GUIDELINES FOR THE EFFECTIVE USE OF TELEMEDICINE IN PUBLIC HEALTHCARE IN RESOURCE CONSTRAINED SETTINGS

K.T. KATIVU

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GUIDELINES FOR THE EFFECTIVE USE OF TELEMEDICINE IN PUBLIC HEALTHCARE IN RESOURCE CONSTRAINED SETTINGS

By

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DECLARATION

I, Kevin Kativu (207059581), hereby declare that the dissertation for Magister Technologiae in Information Technology is my own work and that it has not previously been submitted for assessment or completion of any postgraduate qualification to another University or for another qualification.

Kevin Kativu

ABSTRACT

On September 8 2000, world leaders gathered at the United Nations summit and resolved to help citizens in the world's poorest countries to achieve a better life by the year 2015. This resolve was outlined in the Millennium Development Goals that were subsequently published with goals 4, 5 and 6 specific to healthcare. The integration of ICT's in the remote delivery of services has opened new avenues from which centralised, scarce resources can be accessed remotely for the benefit of the general population. Telemedicine has made great strides in the developed world with remote populations benefiting from the improved access to healthcare. In the Eastern Cape Province of South Africa, the sub-field of teleradiology has shown promise for enabling the wider delivery of specialist services. However, in resource constrained settings such as developing countries, telemedicine has had limited success and as a result, the equitable access to healthcare for remote populations remains inconceivable. This is exacerbated by the migration of healthcare professionals both domestically and internationally. The public sector has suffered the most with acute staff shortages in the public healthcare institutions, more so in rural and remote areas. This study identifies the prevailing challenges posing as barriers to the effective use of telemedicine services in the Public health sector in resource constrained settings and provides recommendations and guidelines aimed at facilitating the adoption and effective use of telemedicine. Challenges are identified from literature and from the first person accounts of specific role-players who are directly involved with telemedicine in their respective institutions. Participants are drawn from institutions offering telemedicine services within the Eastern Cape Province of South Africa. Challenges identified from literature are collated with those identified from the participant interviews to provide a concise list of factors that is used as input to the recommendation and guideline development process. The results thus far point to an enthusiastic environment coupled with a semi-capable infrastructure but however hampered by staff shortages and a general lack of support structures and propulsion mechanisms to adequately encourage the wider use of telemedicine. The proposed guidelines aim to address the challenges at the different role-player levels.

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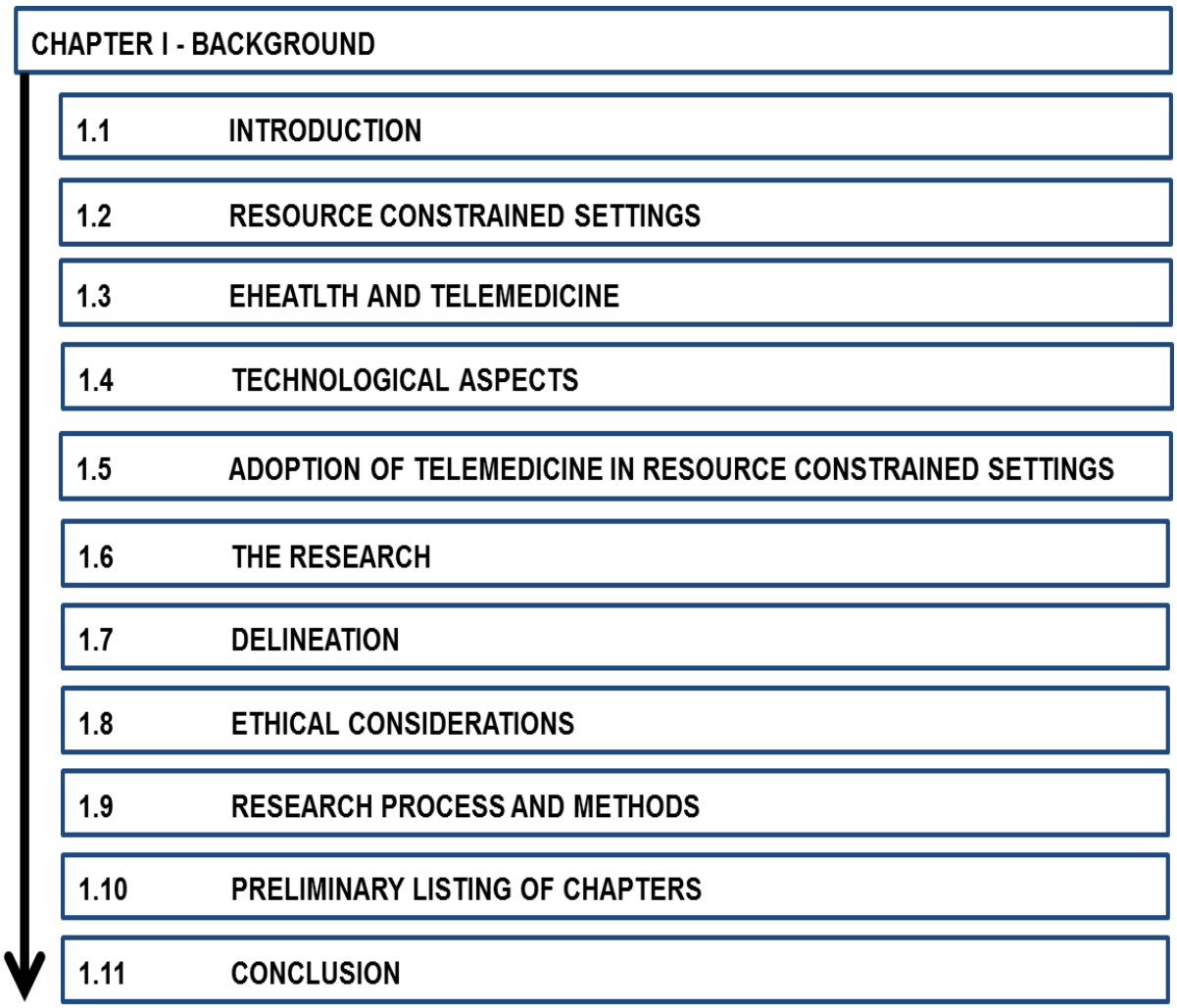
LIST OF ACRONYMS

Acronym	Description
CT	Computed Tomography
ECDOH	Eastern Cape Provincial Department of Health
ECG	Electrocardiogram
HDI	Human Development Index
HOD	Head of Department
HRH-SA	Human Resources for Health - South Africa
ICT	Information and Communication Technologies
IT	Information Technology
ITU	International Telecommunications Union
MDG	Millennium Development Goals
MRI	Magnetic Resonance Interface
MTSF	Medium Term Strategic Framework
NDOH	National Department of Health
OECD	Organisation for Economic Co-operation and Development
PACS	Picture Archiving and Communication System
PDOH	Provincial Department of Health
TOE	Technology, Organisation, Environment
UN	United Nations
UNDP	United Nations Development Program
UPS	Uninterruptable Power Supply
USD	United States Dollar
WHO	World Health Organisation

CHAPTER I BACKGROUND



1.1 Introduction

The recent advances in the Information and Communications Technology (ICT) field have had a profound effect on the accessibility of medical services, primarily in previously remote and disadvantaged areas. Mars and Dlova (2008) report that South Africa, and the rest of Sub-Saharan Africa face a shortage of medical practitioners. This problem is most persistent in Africa and its effects are particularly severe in the public sector. The shortage of health workers and medical practitioners can be attributed to a large range of factors which include the persistent movement or ‘brain drain’ of health workers from the less developed countries, as suggested by Wadda (2000). Additionally, The Human Resources for Health South Africa (HRH)

(2011) cite a lack of employment opportunities and an unfavourable working environment in the public sector as a major pushing factor in health professionals migrating. Table 1.1 summarizes the current state of the health sectors in both the developed and developing countries

WHO Region	Number of countries		In countries with shortage		
	Total	With shortages	Total stock	Estimated shortage	% increase required
Africa	46	36	590 198	817 992	139
Americas	35	5	93 603	37 886	40
South-East Asia	11	6	2 332 054	1 164 001	50
Europe	50	0	n/a	n/a	n/a
Eastern Mediterranean	21	7	312 613	306 031	98
Western Pacific	27	3	27 260	32 560	119
World	192	57	3 355 728	2 358 470	70

Table 1.1: Estimated Critical Shortages of Doctors, Nurses and Midwives, by WHO Region: Sourced: WHO (2006) [a]

Table 1.1 illustrates the difference between the number of African countries with shortages (36 of 46) and European countries (0 of 0). In 2006, the World Health Organisation (WHO) estimated that at least 2 360 000 health service providers and 1 890 000 management support workers, or a total of 4 250 000 health workers, are needed to fill the health workforce gap (WHO, 2006).

Table 1.2 presents the availability of the health workforce by population density in the different continents. This further elaborates on how the shortage of health workers and medical practitioners can have a crippling effect on the patient to practitioner ratios. Africa and the Eastern Mediterranean continents (as typically resource constrained settings) have the worst figures.

WHO region	Total health workforce		Health service providers		Health management and support workers	
	Number	Density /1000 population	Number	% of total heath workforce	Number	% of total health workforce
Africa	1 640 000	2.3	1 360 000	83	280 000	17
Eastern Mediterranean	2 100 000	4.0	1 580 000	75	520 000	25
South-East Asia	7 040 000	4.3	4 730 000	67	2 300 000	33
Western Pacific	10 070 000	5.8	7 810 000	78	2 260 000	23
Europe	16 630 000	18.9	11 540 000	69	5 090 000	31
Americas	21 740 000	24.8	12 460 000	57	3 280 000	43
World	59 220 000	9.3	39 470 000	67	19 750 000	33

Table 1.2: Global Health Workforces by Density: Sourced: WHO (2006) [b)]

Table 1.2 shows Africa as having 2.3 heath workers per 1000 people while Europe and the Americas have 18.9 or 24.8 health workers per 1000 people respectively. This serves to further highlight the shortage crisis in resource constrained settings. Table 1.3 summarises push and pull factors that have contributed to the existing migration trends.

Push factors	Pull factors
Low pay (absolute and/or relative)	Higher pay & remittance opportunities
Poor working conditions	Better working conditions
Lack of resources to work effectively	Better resources health systems
Limited career opportunities	Career opportunities
Limited educational opportunities	Provision of post-basic education
Impact of HIV and AIDS	Political stability
Unstable/dangerous working environment	Travel opportunities
Economic instability	Aid work

Table 1.3: Push and pull migration factors. Sourced HRH- SA (2011)

Haas, Glymour, and Berkman (2011) explain that the push and pull factors driving the migration of health workers are not specific to healthcare but apply to the migration of skilled workers in general. Schrecker and Labonte (2002) further attribute the migration flow of health professionals to the push, pull and stick effects as illustrated in the diagrammatic summarisation of Table 1.3 in Figure 1.1.

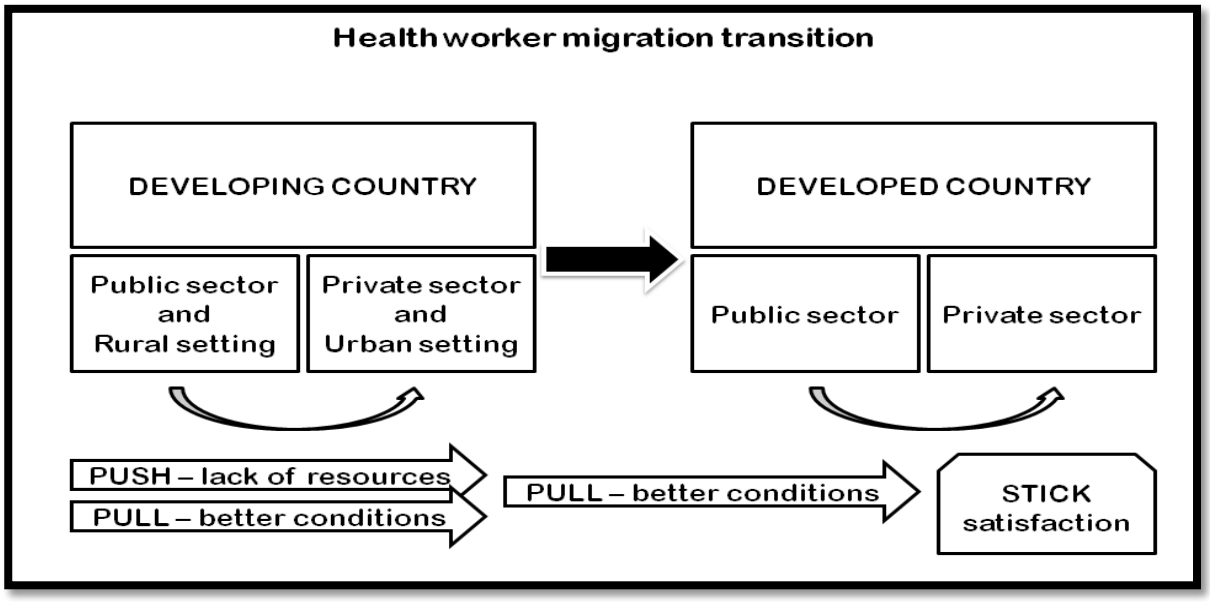


Figure 1.1: Push and pull migration factors

The push effects have been described by Haas et al.(2011) as the reasons why people might want to emigrate and the *pull* effects as reasons why a country might attract immigrants. These effects are present on domestic, regional and international levels and are characterized by an open ended drive towards the international level.

