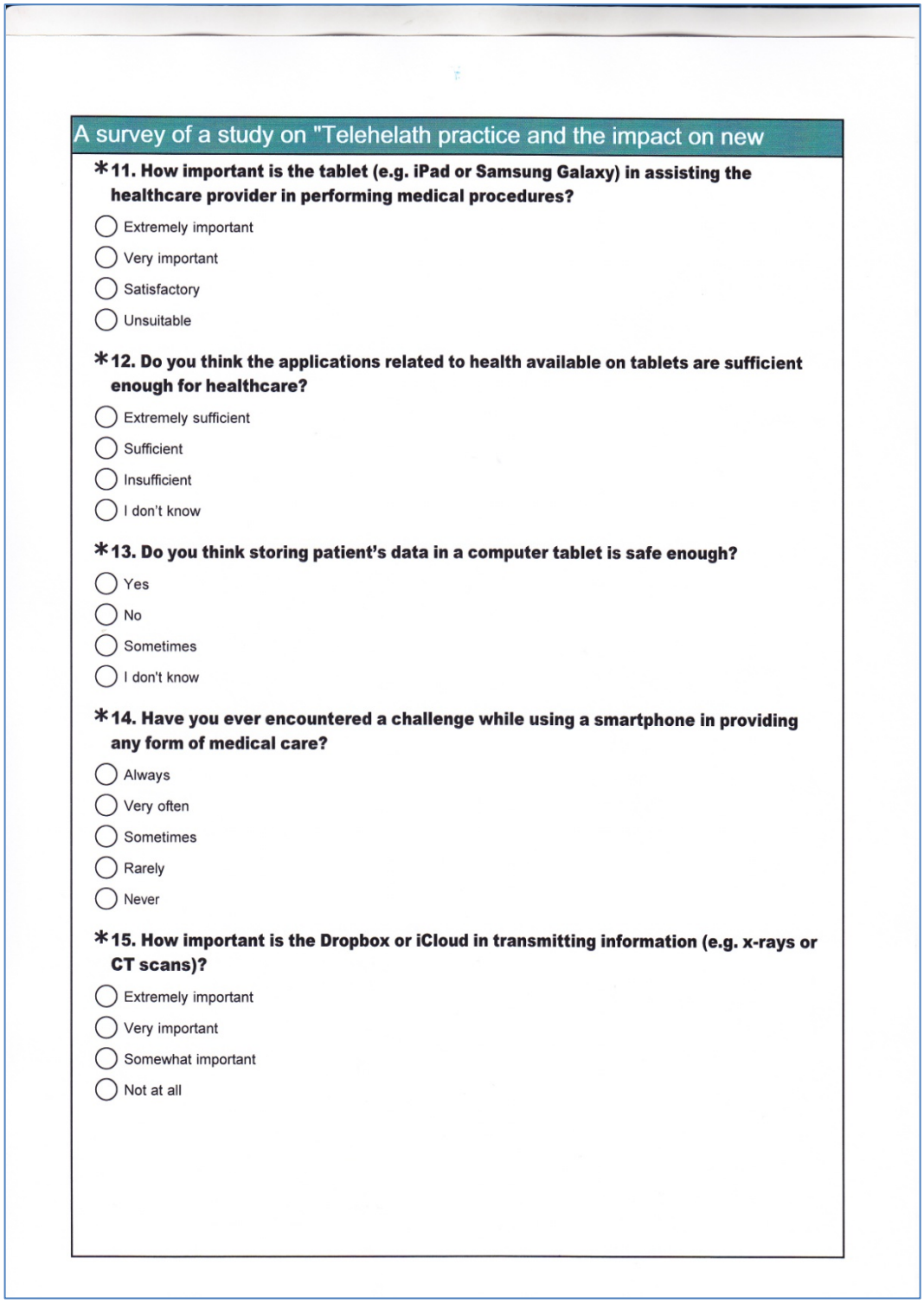
- [ ] PDAs
- [ ] smart phones
- [ ] Cell phones
- [ ] RFIDs
- [ ] computer tablets "iPad or Galaxy tap"
- [ ] social networks "Facebook"
- [ ] Videoconferencing "Skype"
- [ ] Dropbox or Cloud

***9. Which is the most effective of the above?**

***10. How important is the use of a smart phone in providing quality services in your facility?**

- ◯ Extremely important
- ◯ Very important
- ◯ Satisfactory
- ◯ Unsuitable

Section 3- impact of NTs on telehealth, part 1 cont. (questions 11- 15)



A survey of a study on "Telehelath practice and the impact on new

***11. How important is the tablet (e.g. iPad or Samsung Galaxy) in assisting the healthcare provider in performing medical procedures?**