According to Grignon and Sweetman (2012), the shortage of health care professionals in developed countries can be perceived to be the key driver to the migration of healthcare professionals from developing countries. So much so that in 2010, the WHO adopted a global code of practice adopted by 193 member states on the international recruitment of health personnel with a focus on ethics and protecting less-developed sending countries (Taylor, Hwenda, Larsen, & Daulaire, 2011). To put this further into perspective, in 2006, the WHO identified 57 countries with a critical health worker shortage and of these, 36 were from Sub-Saharan Africa (Haas et al., 2011).

There is, therefore, a growing need to utilise the scarce resources more effectively to improve the distribution and the quality of health services in resource constrained settings.

1.2 Resource Constrained Settings

The United Nations maintains a Human Development Index (HDI) that aids in differentiating developed countries from developing countries. Developing countries are those with a HDI from medium to low as illustrated in Figure 1.2.

Developing countries, in the general sense, are typically considered resource constrained. Africa, Eastern Mediterranean, South-East Asia and the Western Pacific emerge with medium to low HDI figures. As co-published by the Organisation for Economic Co-operation and Development (OECD) and World Health Organisation (2008), in 2000, (based on WHO calculations), a figure of USD 60 per capita was marked as the requirement for a comprehensive health system; however, developing countries were spending an estimate of USD 11 per capita per annum.

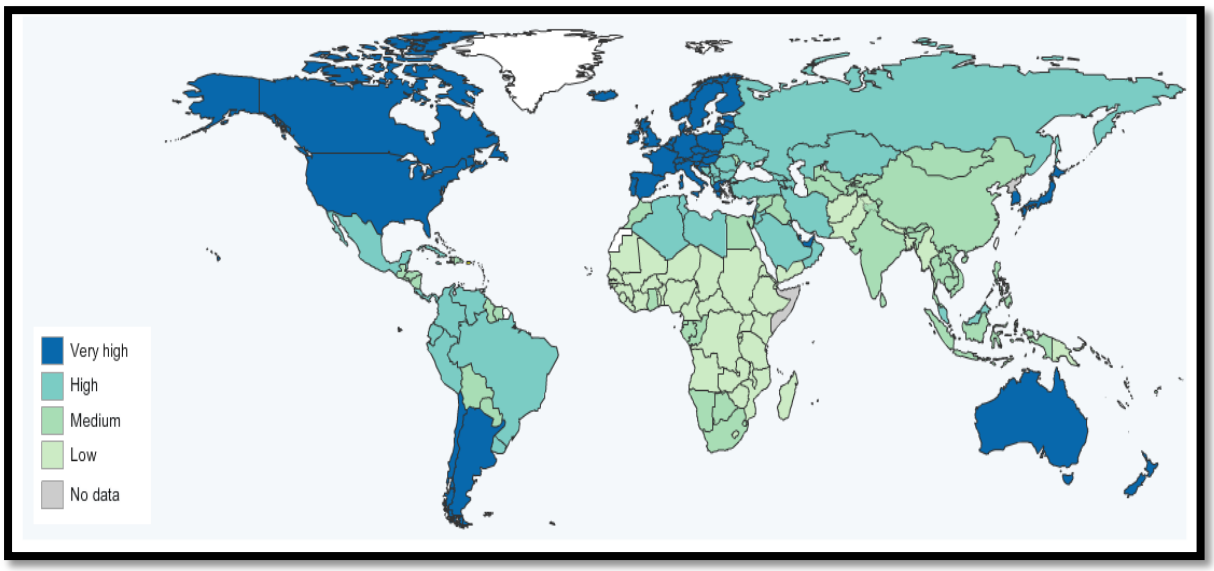


Figure 1.2: Human Development Index Values 2011: (*United Nations 2011)*

It is important to note that resource constrained settings may exist as a subset of both developed and developing countries despite being primarily located in developing countries. Figure 1.2 provides general indications of where resource constrained settings are most likely to exist but does not explicitly identify them.

Developing countries generally have an inadequate National Health Service delivery system. The OECD and WHO (2008) note how in many developing countries, the public sector lacks the capacity to deliver health services to the entire population. Furthermore, the primary beneficiaries of these limited health services are the urban community, which is particularly problematic considering Mars and Seebregts (2008), suggest an estimated 46% of South Africans reside in rural areas and the WHO further suggests an estimated 50% of the global population resides in rural areas (WHO, 2010a).

Developed countries, on the other hand, tend to have good National Health Service delivery systems. Their focus is justifiably on the urban centres where the majority of the population reside. Edworthy (2001) consequently argues that the development of ICT facilitated health services may have a more profound effect in developing countries than developed countries.

The term “resource constrained settings” describes the typical scenario in the remote areas of developing countries as well as the public healthcare systems and for this reason; this study uses the term to describe the underfunded and typically low-staffed, public health sector in developing countries.

The use of Information and Communication Technologies for example, eHealth and Telehealth, to facilitate health services in resource constrained settings, has a broad scope. It is important to describe how these different facets relate to each other.

1.3 eHealth and Telemedicine

eHealth is defined as *“the cost-effective and secure use of information and communications technologies in support of health and health-related fields, including health-care services, health surveillance, health literature, and health education, knowledge and research”* (ITU Technology Watch, 2011). Healy, (2008) further describes eHealth as enabling, among other things, the exchange of healthcare and administrative data and the transfer of medical images and laboratory results. Figure 1.3 illustrates the relationship between eHealth and its constituent parts.

Telehealth is used to encompass a broader definition of remote healthcare which includes telemedicine. Telehealth, however, does not always include the aspects of delivering clinical services.

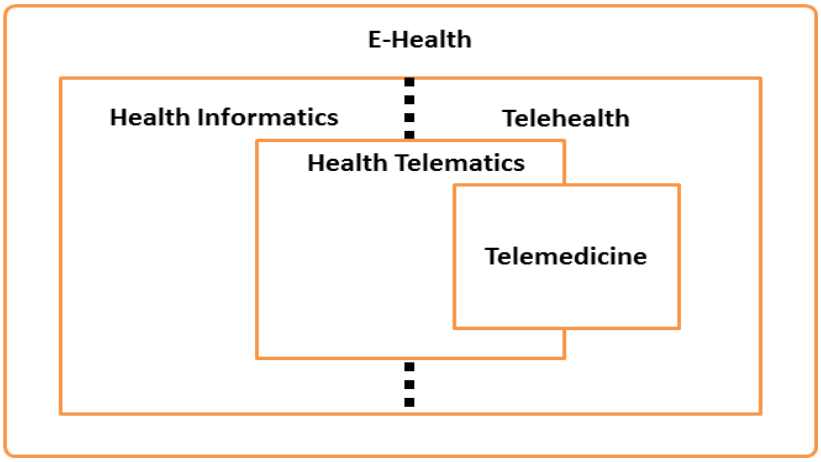


Figure 1.3: The eHealth Domain. (*Armenian Association of Telemedicine 2012)*

Telemedicine can be defined as the use of ICT's to provide remote medical and clinical services. Hersh et al. (2006) define telemedicine as the use of telecommunications technology for medical diagnostic, monitoring, and therapeutic purposes where distance and/or time separate the patient and health care provider. This definition of telemedicine emphasises the interaction of the practitioner / clinician with the patient.

Health informatics deals with the ICT resources, devices, and methodologies involved in the delivery of healthcare services. Within health informatics, the conjoined subfield of health telematics is found.

Health telematics is defined by the WHO as a composite that covers the health-related activity, services and systems that use ICT's to deliver remote healthcare (Rigby & Roberts, 2000). Telemedicine, according to the WHO definition, is, therefore, the use of health telematics to deliver healthcare over distances by clinicians or medical practitioners.

Telemedicine emerges as a potential solution to address the shortage of heath care workers and medical practitioners. Wright and Androuchko (1996) highlight the role

telemedicine has in reducing the current shortage of resources in the medical field. These resources include trained medical workers, medical facilities, equipment and infrastructure.

A definition by the American Telemedicine Association, by including additional aspect of education, broadens the scope. This can be either the education of the practitioner or the patient with the goal of improving patient care (Spooner & Gotlieb, 2004). Education plays a crucial role in ensuring that the technology is used effectively and the provisioned health services are acceptable by the current standards.

Whitacre (2011) additionally describes telemedicine as having an economic impact on rural communities. These result from reduced travel (lower transportation costs) and greater productivity due to the decrease in missed work time. Additionally, it offers employment opportunities within the rural communities stemming from the increased local laboratory and pharmaceutical activity.

1.4 Technological Aspects

Spooner and Gotlieb (2004) describe the information transferred in a telemedicine exchange as including the following:

- Live bi-directional audio or video, recorded audio or video sent after the encounter (store and forward technology) medical records;
- Medical images sound or outputs from medical devices such as pulmonary function instruments, electrocardiographs, and ultrasonography devices.

The techniques used for the transfer of this information depend on the application. Mars and Dlova (2008) identified two broad but distinct categories within the techniques used for telemedicine practice, namely store-and-forward and Real-time technologies.

Pandian, Safeer, Shakunthala, Gopal, and Padaki (2007) describe how store and forward techniques can be used for transferring medical data and digital images between locations asynchronously, examples include Electrocardiography (ECG), X-

Rays, Computerised Tomography (CT) and Magnetic Resonance Images (MRI) to mention a few.

The common Real-time techniques typically use video conferencing or two-way interactive televisions as described by Collins, Nicolson, and Bowns (2000). This provides a simulation of the face-to-face experience that a patient and practitioner would typically enjoy in a physical consultation. This type of interaction gives the feeling of being physically present in a remote location and can be termed as telepresence.

Advances in technology have created new dimensions in the traditional Real-time Techniques. Mishra (2005) describes telesurgery as a procedure or intervention performed on an inanimate trainer, animate model or patient in which the surgeon or operator is not at the operation site. Additionally, the aspects of telerobotics and telementoring may come into play.

Telerobotics is essentially the use of a remote controlled robotic device to interact with objects in a remote environment. Telementoring refers to the collaborative support that an experienced surgeon may offer a less experienced counterpart in an operational environment. Teleproctoring emerges as a sub-field of Telementoring in which the performance of a trainee surgeon is remotely evaluated during the mentoring process.

The benefits of these advanced real-time techniques include savings in cost, time and improved convenience. Furthermore, telementoring and telerobotics result in higher accuracy resulting from expert collaboration and the precision of robotic equipment.

1.5 Adoption of Telemedicine in Resource Constrained Settings

There has been significant progress in the adoption of telemedicine, however, the penetration and further propagation of this technology is stunted. Jack and Mars (2008) identified the leading causes as being technical and organisational challenges, on-going training, and resistance to change, amongst others. The authors substantiate their findings by highlighting that in South Africa, in 2010, the

National Department of Health (NDOH) placed a moratorium that effectively prohibits the launching of any new telemedicine projects until a strategy that could ensure their success was in place.

Further limitations to the adoption of telemedicine were identified in a pilot project in Mali (Western Africa) named Keneya Blown. In their study, Geissbuhler, Ly, Lovis, and L'Haire (2003) identified the shortage of power supply, lack of bandwidth and the availability of adequately skilled professionals as factors that affect the effective adoption of telemedicine. These limitations are characteristic of resource constrained settings.

In Nigeria, Godstime, Kayode, and Halilu (2009) evaluated a telemedicine pilot project by the National Space Research and Development Agency. Communications, funding, organisational and institutional factors were identified as barriers to the effective running of the pilot project.

Jordanova and Lievens (2011) identified the issues of remuneration as posing a barrier. Many insurance companies still need to recognise telemedicine as practice. Hence, practitioners and clinicians are reluctant to use telemedicine systems. Jordanova and Lievens (2011) further explain how the public health care sector in South Africa is run by the government, who remunerate the public health care workers. Consequently, issues such as the development of incentive schemes and the remuneration for telemedicine become a problem. This lack of incentive, especially at the service referral site, has been cited as one of the major factors contributing to the failure of telemedicine in the Eastern Cape.

In 2011, the NDOH successfully developed an eHealth strategy aligned with the strategic priorities of the health sector. This document was endorsed by the National and Provincial heads of health on the 23rd of March, 2012 and further endorsed by the national Health council on the 19th of April, 2012 (NDOH , 2012). The strategies outlined in the document aim to assist in the implementation of eHealth on a national scale. Telemedicine is included in these new strategies.

1.6 The Research

PROBLEM DEFINITION
Research has shown that the use of telemedicine has the potential to reduce service delivery costs and cushion the public health sector in resource constrained locales from the health worker shortage crisis. However, telemedicine has not adequately established itself beyond the pilot phase in resource constrained settings particularly in the area of state funded or Public Health care. The primary problem to be addressed in this research is, therefore, the poor adoption and sustainability of telemedicine in the public health sector in resource constrained areas.

RESEARCH QUESTIONS		
Primary Research Question	*What measures can be put in place to improve the effective adoption and sustainability of telemedicine in resource constrained settings?*	
Secondary Research Questions	1	*How can telemedicine contribute to an improved health service delivery system?*
	2	*What are the factors that pose a barrier to the effective adoption and sustainability of telemedicine in resource constrained settings?*
	3	*What guidelines can be implemented to support the effective and sustained use of telemedicine within the abovementioned context?*

RESEARCH OBJECTIVES		
Primary Research Objective	The drafting of guidelines for the effective and continual use of telemedicine technologies in public health service delivery for resource constrained settings	
Secondary Research Objectives	1	*Investigate the contribution of telemedicine to an improved health delivery system.*
	2	*Identify the possible barriers to the effective adoption and propagation of telemedicine in resource constrained settings.*
	3	*Establish guidelines and recommendations that can be implemented to enhance the prospects of a sustainable telemedicine implementation in resource constrained settings.*

1.7 Delineation

This study aims to provide guidelines that are generalizable to resource constrained settings as described in section 1.2. The sample for the collection of primary data is limited to public health care facilities in the Eastern-Cape Province of South Africa.

Perret, (2001) suggests that the Eastern Cape is one of the poorest provinces in South Africa. According to the ECDOH as at 2008, the population distribution spread was 63.4% rural and 36.6% urban. A further 64.4% of the population lived in poverty and the unemployment rate was 52.6% (ECDOH, 2008). To further compound the situation, approximately 93.6% of the population of the Eastern Cape relies on the public health services for health care.

The Eastern Cape Province presents an accurate representation of a resource constrained setting based on the above-mentioned demographics.

1.8 Ethical Considerations

Ethical clearance was obtained from the Nelson Mandela Metropolitan University Ethical Clearance Committee before conducting the research (attached as Appendix I). Based on this clearance, the ECDOH gave permission for the conducting of this study in public health institutions within the province (attached as Appendix II).

1.9 Research Process & Methods

This section reviews the research process and associated methods applied in this research and are illustrated in Figure 1.4. The research methods are qualitative and their suitability is discussed in Chapter II.

As shown in Figure 1.4, the identification of the research questions led to the collection of data using literature reviews and interviews as research instruments. This led to the analysis of the collated data to produce a concise list of factors. These factors were then used as input to the recommendation and guideline development process.

1.9.1 Literature Review

A literature review was conducted to identify the factors affecting the adoption and sustained use of telemedicine from the viewpoint of published authors. The list of identified factors was used to theme the interview questions and was later collated with the empirical evidence from the interviews to provide a concise list of factors as input to the development of the guidelines.

1.9.2 Interviews

Interviews were used to collect the empirical evidence from the perspective of the participants. The interviews involved the collection of a first person narrative from the participants regarding their daily activities that fall under the scope of telemedicine. The list of factors identified from the interviews was later collated with the list of factors identified in the literature review to provide input into the recommendation and guideline development process.

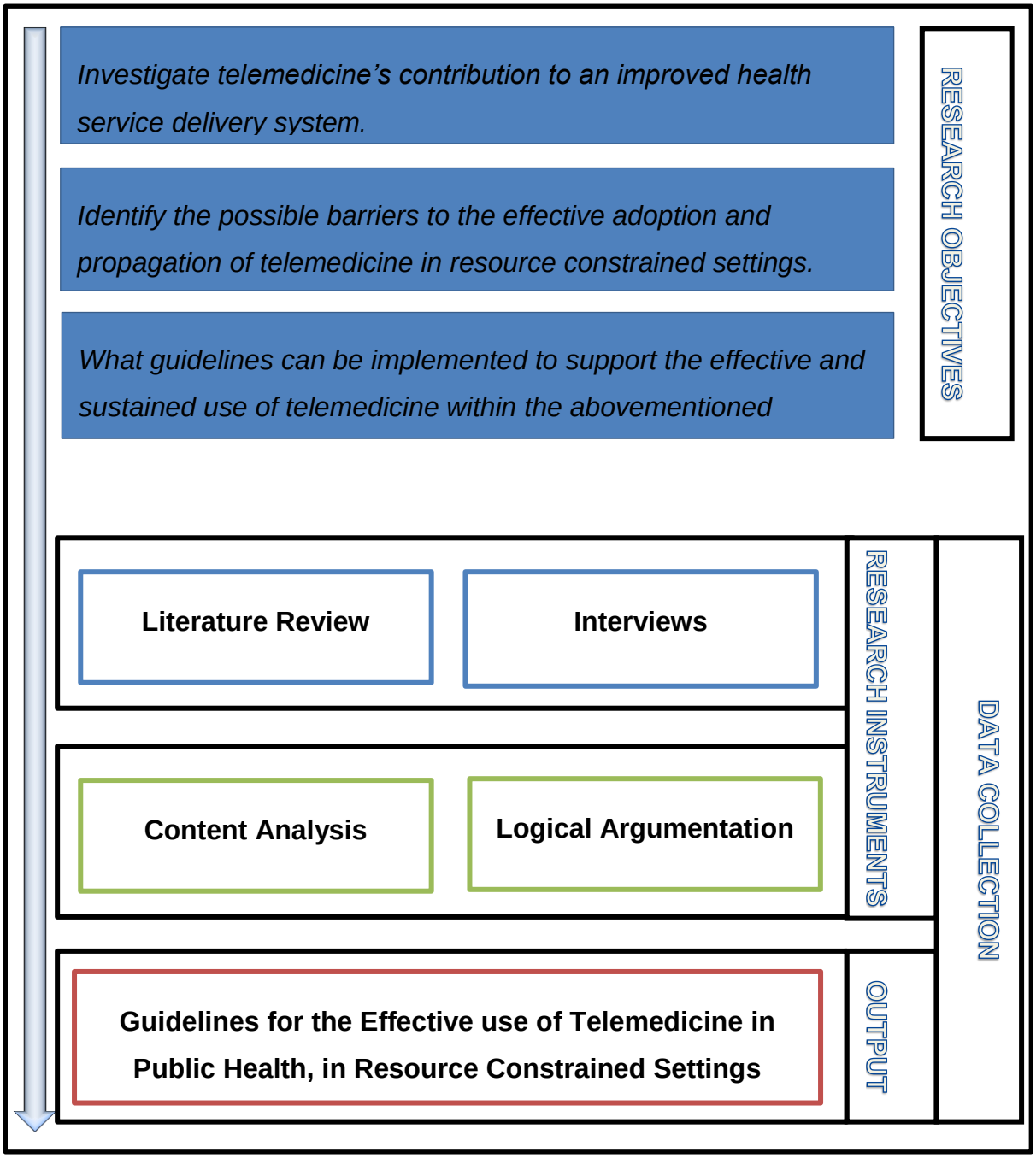


Figure 1.4: Research Process and Methods.

1.9.3 Content Analysis

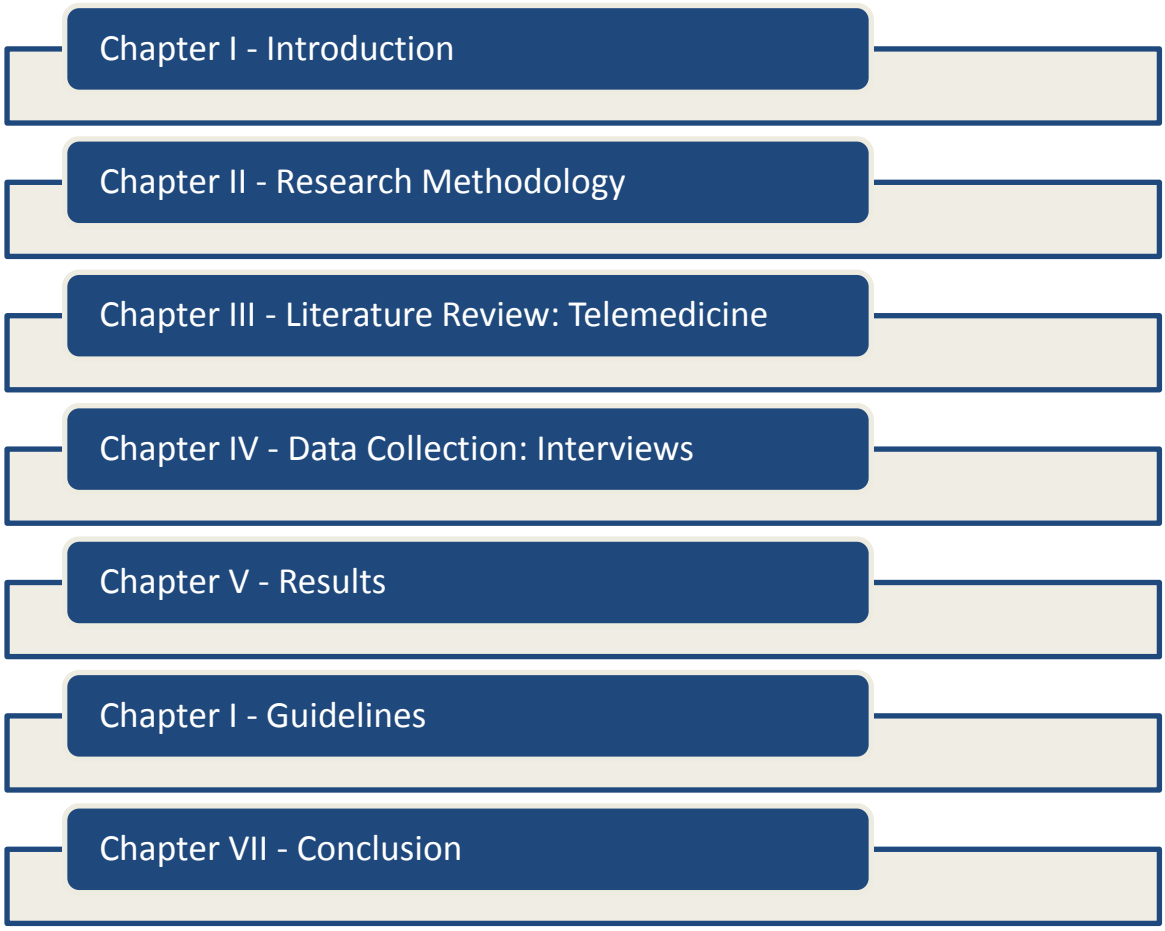
Qualitative content analysis techniques were employed to derive themes from the recorded interview data. This was used to process the intermediate findings by making use of coding and theming strategies to identify points of interest within the collected empirical data.

1.9.4 Logical Argumentation

Logical argumentation was used in the discussion of the findings as informed by the literature review and results from the content analysis in an effort to rationalise the identified factors and the implications thereof.

1.10 Chapter Listing

In concluding the introduction to the research, an outline of the chapters is presented below:

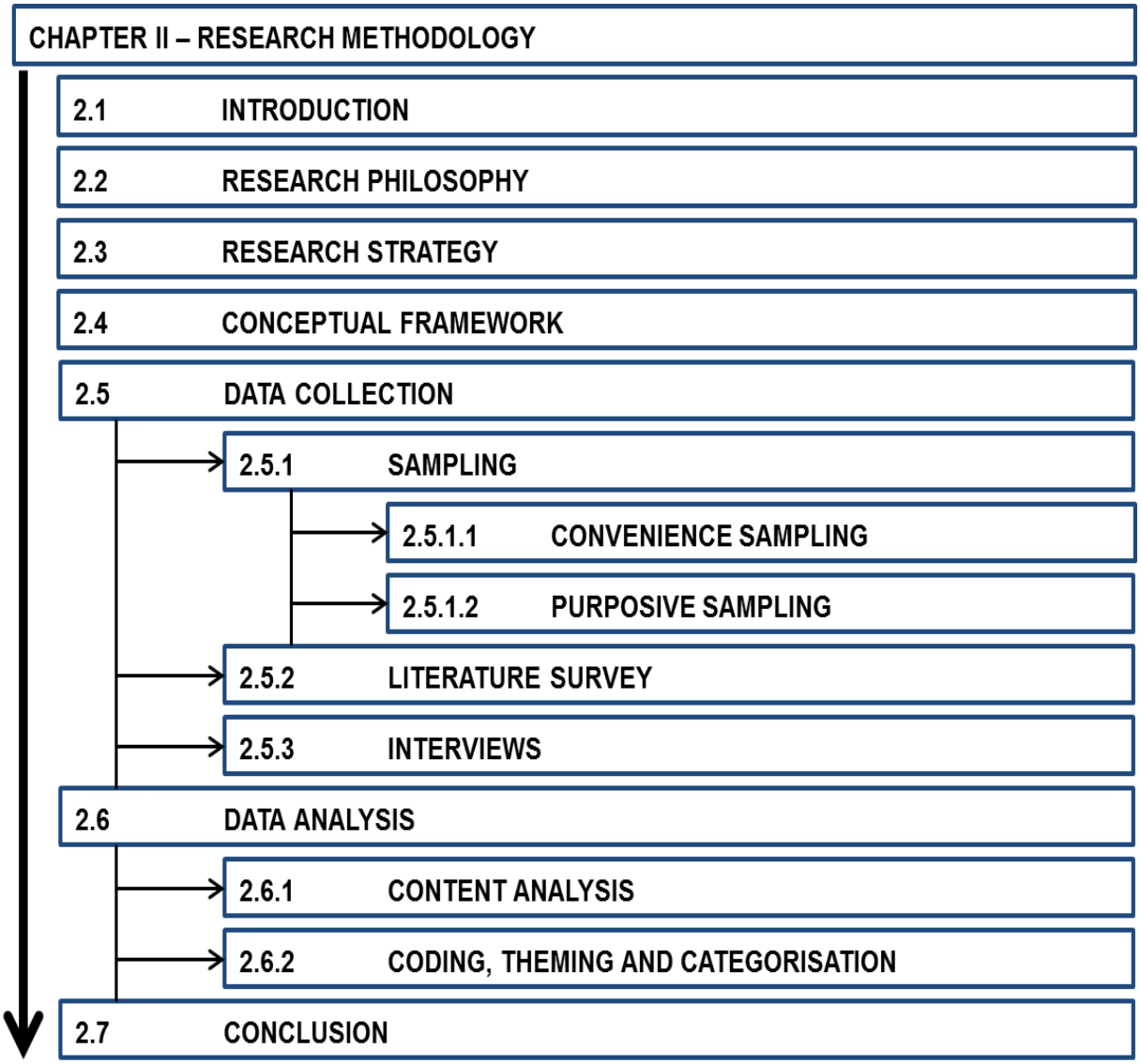


1.11 Conclusion

This chapter introduced the research area and provided an initial description of telemedicine within the eHealth domain and the transmission mechanisms. This was followed by the research questions and the objectives of the study. Chapter II delves

further into the research methodology and motivates the selection of the research strategy and methods.