- ◯ Extremely important
- ◯ Very important
- ◯ Satisfactory
- ◯ Unsuitable

***12. Do you think the applications related to health available on tablets are sufficient enough for healthcare?**

- ◯ Extremely sufficient
- ◯ Sufficient
- ◯ Insufficient
- ◯ I don't know

***13. Do you think storing patient's data in a computer tablet is safe enough?**

- ◯ Yes
- ◯ No
- ◯ Sometimes
- ◯ I don't know

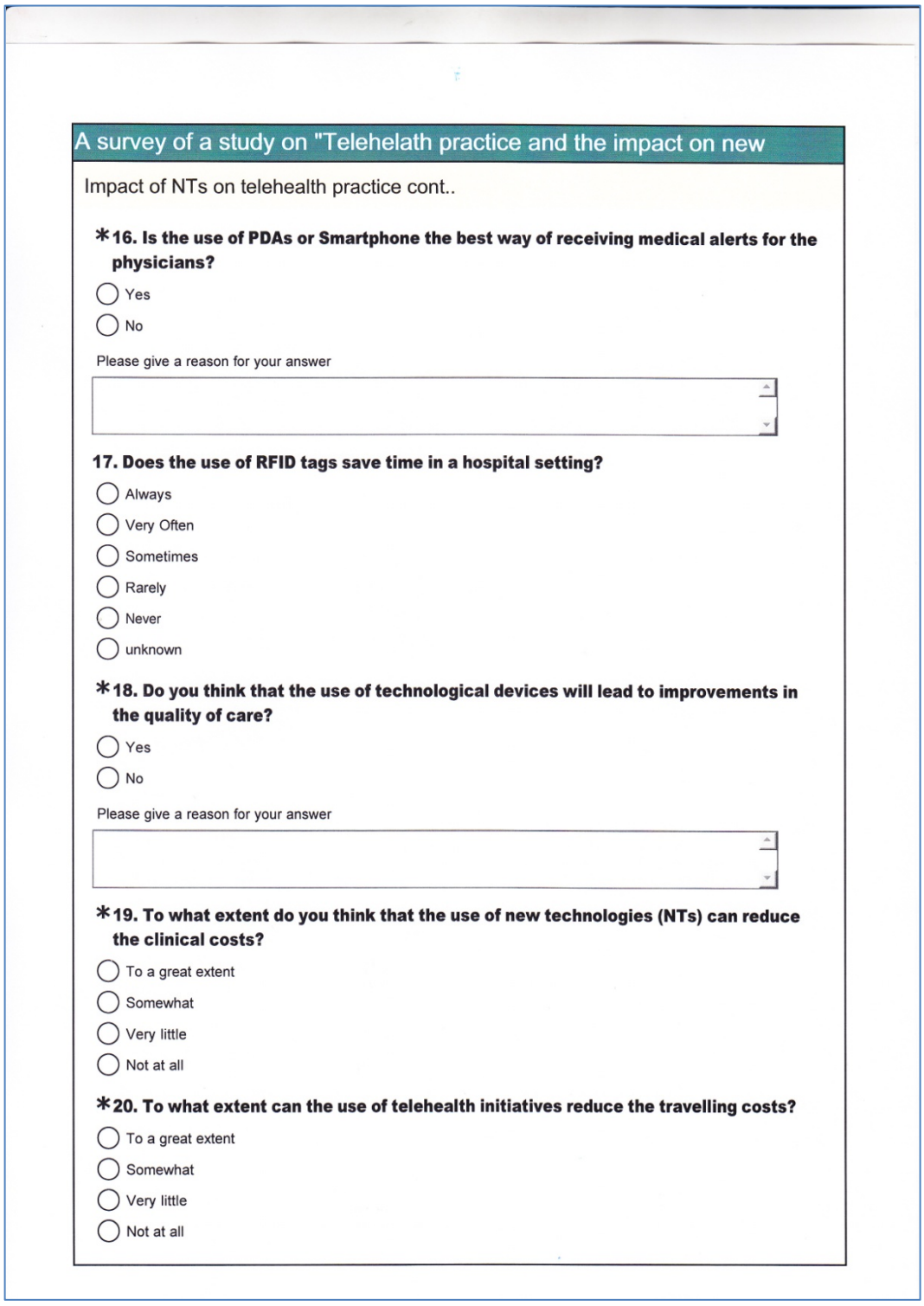
***14. Have you ever encountered a challenge while using a smartphone in providing any form of medical care?**

- ◯ Always
- ◯ Very often
- ◯ Sometimes
- ◯ Rarely
- ◯ Never

***15. How important is the Dropbox or iCloud in transmitting information (e.g. x-rays or CT scans)?**

- ◯ Extremely important
- ◯ Very important
- ◯ Somewhat important
- ◯ Not at all

Section 3- impact of NTs on telehealth, part 2 (questions 16-20)



A survey of a study on "Telehelath practice and the impact on new

Impact of NTs on telehealth practice cont..