CHAPTER II – RESEARCH METHODOLOGY



2.1 Introduction

Chapter I discussed the research area and provided an introductory view on the current health care environment in resource constrained settings. Telemedicine was identified as a potential catalyst in addressing the crippling healthcare labour crisis in developing countries as well as improving healthcare accessibility for all.

The purpose of this chapter is to outline the research methodological aspects of this study. The research philosophy will be discussed, which will lead into a discussion of

the research methods and instruments selected based on their suitability in meeting the research objectives. The chapter concludes by summarising the research design before leading into the Literature chapter (Chapter III).

2.2 Research Philosophy

Assumptions provide guidance for conducting research by prescribing the researchers role and techniques to be used in the research. This follows the three philosophical assumptions as described by Lewis, Saunders and Thornhill (2007). Epistemological assumptions are concerned with what constitutes acceptable knowledge in a field of study. Ontological assumptions are concerned with the nature of reality and the methodology is concerned with how the researcher actually conducts the research. These assumptions constitute the basis for a research paradigm.

Morgan and Smircich (1980) identify two extremes in the research approaches, namely, the subjectivist and objectivist approaches as illustrated in Figure 2.1 below:

Subjectivist Approaches to Social Science			Objectivist Approaches to Social Science		
Reality as a projection of human imagination	Reality as a social construction	Reality as a realm of symbolic discourse	Reality as a contextual field of information	Reality as a concrete process	Reality as a concrete structure

Figure 2.1: Research Approaches*:* Sourced Morgan and Smircich (1980)

The subjectivist approaches are primarily aligned with the phenomenological paradigm and are commonly associated with qualitative research. Phenomenological research is known to be synonymous with humanistic or interpretive research as suggested by Hussey and Hussey (1997). Subjectivist approaches result in the collection of qualitative data. Creswell (1998) describes a qualitative approach as one in which the investigator collects open-ended, emerging data with the primary intent of developing themes from the data. Commonly used research strategies include case studies, ethnographies, phenomenologies and narratives.

The objectivist approaches are aligned with the positivist paradigm and are associated with quantitative research. Positivistic approaches seek to identify, quantify and report on phenomena. With the quantitative approach, the investigator primarily uses pre-determined instruments that produce statistical data. Positivism is synonymous with the objectivist, scientific, experimentalist, and the traditionalist (Hussey and Hussey, 1997) and employs research methods such as experiments (Creswell, 1998).

Cunliffe (2010), in an effort to align Morgan and Smircich's typology, argues that the distinction between subjective and objective is fading. This is consistent with the emergence of mixed research methods which are neither explicitly subjective nor objective. As a result, more research strategies lean towards one end of the spectrum rather than being explicitly subjective or objective.

The exploratory nature of this study entails the use of qualitative research methods which aligns this study with the phenomenological paradigm. The appropriate research strategies are subsequently discussed.

2.3 Research Strategy

The selection of a research strategy is influenced by the paradigmatic alignment of the individual study. As already established in section 2.2, this research is aligned with the phenomenological paradigm and as such, employs qualitative research methods. Two qualitative research strategies, viz. case studies and surveys, emerge as possible candidates for use in this research and are subsequently discussed.

Yin (2003) compares the application of the different research strategies and describes case studies as strategies that ask "how" and "why" type of questions. The use of case studies as a research strategy requires the control of behavioural events and the focus is on contemporary events. Case studies allow for the in-depth exploration of an event, activity, process or individual, according to (Creswell 1998), however, the environment under study must be conducive to the establishment of a case or multiple cases and offer the required depth. This is not viable for this study

hence, the case study strategy although qualitative, is not suitable for use in this study.

Surveys can be both qualitative and quantitative, the implications of this alignment affects the application of the relevant research methods and its requirements. The qualitative survey aims to collect information on the meanings that people attach to their experiences; typical questions are what, how and why. An ideal research strategy for this study should be centred on the views and perspectives of the participants hence, qualitative surveys are appropriate for this study.

2.4 Conceptual Framework

Tornatzky, Fleischer, and Chakrabarti (1990) developed the Technology Organisation Environment (TOE) Framework which has been used extensively in information systems research to analyse technology adoption behaviour. It is furthered described as the process by which a firm adopts and implements technological innovations. Baker (2012) explains how the TOE framework is an organisational level theory that explains how the three elements (Technology, Organisation, Environment) may influence the technological adoption decisions of a firm or organisation. This is depicted in Figure 2.2.

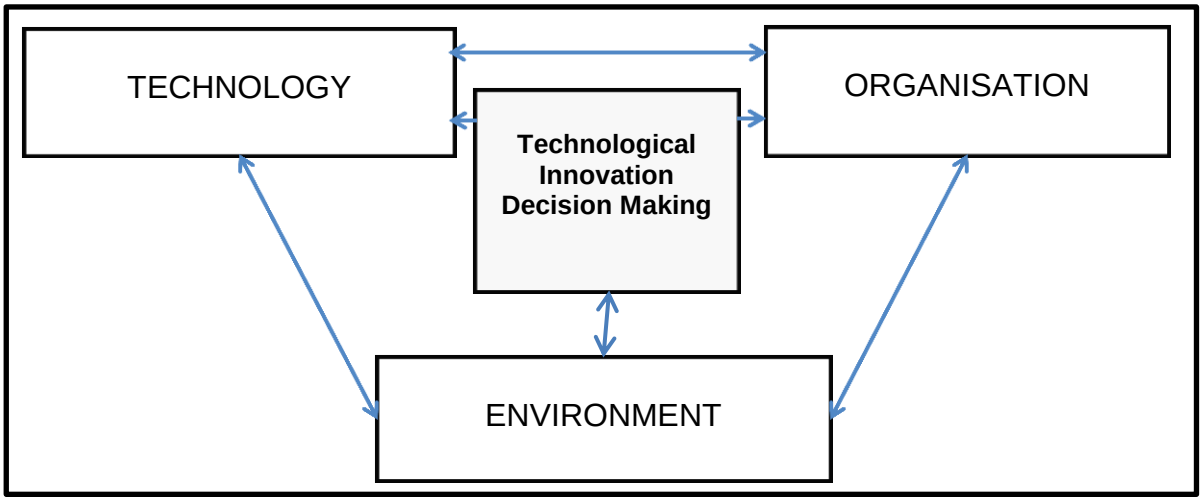


Figure 2.2: TOE Framework: Sourced (Tornatzky et al., 1990)

Oliveira, Martins, and Lisboa (2011) further describe the TOE as a useful analytical framework that can be used for studying the adoption and assimilation of different

types of IT innovation. Previous studies employing the TOE framework are listed in Table 2.1.

Title	Authors
Technological, Organizational, and Environmental Antecedents to Web Services Adoption	(Lippert & Govindarajulu, 2006)
Evaluation of Critical Success Factors for Telemedicine Implementation	(Kodukula, 2011)
The Information Technology (IT) Adoption Process and E- Readiness to Use within Yogyakarta Indonesian Small Medium Enterprises	(Gusaptono, Effendi, & Charibaldi, 2012)
The Process of Innovation Assimilation by Firms in Different Countries: A Technology Diffusion Perspective on E-Business	(Zhu, Kraemer, & Xu, 2006)
An Integrated Model of Information Systems Adoption in Small Businesses	(Thong, 1999)

Table 2.1: I.S Studies Employing the TOE Framework

Table 2.1 illustrates that the TOE framework has been used for a wide range of subject areas which all commonly deal with the adoption or assimilation of technology in an environmental context.

The objective of this study is to create guidelines that address the prevailing sub-optimal adoption of telemedicine. The TOE framework is selected for this study primarily because of its relevance in technological adoption and assimilation decisions. Telemedicine is an ICT based service and therefore is heavily reliant on the adoption of ICT's. The TOE framework provides a suitable theoretical foundation for this study. It is used to establish an outline for the interview questions used during the data gathering and the analysis stages of this study.

Subsequent to the identification of categories and themes, the researcher generates the questionnaires to be used in the data collection process. The following section describes the data collection process.

2.5 Data Collection

This study uses a literature survey and qualitative interviews as a means of data collection. These are discussed.

2.5.1 Sampling

Qualitative sampling has less emphasis on the representation of the population but aims to reflect the diversity within group or population under study (Mays and Pope, 1995). Two sampling techniques are employed in this study and these are discussed.

2.5.1.1 Convenience Sampling

Mabry (2008) notes how the willingness of the subject to participate or grant access to the site is an important factor in data collection. Difficulty of access poses a threat to the representativeness of the data collected. Convenience sampling enables the researcher to select the subjects based on accessibility and willingness to participate.

2.5.1.2 Purposive Sampling

Random selection of participants may fail to yield an informative sample for the study. This may have the effect of skewing the research findings due to sampling bias (Mabry, 2008). Maxwell (2008) describes purposive sampling as sampling strategy in which a deliberate selection of settings, persons, or events is made in order to obtain information that cannot be gotten as well from other strategy selections. In this study, purposive sampling enables the researcher to make a sample selection based on the participants' roles within the respective institutions and the participants' ability to provide relevant information pertaining to the study.

This study used both convenience and purposive sampling in selecting the institutions that were considered for this study and the individual participants within the institutions who were approached for interviews. The institutions were selected on the basis of their accessibility to the researcher (convenience) and their capacity to offer telemedicine services (purposive). The individuals were selected on the basis of their willingness to participate (convenience) and their ability to comment on the day-to-day activities surrounding telemedicine (purposive).

Barbour (2008) suggests that sample group members must share at least one common characteristic. On this basis, the composition of the selected participants for this study depended on the ability of the candidates to comment on the daily activities surrounding telemedicine in and around his or her institution. The candidates, therefore, had to have experience or be directly involved in telemedicine at their respective institutions. The diversity within the sample was constituted by the roles of the participants, namely, technical, managerial, clinical and external service providers.

2.5.2 Literature Review

Initially, a literature review was conducted to gain a broad understanding of the telemedicine operating environment within the developed and developing world.

Research papers on health workforce migration, eHealth and telemedicine were sought from web sources available on the Internet, electronic databases and draft policy and policy documentation. A literature survey which centred on the state of telemedicine in developing countries and the public health sector was subsequently conducted. Creswell, Plano Clark, Gutmann, and Hanson (2003) describe the role of a literature as providing a framework for establishing the importance of the study together with providing a benchmark for the comparison of results.

Chapter III uses the literature to provide a background to telemedicine as a technology and the potential benefits of a fully functioning telemedicine service portfolio.

This aids in the identification of an initial set of telemedicine success factors and barriers.

Following the literature survey, interviews were conducted with the selected individuals in the participating institutions.

2.5.3 Interviews

Interviews are a research method that can be applied qualitatively to obtain a unique and in-depth understanding of the perceptions from the different role players within a study. The interview is essentially a conversation whose structure and purpose has been determined by the interviewer (Kvale, 2008). Interviews are the method of choice for primary data collection in this study.

Britten (1995) identifies three main types of interviews, namely structured, semi structured and in-depth interviews. Structured interviews rely on a set of predetermined and identical questionnaires. The researcher attempts to maintain objectivity by asking the questions in a neutral tone to avoid leading the interviewee. Structured interviews are ideal for the collection of precise data.

In-depth interviews, on the other hand, are less structured but are ideal for collecting rich data on one or two issues, hence, the scope of the questionnaire being administered is usually limited. These techniques differ in application and in scope, hence, the selection of either may result in a different set of results.

The semi-structured interview is suitable for research that tries to understand the relationships between variables and where it is necessary to probe, explore or seek for new insights into a subject. This interviewing technique is more subjective as it prompts the interviewee into making an open and largely subjective response without confining the interviewee to an options based response. Kvale (2008) defines the semi structured interview as an interview whose aim is to obtain descriptions of the life world of the interviewee with respect to interpreting the meaning of the described phenomena.

This study employs semi-structured interviews due to their ability to probe for new insight into a subject as suited to an exploratory study.

2.6 Data Analysis

The data collected in this study is primarily qualitative. The recorded data was transcribed verbatim to organise it into a systematic and logical way. This allowed the data to be coded, themed and categorised for analysis.

2.6.1 Content Analysis

Content analysis is a research method that may be used with either qualitative or quantitative data (Elo & Kyngäs, 2007). Collected data is often not sufficiently pliable for analysis until the information conveyed is condensed and made systematically comparable. Data analysis can be inductive or deductive. Kyngäs and Vanhanen, (1999) describe deductive content analysis as a technique used when the structure of analysis is operationalized on the basis of previous knowledge. Zhang and Wildemuth (2009) suggest the use of deductive content analysis for quantitative studies. Lauri and Kyngäs (2005) recommend the use of inductive content analysis where limited or fragmented former knowledge of a phenomenon prescribes the use of inductive content analysis. This study is primarily qualitative and as such, utilises the qualitative content analysis techniques.

Hsieh and Shannon (2005) and Zhang and Wildemuth (2009) describe the content analysis strategies as summarised in Table 2.2.

Conventional content analysis (inductive content analysis)
• Conventional content analysis is generally used when the aim of the study is to provide a description of a phenomenon. • Coding categories are derived directly and inductively from the raw data.
Directed content analysis (deductive content analysis)
• Directed content analysis aims to extend existing knowledge on phenomenon with the aim of providing further description or filling in a void in the existing research. • The initial coding starts with a theory or relevant research findings.

Summative content analysis
• Involves the counting and comparison of key identifiers within the content followed by an interpretation of the underlying context. • Summative content analysis starts with the counting of words or manifests content, and then extends the analysis to include latent meanings and themes.

Table 2.2: Content Analysis Techniques. Sourced Hsieh and Shannon (2005) and Zhang and Wildemouth (2005)

The exploratory nature of this study is suited to the use of conventional content analysis; however, an initial set of themes and categories was derived from literature. As a result, an element of directed content analysis is present in this study.

2.6.2 Coding, Theming and Categorising

Coding is essentially a labelling strategy that can be used with transcribed data to allow for the easy identification and retrieval of information pertaining to a particular topic. Two coding techniques have been described by Gibbs (2008), these are data driven coding and concept driven coding.

Data driven coding is an open coding technique. Data driven coding is inductive and as a result, aligns with conventional content analysis. This allows categories to emerge as the researcher analyses the material.

Concept-driven coding is deductive and relies on previous knowledge. Concept-driven coding is aligned with directed content analysis. The categories used in the analysis may be sourced from a theory, existing knowledge or everyday experience (Schreier, 2012).

This study employs both the concept and data driven coding schemes. The critical success factors identified in the literature hinged on the theoretical framework which provided an initial set of categories. These were used to verify the continued prevalence of the existing issues. Additionally, the raw data was analysed for new

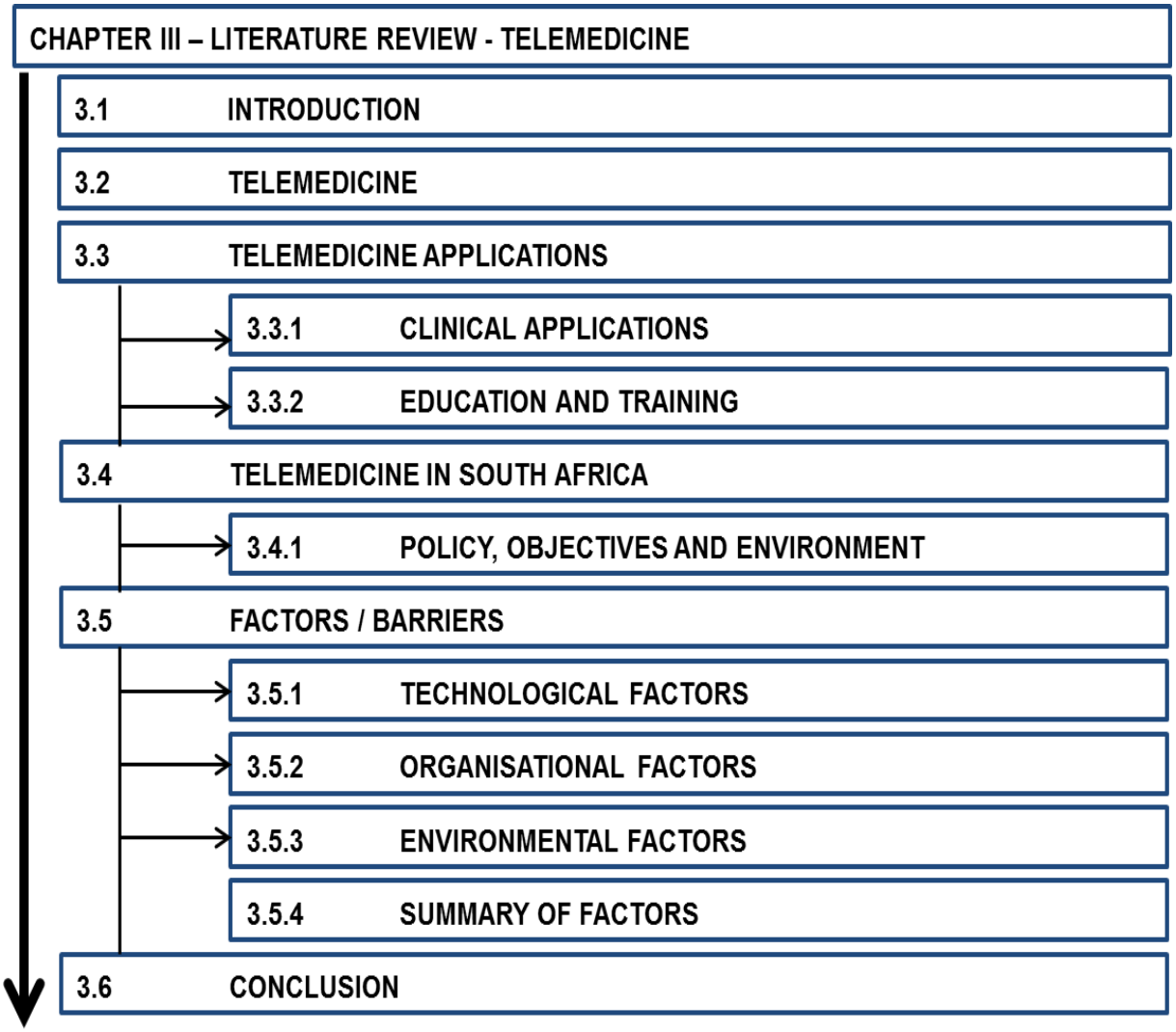
and previously unidentified issues of significance. These resulted in the creation of new categories or the further population of the pre-existing categories.

The coding, theming and categorisation mechanisms used in this study are briefly revisited in Chapter IV.

2.7 Conclusion

This chapter reviewed various research philosophies and strategies in an effort to establish an appropriate strategy for this study. The qualitative survey strategy was selected for the purposes of this research and a detailed description of the process involved and methods employed from inception through the analysis to the conclusion was described. The following chapter aims to synthesise the existing literature regarding the health workforce, public health institutions and telemedicine.

CHAPTER III – LITERATURE REVIEW: TELEMEDICINE



3.1 Introduction

Telemedicine is defined as the use of information technology for the remote delivery of health care services. The need for telemedicine has been necessitated by the general poor standard of healthcare delivery in remotely located areas (typically rural areas) owing to a variety of limitations. The implications of a widely-adopted telemedicine strategy in resource constrained settings are prodigious. This chapter reviews the background of telemedicine and its potential contribution to the public health sector.

3.2 Telemedicine

Telemedicine is the use of information and communication technologies to deliver remote healthcare, as defined by the WHO. Telemedicine has applications in primary, secondary and tertiary healthcare.

- Primary health care: This generally refers to healthcare services provided outside of a hospital environment. This tends to be the first point of interaction between the patient and the healthcare system. Providers of primary healthcare include general practitioners, dentists and pharmacists.
- Secondary healthcare: This refers to healthcare services provided within a non-teaching hospital. Primary care providers make referrals to secondary and tertiary care institutions.
- Tertiary healthcare: This refers to healthcare provided by specialist doctors usually within teaching hospitals. Examples include cardiologists and urologists.

Telemedicine can provide an interface between primary, secondary and tertiary healthcare applications. The use of ICT's for medical diagnosis, on-going patient care and health related, distance learning all constitute part of telemedicine as described by the WHO (2010).

Two techniques are primarily used for the delivery of telemedicine as discussed in Chapter I section 1.4. Real-time techniques such as videoconferencing are an immediate but resource heavy technique. The delivery of real-time services require a significantly high level of telecommunications and connectivity infrastructure development and as such, are more challenging to deploy in the under-developed, resource constrained settings.

Store and forward techniques are found to harness great potential in resource constrained environments. Their low infrastructure and connectivity requirements render them particularly suitable for the delivery of rural and remote health care. Hersh et al. (2006) describe store and forward telemedicine systems as those that provide the ability to capture and store digital images, audio and text from patients.

The storage of multimedia eliminates the need to synchronise the availability of the practitioner and the patient. Fortuin and Molefi (2006) note how several successful store and forward implementations of teledermatology have been deployed in remote areas with little telecommunications infrastructure. The WHO (2010[c]) identifies the following four integral elements to telemedicine:

- Its purpose is to provide clinical support.
- It is intended to overcome geographical barriers by connecting users who are not in the same physical location.
- It involves the use of various types of ICT.
- Its goal is to improve health outcomes.

These elements are both the foundation on which telemedicine applications are built and can be used as a benchmark by which telemedicine applications are evaluated for effectiveness.

Section 1.3 in Chapter 1 detailed the relationship between eHealth and telemedicine, additionally, telemedicine was identified as a sub-component of telehealth, which is a sub- component of eHealth and as such, the development and maturity of the eHealth will have a strong bearing on the development and maturity of both telehealth and telemedicine.

The following section discusses the various sub-specialities and applications of telemedicine in a generic context.

3.3 Telemedicine Applications

The sub-specialities of telemedicine are numerous and often difficult to quantify. The transmission techniques were discussed in section 1.4 of Chapter I. This section discusses the categorised applications of telemedicine that use the identified transmission techniques, namely real-time and store-and-forward.

Telemedicine can be used for clinical applications such as paediatric care, maternal health, disease management, eye care and oral health and education and training amongst others. The transmission mechanisms employed depend on the existing

infrastructure and the urgency of the application. Wootton (2001) lists three main categories under which telemedicine applications for healthcare can be classified. Table 3.1 presents a tabular representation of these categories:

Category	Store And Forward	Real-Time
Clinical	Digital images may be sent via e-mail direct to the specialist for diagnosis and management advice.	Videoconferencing may be used for clinical consultations involving the patient, Primary care provider and specialist at a tertiary hospital.
Educational	Educational material can be sent by mail in the form of tutorial notes, audio or video resources.	Lectures can be transmitted via videoconference to multiple sites simultaneously.
Administrative	Memo and meeting notes may be mailed by post or fax for later perusal.	Telephone conferencing may be used for interactive discussions between participants.

Table 3.1: Telemedicine transmission techniques and applications: Sourced *(Smith, 2005)*

Three broad categories of telemedicine applications emerge, namely clinical, educational and administrative. The various telemedicine applications can be classified by these three broad categories. For the purposes of this study, two of the three categories are discussed in the following sections. Tables 3.2 and 3.3 list the different applications that are grouped under the clinical and educational categories respectively.

3.3.1 Clinical Applications

Clinical applications typically involve the interaction of a healthcare practitioner and a patient or patient information. These applications are primarily used to deliver primary healthcare directly to patients. These applications are presented in Table 3.2.

Application	Description
Telepathology	Remotely located pathologists and third-party providers can securely share images of specimens for diagnosis purposes allowing for interpretation by a secondary expert pathologist to complete primary and non-primary diagnostic evaluation. (European Coordination Committee of the Radiological Electromedical and Healthcare IT Industry, 2011)
Telepediatrics	Doctors specialising in the care of infants, children and adolescents can avail their services to the typically remote and underserved population.
Teledermatology	Images and videos depicting dermatologic conditions can be transferred to or shared with off-site specialists who are geographically separated from the patients
Teleradiology	Enables remote evaluation of digital diagnostic images such as CT scans, MRIs and X-Rays
Teleultrasound	Imaging technology with applications in prenatal screening, internal medicine as well as fractures
Teleophthalmology	Enables remotely located ophthalmologists to deliver medical or surgical eye care
Teledentistry	Allows dentists of any speciality to remotely assist in the provision of dental care, diagnosis as well as providing a support to other dentists who may require specialist skills

Table 3.2: Clinical Applications of Telemedicine.

3.3.2 Education and Training

Telemedicine entails an aspect of education and training. This can be used between healthcare professionals, practitioners and patients as well as mentor and students. The educational and training aspects facilitate the remote availability of training

materials and domain experts, thereby, widening the scope of operation for training healthcare practitioners. Table 3.3 presents some typical education and training based applications of telemedicine.

Application	Description
Telementoring	Tele-mentoring is a telemedicine technique that involves the remote guidance of a treatment or a procedure where the care giver has no or limited experience with the featured technique
Teleproctoring	A proctor is an impartial observer and reporter of events. Tele-proctoring can be used in education and examining sphere. Tele-proctoring can be used to assess and examine medical staff remotely. This allows trainees to be evaluated in their natural working environment.
Information Dissemination	This involves holding workshops or information sessions for the general public to provide health related information

Table 3.3: Educational Applications of Telemedicine.

As previously discussed, telemedicine is a broad field and the list of applications is not exhaustive. In this section, the applications and the services that use the applications were discussed. Typical services that exist in the South African landscape were introduced. The next section focuses on the telemedicine environment within South Africa. This section will discuss the supporting infrastructure development and legislative environment.