***16. Is the use of PDAs or Smartphone the best way of receiving medical alerts for the physicians?**

- ◯ Yes
- ◯ No

Please give a reason for your answer

17. Does the use of RFID tags save time in a hospital setting?

- ◯ Always
- ◯ Very Often
- ◯ Sometimes
- ◯ Rarely
- ◯ Never
- ◯ unknown

***18. Do you think that the use of technological devices will lead to improvements in the quality of care?**

- ◯ Yes
- ◯ No

Please give a reason for your answer

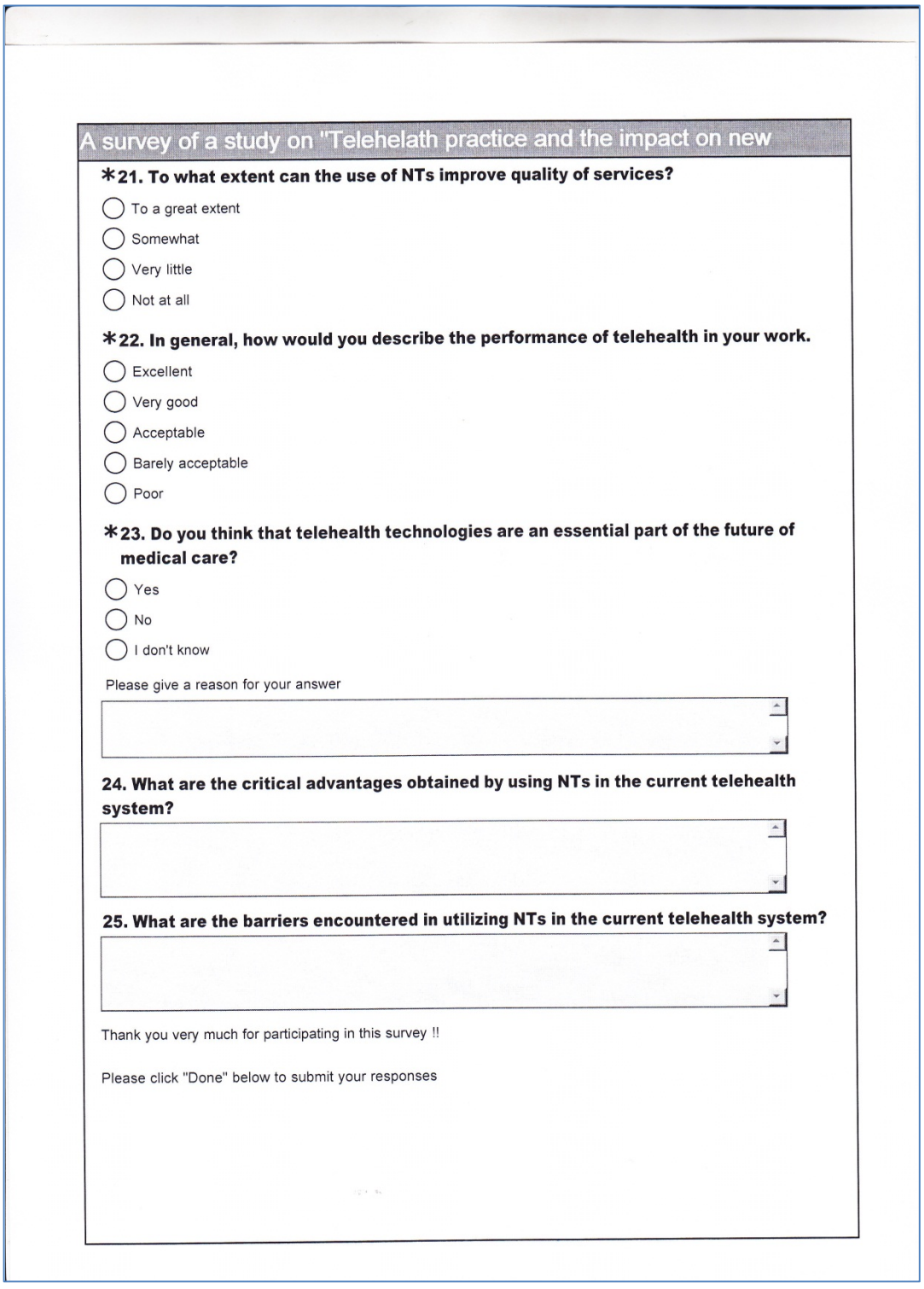
***19. To what extent do you think that the use of new technologies (NTs) can reduce the clinical costs?**

- ◯ To a great extent
- ◯ Somewhat
- ◯ Very little
- ◯ Not at all

***20. To what extent can the use of telehealth initiatives reduce the travelling costs?**

- ◯ To a great extent
- ◯ Somewhat
- ◯ Very little
- ◯ Not at all

Section 3- impact of NTs on telehealth, part 2 cont. (questions 21-25)



A survey of a study on "Telehelath practice and the impact on new

***21. To what extent can the use of NTs improve quality of services?**

- ◯ To a great extent
- ◯ Somewhat
- ◯ Very little
- ◯ Not at all

***22. In general, how would you describe the performance of telehealth in your work.**

- ◯ Excellent
- ◯ Very good
- ◯ Acceptable
- ◯ Barely acceptable
- ◯ Poor

***23. Do you think that telehealth technologies are an essential part of the future of medical care?**

- ◯ Yes
- ◯ No
- ◯ I don't know

Please give a reason for your answer

24. What are the critical advantages obtained by using NTs in the current telehealth system?

25. What are the barriers encountered in utilizing NTs in the current telehealth system?

Thank you very much for participating in this survey !!

Please click "Done" below to submit your responses

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