3.4 Telemedicine in South Africa

The previous section discussed the different categories under which telemedicine applications are classified. This section reviews telemedicine and its application in the developing world context with a particular focus on the South African Eastern Cape province as a model for resource constrained settings.

The South African public health sector falls under the domain of the NDOH which is responsible for policy and resource disbursement at a national level. The NDOH delegates the national strategies to the Provincial Departments of Health (PDOH) which is responsible for policy and resource distribution at a provincial level. Mars and Seebregts (2008) notes that the public health sector provides for 82% of the population and has access to only 40% of the national health budget. The PDOH is an instrument of the NDOH, therefore, the successful implementation and adoption of telemedicine is the prerogative of the PDOH.

In 1999 the NDOH initiated twenty-eight pilot projects with a main focus on teleradiology, teleultrasound, telepathology and teleophthalmology (Dyk, Schutte, & Fortuin, 2011). This followed the establishment of a National Telemedicine Task Team in 1998. Mars (2009) details the three phase project rollout as depicted in Figure 3.1.

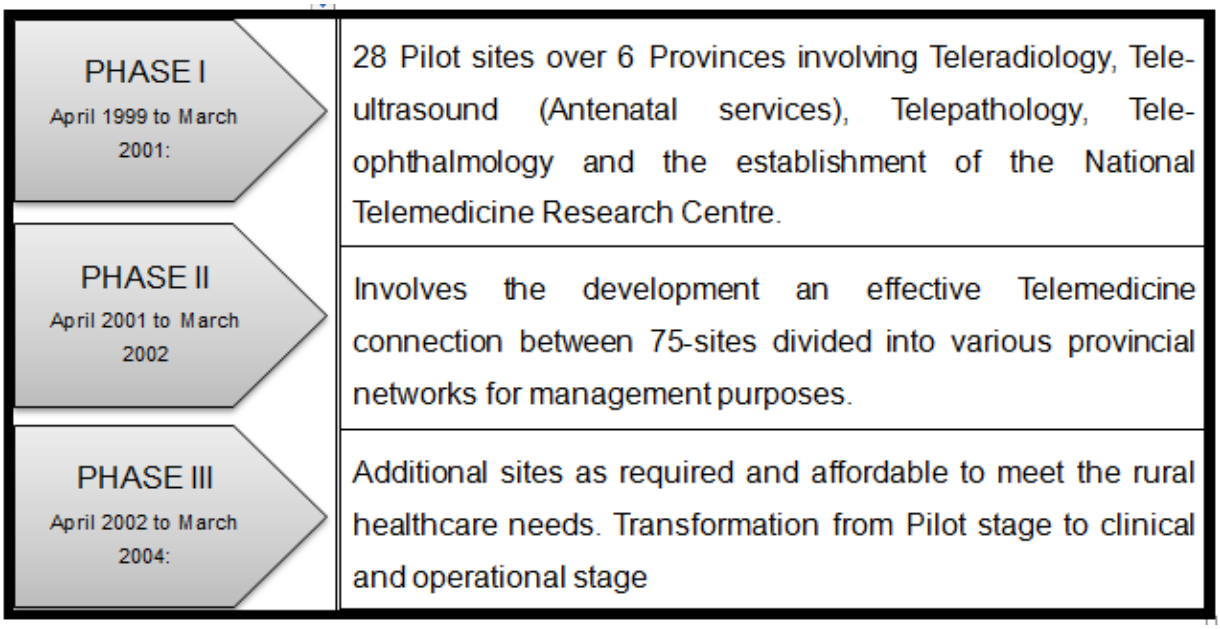


Figure 3.1: Telemedicine Rollout Phases. Sourced (Mars 2009)

Phase I was implemented with little success. Mars and Seebregts (2008) cite the shortage of healthcare workers in the public sector and their reluctance to take on any additional work as a major reason for its failure; the top down approach, the lack of capacity and failure to manage change were identified as other contributing factors. As a result, Phases II and III were not implemented due to the poor results from Phase I.

In 2010, the Minister of Health announced that of the 86 telemedicine projects initiated; only thirty-eight were functioning (Wynchank & Fortuin, 2012). The reasons cited include lack of connectivity and insufficient coordination and management. In the same year, a moratorium on the acquisition of ICT solutions was implemented by the NDOH. This effectively prohibits the launching of new telemedicine projects. This moratorium remains in place until the finalisation of a national ICT strategy (NDOH, 2012).

The policies and legislative environment governing the use of such technologies, as with any technological innovation, play a significant role in the development and advancement of any initiatives. The next sub-section looks at the policy objectives and environment.

3.4.1 Policy Objectives and Environment

On a global perspective, a key healthcare benchmark in health service delivery is the conformation to the millennium development goals (MDG). There are eight MDG's; of these, three have applications specific to healthcare, these are:

4. Reduce child mortality;
5. Improve maternal health;
6. Combat HIV/AIDS, malaria and other diseases.

South Africa has established the Medium Term Strategic Framework (MTSF) in an effort to conform to these targets, which is a representation of government intent to address the challenges faced in South Africa. This is illustrated in figure 3.2.

EHealth and telemedicine have the potential to be key drivers in meeting these policy objectives. The ability to provide quality healthcare instantaneously at a distance will have great implications on the success of the government in meeting these objectives. Presently, South Africa is expected to miss some of the 2015 target as published in the MDGs Country Report (UNDP, 2010).

Millenium Development Goals	4.	Reduce child mortality
	5.	Improve maternal health
	6.	Combat HIV/AIDS, malaria and other diseases
Government of South Africa	Outcome Area 2:	A long and healthy life for all South Africans
MTFS Strategic Element	Strategic priority 5:	Improve the health profile of all South Africans

Figure 3.2: Policy, Goals and Targets

The South African public health landscape stands to benefit from the wide integration of ICT's and development of health information systems. 46% of the South African population reside in the rural areas (Mars, 2009), therefore, remote delivery of health care will be of great significance in addressing the national health policy objectives.

South Africa is in the process of drafting a National eHealth policy that will effectively guide the use of ICT's and related technologies in supporting healthcare. It is expected that the prevailing moratorium will be lifted once the policy has been approved and published.

3.5 Factors / Barriers to Adoption

This research aims to identify the barriers to the effective adoption of telemedicine. Adoption is a key word and is synonymous with acceptance and implementation. The free dictionary *(www.thefreedictionary.com)* defines adoption as "the act of accepting with approval; favourable reception". The barriers presented in this section were identified in developing countries with similar demographics to South Africa. The following sub-sections categorise these barriers according to the TOE framework.

3.5.1 Technological Factors

Paul, Pearlson, and McDaniel (1999) describe technological barriers as instances where the use of technology proves to be insufficient to address the objectives for

which the technology was acquired. At this point, the technology is defined as the hardware, software and communication medium necessary to support the activities.

3.5.1.1 Privacy and Confidentiality

One of the barriers identified by Paul et al. (1999) was the concern for privacy and confidentiality of patient data. This concern is shared by Mayoka (2011) and Miyazaki, Igras, Liu and Ohyanagi (2012). The issues raised include the sharing of data, manipulation of patient records and the secure storage of patient information.

3.5.1.2 Telecommunications and Infrastructure

One of the key benefits of telemedicine is the provision of healthcare to rural and geographically isolated areas. However, poor telecommunication infrastructure development in these areas generally hinders the portfolio of services and the quality of services that can be availed to these communities. Huddart, Picazo, and Duale (2003) cite poor communication services and electronic connectivity as barriers leading to the poor supervision of rural health facilities. This poor supervision has a direct impact on staff enthusiasm and the quality of services rendered. Fortuin and Molefi (2006) also identify the lack of infrastructure as a challenge related to telemedicine.

Apart from the scarcity of telecommunications infrastructure, there is a general lack of equipment in remote institutions as suggested by Chudi (2010) who explains how it is not un-common to find medical specialists employed at institutions without functioning equipment. This is testimony to the general lack of infrastructure development.

3.5.1.3 Standards and Interoperability

Other technological factors include the lack of standardization. The development of multiple eHealth standards has resulted in a multivendor environment that is not fully interoperable. Adebesin et al. (2010) cite this as a major barrier to e-health adoption. This means different systems may be unable to share information due to their conformance to different standards, thereby, defeating the purpose of using electronic media. The American Telemedicine Association further corroborates this lack of interoperability by noting that it has yet to be achieved in areas such as home

telehealth and remote monitoring for patients and consumers (American Telemedicine Association, 2006).

Table 3.4 illustrates the interoperability challenges faced in South Africa.

PROVINCE	PATIENT MANAGEMENT / HOSPITAL INFORMATION SYSTEM USED
Eastern Cape	DELTA 9
Free State	Meditech; PADS
Gauteng	Medicom; Soarian MedSuite; Pharm Assist; PAAB;
KwaZulu-Natal	Medicom; Meditech; PALS; Proclin; REMED (Chillisoft)
Limpopo	Medicom
Mpumalanga	PAAB
North West	PAAB
Northern Cape	Nootroclin
Western Cape	DELTA 9; PHC Information System (PHCIS)

Table 3.4: Hospital Information Systems by Province. Sourced (Department Of Health South Africa, 2012)

The different systems shown in Table 3.4 are all successfully implemented but the lack of standardisation results in proprietary systems that are not interoperable.

3.5.1.4 System Ownership

Yellowlees (2005) notes that there is a general tendency for bureaucratic agents to be the primary drivers of a telemedicine system rather than the clinicians who use said systems. This may result from the vendors supplying the technology with a profit motive while ignoring the views and perspectives of all the stakeholders such as the patients and the practitioners. This may explain the general lack of participatory ownership as cited by Mars (2009).

As already mentioned, telemedicine is a prerogative of the PDOH and as such, the department has to exercise ownership over the projects. Yellowlees (2005) describes ‘ownership’ as being directly involved in all stages of planning,

implementation and evaluation. Contrary to this, Mars (2009) cites the failure of the PDOH to take ownership of the projects and commit the necessary resources.

3.5.2 Organisational Factors

Organisational factors are those that affect the internal operations of the organisation. These affect the decision making processes and internal policies that govern the daily activities of the organisation. These factors have a large influence on the success of the various initiatives and services offered by the institution.

3.5.2.1 Skills Availability and Training

Mars and Seebregts (2008) explain how many healthcare workers lack basic computer training, a factor that is corroborated by Mayoka (2011), Paul et al. (1999) and Cilliers and Flowerday (2013) among others. Furthermore, Wynchank and Fortuin (2012) emphasise the inadequacy of the ICT skills among healthcare professionals for the effective operation of telemedicine. Primary healthcare in rural areas is usually delivered through clinics that are directed by nursing sisters whose ICT background is very limited which aggravates the situation.

The adoption of eHealth in developing countries requires caution. A knowledge gap exists between the computer literate and non-literate. As a result, it is important to ensure all the participants in telemedicine are adequately up-skilled in order to operate effectively at the same level.

3.5.2.2 Resistance to Change

Resistance to change is identified as an organisational barrier. Healy (2008) explains how progress in the field of healthcare is a compromise between the desire to move forward and the extent to which professionals and end users are willing to tolerate change. Additionally, the introduction of telemedicine brings about changes in the daily operations of the clinicians. If not properly introduced, these changes may be perceived as a nuisance by those who have to change or make amendments to their style of work. Additionally, telemedicine is seen to introduce an additional workload instead of replacing some established methods. This contributes to resistance on the part of the clinicians.

Pelletier-fleury and Lanoe (1997) further suggest that the barriers to the diffusion of telemedicine may be linked the environmental cost of implementing this technology. They suggest that the use of telemedicine requires the restructuring of some organisational aspects which may include revisiting some long-standing relationships with producers and beneficiaries from the standard health practice.

3.5.2.3 Finance and Sustainability

Finance and sustainability is both an environmental and organisational factor. Mayoka (2011) identified the lack of resources at hospitals to support the implementation of telemedicine as a barrier. This lack of resources may be a result of the lack of planning for the sustainability of (proven) solutions as suggested by Scott (2006). Wynchank and Fortuin (2012) indicate that few African telemedicine activities are funded by their governments; therefore, careful sustainability planning is required to ensure that sustainability is embedded into the projects to ensure their longevity. The public health sector in South Africa is collectively financed by the government through the PDOHs. Mars (2009) cites the lack of human and financial resource commitments to the projects. Fortuin and Molefi (2006) additionally indicate that there are many projects which are unsustainable to incorporate into the daily activities of the DOH. Mishra, Pradeep and Mishra (2009) cite unsustainable funding models as a major challenge with telemedicine in developing countries.

3.5.2.4 Needs Assessment

Wynchank and Fortuin (2012) allude to the need for needs assessment before embarking on telemedicine projects. This involves identifying the services and activities required. This is supported by Scott (2006) who identifies the lack of needs assessment planning as a challenge to the effective implementation of telemedicine projects.

3.5.2.5 Change Management

In addition to Scott's identification of the lack of consideration for change management issues as limitation, effective change management has been identified as a key element in the successful development of telemedicine systems by Yellowlees (2005).

This view is supported by (van Dyk & Schutte, 2012). Additionally, the South African DOH has listed change management as a key deliverable in establishing enterprise architecture for the 2012 – 13 periods. However, Mars and Seebregts (2008) have ascertained that there exists a general lack of change management skills in the e-health sector in South Africa.

3.5.2.6 Evaluation Planning

Mishra et.al (2009) cite the lack of trial and evaluation data and the lack of published results and shared experiences as a challenge. This hampers the ability of future projects to benefit from the lessons learnt from those already implemented or attempted. As a result, the same challenges that could have been incorporated in the planning phases of new projects are once again experienced. Similarly, Scott (2006) identified the "lack of sound evaluation planning or execution" and "limited or no dissemination (formal or informal) of findings". The lack of a knowledgebase of lessons learnt and success factors identified means the propagation of successful telemedicine systems will be laden with barriers.

3.5.3 Environmental Factors

Environmental factors are those considered to be external to the organisation. These factors are likely to have a uniform effect on all the institutions operating within the locale and the authority to effect changes at this level are typically removed from the institutions. These factors are likely to be addressed at a national and/or provincial level.

3.5.3.1 Cost of Telecommunications

The high cost of telecommunications has been cited by Mayoka (2011), Morris (2006), Mars and Seebregts (2008) as a barrier to the effective adoption of eHealth. Elder and Clarke (2009) further support this view by suggesting that mobile telecommunications infrastructure in Africa is too slow and expensive for Internet connectivity. As already established Telemedicine is a constituent of eHealth and as such, inherits the barriers to eHealth adoption. Telemedicine is highly dependent on the telecommunications infrastructure. The high cost of telecommunication has a definite impact on the overall cost of implementing telemedicine. Telecommunication

costs alone historically have been known to render telemedicine projects unsustainable. These costs have fallen significantly in the developed world but are still relatively high in developing countries.

3.5.3.2 Legal Uncertainty

Pelletier-fleury and Lanoe (1997) explain how collaborative telemedicine activities may raise legal questions about the medical information being transmitted in multimedia form. These questions include the patients' privacy and confidentiality, ownership of the transmitted data, malpractice liability and reimbursement for the services rendered. The lack of a clear definitive policy regarding the legal aspects may result in increased uncertainty among both healthcare professionals and the consumers.

3.5.3.3 Legislation, Policy and Guidelines

Stanberry (2001) suggests that there is a lack of or complete non-existence of professional guidelines, standards and regulations needed for the legal and ethical practice of telemedicine. Jack and Mars (2008) allude to this and add that developing countries need to formulate guidelines that are specific to their prevailing environment.

3.5.4 Summary of Factors /Barriers

Table 3.5 summarises the identified and discussed barriers and presents the various literature sources used in this survey that mention these barriers. These factors are later collated with the primary data from the interviews to provide a concise list of factors for use in the guideline development process.

The identified factors are subsequently depicted diagrammatically in the respective TOE framework categories in Figure 3.3.

Barriers	Authors
Technological	
Patient privacy and confidentiality	(Paul et al., 1999), (Mayoka, 2011)(Miyazaki et al., 2012)
Telecommunications & Infrastructure	(Huddart et al., 2003) (Fortuin & Molefi, 2006) (Chudi, 2010)
System ownership	(P. M. Yellowlees, 2005) (Mars, 2008)
Technological interoperability	(Adebesin et al., 2010) (American Telemedicine Association, 2006) (Mars, 2009) (National Department of Health, 2012)(Miyazaki et al., 2012) (S. Mishra et.al 2009)
Organisational	
Skills availability and training	(Maurice Mars & Seebregts, 2008) (Mayoka, 2011) (Paul et al., 1999) (Cilliers, 2010)(Miyazaki et al., 2012)
Resistance to change	(Healy, 2008) (Pelletier-fleury & Lanoe, 1997)
Finance and sustainability	(Mayoka, 2011) (Scott, 2006)(Miyazaki et al., 2012) (Mars, 2009) (Wynchank & Fortuin, 2012) (Scott, 2006) (Fortuin & Molefi, 2006) (S. Mishra et.al, 2009)
Lack of Needs assessment planning	(Wynchank & Fortuin, 2012) (Scott, 2006)
Change management issues	(P. M. Yellowlees, 2005) (Dyk & Schutte, 2012) (Scott, 2006) (Mars & Seebregts, 2008) (Cilliers, 2010)
Lack of sound evaluation planning	(Scott, 2006) (S. Mishra et.al, 2009)
Environmental	
Cost of telecommunications	(Mayoka, 2011); (Morris, 2006);(Maurice Mars & Seebregts, 2008) (Elder & Clarke, 2009)

Barriers	Authors
Environmental	
Legislation, policy and guidelines	(Jack & Mars, 2008)(Stanberry, 2001)(Pelletier-fleury & Lanoe, 1997)

Table 3.5: Summary of Identified Factors.

These factors are diagrammatically categorised according to the TOE framework in Figure 3.3.

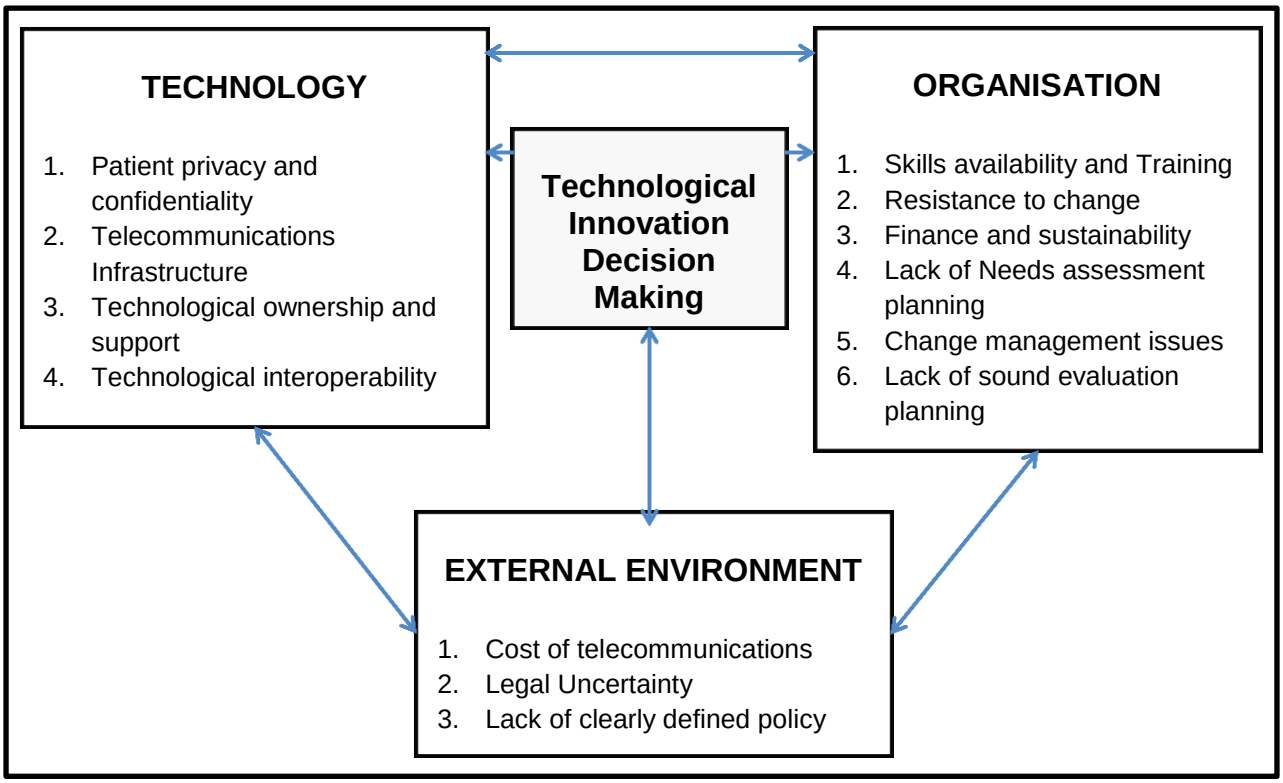


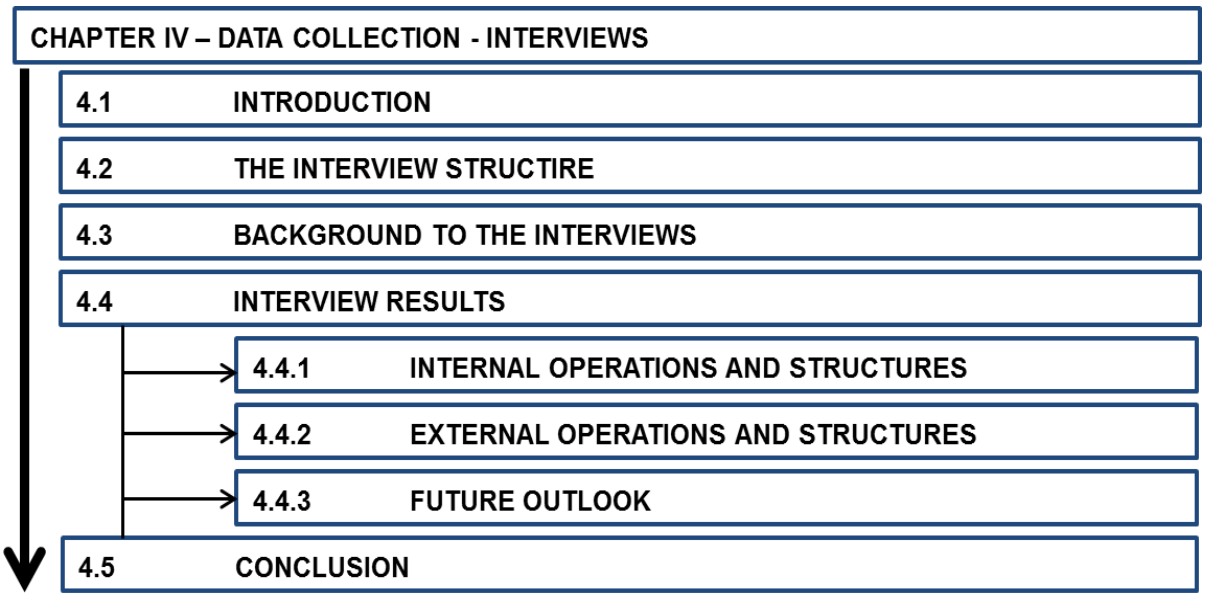
Figure 3.3: Categorised factors in the TOE framework.

3.6 Conclusion

This chapter continued the introduction into telemedicine and the associated services and applications that were discussed in Chapter I. The chapter provided a more detailed examination of the different services and techniques that are considered applicable to the field. The study was conducted in the Eastern Cape Province of South Africa and hence, telemedicine was investigated in context from a national level down to the provincial level.

The chapter concluded by presenting the results of the literature survey to identify the factors that pose a barrier to the effective adoption and sustained use of telemedicine in public health in resource constrained settings. The following chapter presents the factors and/or barriers identified from the interviews.

CHAPTER IV – DATA COLLECTION



4.1 Introduction

Chapter II discussed the detailed process followed for the analysis of the collected data based on the principles of conducting a qualitative survey. Chapter IV presents the empirical results collected from the interviews. The chapter will follow the theme established by the TOE framework and the results presented according to the specific comments of the respondents to the posed questions.

The results are presented according to the questionnaire used to interview the participants. These questionnaires are attached as Appendices V and VI.

4.2 The Interview Structure

Two questionnaires were created and are attached as Appendices V and VI. The questionnaires were designed with slight variations to cater for the role-diversity within the research sample. One questionnaire was more technical and managerially aligned whilst the other focused on the clinical respondent role. The collective feedback from the respondents was, therefore, diverse and role specific which

allowed the most knowledgeable people in a particular area to provide the answers. Creswell (2013) suggests that qualitative researchers often collect field data at the site where participants experience phenomena under study. As far as possible, every effort was made to interview the participants in their operating environment to minimize any possible inconvenience and perhaps obtain more accurate responses as the respondents could easily make reference to their environment. Face-to-face and telephonic interviews were used depending on the availability of the participant. It is worth noting that despite their commitment to participate, some of the respondents were still engaged in work related activities during the interviews. The following section recaps the research strategy.

4.3 Background to the Interviews

Chapter II introduced phenomenology as the research strategy selected for this study. Chapter III presented the results from the literature survey in the form of Technical, Organisational and Environmental challenges termed as factors. The categorized factors were used to theme and design the interview questions. The second phase of the study involved the use of interviews to both corroborate and expose new or previously unidentified issues of significance.

As indicated in section 1.7, the study was conducted in the Eastern Cape because it presents an accurate representation of resource constrained settings. The sample was limited to Public Health institutions within the Eastern Cape, the motivation for which was provided in Chapter II, section 2.5.1.

Among the participant roles identified, were IT support technicians, an external service provider, management staff, and a clinician. The roles were not clearly defined because some participants occupied dual roles and as such, were able to comment in more than one capacity.

The combined experience of the research sample spanned 25 both urban and rural institutions in the Eastern Cape. Five participants from the institutions were selected for the interviews because they met the selection criteria and the overall sample group would have the four required (role-based) influences, namely, technical,

managerial, clinical and external service providers. The participant profile is summarized in Table 4.1.

Role	No. Of Participants
Technical	2
Technical / Managerial	1
Clinical	1
Service Provider	1

Table 4.1: Summarised Participant Profile

4.4 Interview Results

Telemedicine and specifically teleradiology was suspended in the Eastern Cape in August 2012 due to budgetary constraints. It had been apparent that effective telemedicine services were non-viable within the province and the suspension of these services further highlights the issue.

The participants selected for these interviews had been involved in the telemedicine activities at these institutions.

The interview questions and their respective theme/category alignment are detailed in Table 4.2.

Interview Question Mapping		
Category	Questionnaire 1	Questionnaire 2
Technology	1, 2, 3,10, 12,13	1, 2, 6, 7, 8, 9, 12
Organization	5,6, 7,8,10,15,17	3, 4, 5, 13, 14, 15
Environment	4,9,10, 11, 14,16	10, 11,

Table 4.2: Interview Question Categorisation

The aim of the data collection was to qualitatively obtain a complete and concise list of factors affecting the adoption and growth of telemedicine. Issues such as the frequency and distribution of each factor are not of significance. The list is presented in section 5.3 in Chapter V.

The general structure of the interviews started with the participant highlighting the services offered and the infrastructure and equipment used in the delivery of these services. Additionally, factors such as service utilization and equipment maintenance were investigated.

4.4.1 Internal Operations and Structures

The following discussion pertains to questions that required the participant to highlight the internal operations and structures according to the institutions they operate in.

The first step taken in establishing the status of telemedicine in the area of study was to establish the type of services offered.

One participant identified both teleradiology and teleconsultation as the services offered. Additionally, there was mention of a teledentistry initiative that failed due to a shortage of skilled staff.

****

"Okay well we use teleradiology ya, and we use uhm teleconsultation at provincial hospital uh do you want me to explain what that is?"

****

"I know that at one stage they wanted to roll out teledentistry but that fell flat because they just didn't have the people to do it"

****

The other participants identified teleradiology as the only service being offered whilst one mentioned only the use of digital radiology. From the responses received, it

became apparent that the concept of telemedicine was not well defined because it was not clear to all the participants that teleradiology is a constituent part of telemedicine. The following response highlights this issue:

****

"We were not how can say really informed about how telemedicine joins with teleradiology"

****

As a result, teleradiology was seen to be a stand-alone project and not part of an overall strategy or project.

The type of equipment implemented for these services was generally consistent although some institutions used different service providers for their infrastructure. The typical equipment applications are similar to the illustration in Figure 4.1.

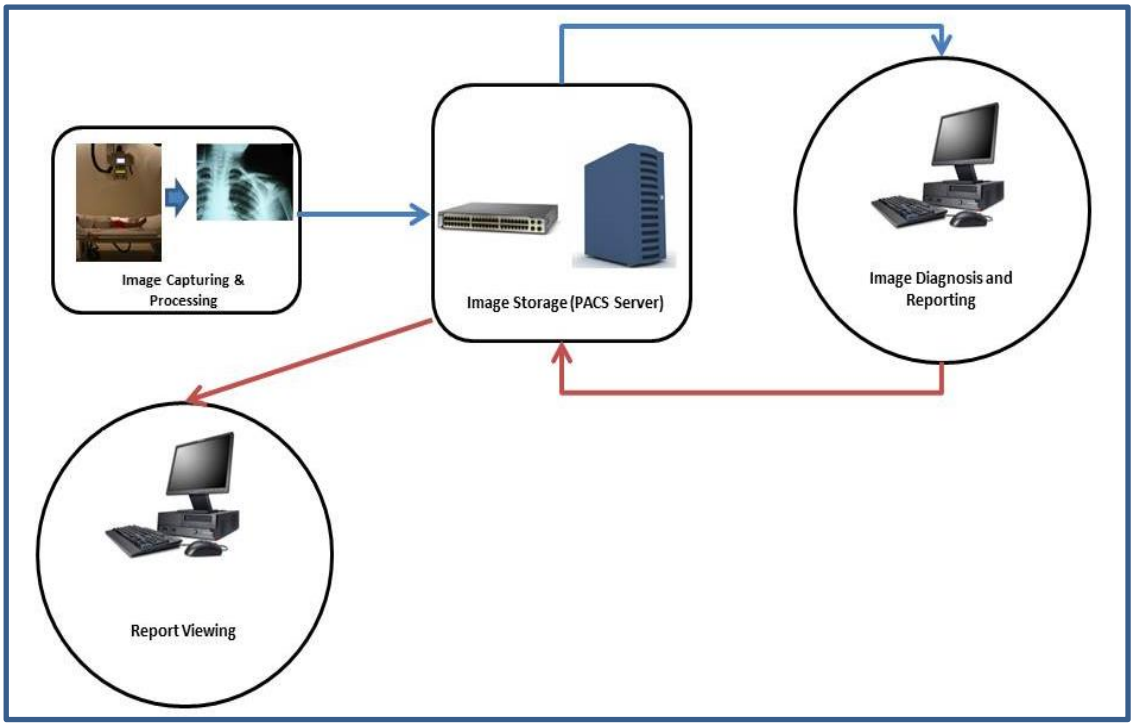


Figure 4.1: Typical Teleradiology Setup

Each system typically comprises of a picture archiving and communication system (PACS) server that is used for image storage and retrieval. Remote access to the images on the server is facilitated through the use of either fixed viewing stations (desktop computers) or mobile viewing stations (mobile devices operating on

wireless connections). This can either be done within the institution or between two or more institutions. Institutions sending their images are termed as the referring institutions and those receiving and performing the diagnosis are termed as the referral institutions. This enables access to the centralized resources from the wards within the institution.

X-ray machines are used to capture the original image which is stored on the PACS server before being transferred to a radiologist electronically, who responds with a diagnosis report. This can be summarised by the following quotation:

****

"PACS servers in hospitals send studies via the SITA network to a radiologist's PACS for reporting."

****

Equipment maintenance is pro-active with some institutions conducting routine maintenance and having maintenance agreements with suppliers. In Institutions that use external service providers, the in-house maintenance is conducted by the onsite technicians. Some respondents identified the shortage of equipment as a major challenge although there is an indication that the situation has gradually been improving to a point where the equipment capacity can be considered *"just okay".* The following responses support this:

****

"because they find that the one challenge is that the not all the wards have got enough computers so there's a problem of a distance because we have got maybe 1 computer like for example like in our causality department the challenge of the distance between the actual computer and the point of service like"

****

"We had a challenge with computers, big challenge, that took some time but its okay now but I think we could do better so that is the major one and then just getting the network up and running and the cables and all that, that was quite challenging so uhm it took some time"

****

The lack of equipment was attributed to the typical lack of resources and long deployment times that are not uncommon in government departments.

Service utilization on the whole was very high, ranging between 70% and 100 % as identified by the respondents.

****

"I'd say a good 70 %"

****

"All of the services that we render is fully utilized"

****

"Teleconsultation, teleradiology is fully utilised 100%"

****

However, the majority of the cases were local to the institution and little time is spent on referred cases.

****

"Oh not much, we don't do much patients that are not at [redacted], The bulk of our patients are actually at [redacted]"

****

"If I can make an example, 90% of our patients are actually at [redacted], Very few external"

****

The training strategies differ between the institutions. In some institutions; training programs were conducted at the onset of the teleradiology program, while others provide continual revision training. In some cases, training in the form of a quick overview of the equipment and services is conducted only when new staff members

join the institutions and others have no training at all. The following quotes support these views.

****

"When it all started we were given like the several let's say basic training of the system works"

****

"Teleradiology yes, we have got a full training we do it every 3 months, revision training"

****

"What we do is normally when there is new staff I normally do the settings like for example when there are new people like being integrated so we do all go and do like maybe 5 minutes or 10 minutes overview of how the system works"

****

"no training at all, any new doctors that come here... we've got a lot of intern doctors that rotate so any new doctors that come on site here at Livingstone, we / they just learn from the other doctors how to use the PAX application"

****

The lack of a uniform training strategy may be a contributing factor to the shortage of skilled staff. Additionally, staff rotation is not uncommon within the public sector. The lack of a standardised, structured training regime will inevitably differ the skills and expertise of employees from different institutions. On a positive note, the IT support technicians, through the interaction with the service providers, gained valuable skills on how to manage and configure the system.

The institutions, when queried about any specially trained staff for the specific purposes of telemedicine, indicated that the existing staff received some training regarding the teleradiology system and that there were no specific individuals singled out for the teleradiology project.

****

"No everybody uses it so everybody is trained on how to use it but for teleradiology obviously your x-ray staff are the admin staff and the users outside are more more normal users, uhm for teleconsultation it's pretty much there is no super-user it's just anyone who need to use it"

****

The general consensus among the participants was that the teleradiology initiatives do not add an extra cost burden onto the patients in the public sector. On the contrary, the patients actually benefit from better quality care and cost reductions associated with travelling due to the referrals. One of the participants, when asked if there are any expenses passed on to the patients, responded as follows:

****

"Not in public sector, maybe in the others but for us no, for the teleradiology, the provincial office pays that radiologist that does the reports, that's the only expense but not to the patient, to us. The patient doesn't feel the expense"

****

Additionally, the PDOH has benefitted from reduced printing cost associated with radiology. The film used to print x-rays is quite expensive and one for the participants quantifies the cost savings to around 3 million rands a year.

****

"Teleradiology is fully utilised 100%, they have done away with printing so it saves the department up to 3 million rands a year"

****

Staff shortages were highlighted across the institutions. Staff retention was considered generally quite good, however, the presence of vacant positions or an inadequate staff complement emerged as a limiting factor.

****

"It's not, turnover is not a problem, the problem is to employ more staff, so the staff we had a year ago we still have" "that hasn't changed, the problem is new appointments"

****

"The technology is there but the manpower is not there"

****

Additionally, vacant posts may create communication gaps especially in the delegation channels which results in poor top-down and bottom-up communication.

4.4.2 Operations and Structures External to the Institution

The following set of questions required the participants to comment on issues outside the confines of their institutions.

The status of the availability of policy and /or guidelines with reference to the use of telemedicine was as follows; the general indication was that the provincial policy is established as an umbrella policy and the institutions develop their own policies and guidelines based on this document. This is clearly described by the following respondent:

****

"We have our own policy in place, we have our own teleradiology any telemedicine, we have our own developed for the PE complex"

****

The awareness of the presence of policy and guidelines was good for the most part, however, one of the participants was unaware of such documentation within their institution. This lack of a consistent view on the defined policy and guidelines may reflect bottlenecks in the dissemination of such information.

The participants were asked if they believed there was room for growth into new areas of telemedicine, and the responses were all positive, in one instance, teledentistry was named as a possible growth area. It was clear from the views of the participants that telemedicine held a lot of potential.

The benefits of teleradiology are immense from both a financial and an economic stand-point. All the respondents agreed with this view point and highlighted the significance especially to rural and remote areas. When asked if the South African healthcare landscape could gain from the use of technology to help deliver health related services, one of the participants responded:

****

"The need for such services increases due to the shortage of specialists, increased number of patients and the difficulty to transport patients to district hospitals for treatment."

****

"Challenges include: Network infrastructure, IT skills of hospital staff, fly-by-night businesses that provide these software solutions."

****

The emphasis on better delivery of remote healthcare was mentioned by all the respondents.

If the challenges facing Telemedicine could be adequately addressed, the prospects of an improved healthcare environment become more realisable. Enthusiasm amongst the staff has grown and domain experts are gradually developing within the field.

4.4.3 Future Outlook

The following set of responses was in reply to a set of questions designed to obtain some insight into the future of telemedicine from the participants' perspective.

The participants point out that there was a growing desire to unify the system across the board.

In terms of enthusiasm, the participants were of the same opinion regarding the growing enthusiasm that comes with exposure and training. However, within the institutions, some were not as keen to learn the required skills while others felt the new systems were a threat to their continued employment. The overall picture regarding enthusiasm is, therefore, mixed. The following responses highlight this point:

****

"Yes, yayaya a lot of the doctors here I mean we we've got to answer questions as to when are you doing an extra ...You know like..."

****

"doctors, we had a lot of problems from them so they came for training and all of that so that took some time, but once they got into the groove of this is how it's going to be done, it's not going away, you know, they were fine, once they bought into the concept you know I mean actually convinced them, then it was fine, so for now, it's been now running for some time, more than a year, so everybody's fine, I haven't heard any negativity you know"

****

"Mixed feelings among hospitals and staff. Only those willing to learn how to use it will see the benefits. Others see it as a threat to their job."

****

With regards to continual developments, some participants highlighted the presence of continual and future plans regarding telemedicine in their respective institutions which give an indication of a growth, albeit, slowly. The shortage of computing equipment was still an issue but has improved since inception. However, many of the development plans have been postponed as indicated by the following responses:

****

"Most hospital managers and departmental staff have been exposed to the different telemedicine developments at exhibitions. Many plans are put on hold until the NHI is finalised."

****

"ya and umm maybe in the next years to come, we should we should be seeing a lot of new eh all the programs being integrated into telemedicine because when it is uh I'd say its cost effective and it's also efficient"

****

In terms of the future projection of telemedicine and the associated services, the general consensus amongst the participants was that there exists potential with the promise of delivering considerable gains to the South African healthcare landscape.

One of the participants provided a list of factors affecting the effective use of telemedicine as follows (via email):

****

Computer equipment and cabling theft

******

Handling computers with care

******

Information Security – (basic authentication, username and password sharing, no firewalls)

******

Identifying the difference between an IT related problem that must be taken care of by IT personnel employed by the department and a PACS related problem.

******

Difficulty to get IT Personnel to visit rural sites to fix computer/network related problems (lack of staff)

******

Viruses

******

Connectivity problems – slow connections / lost connectivity sometimes for days (slow connectivity frustrating as images are slow to download)

******

Power outages

People disconnecting power to PACS server – using the power point for vacuum cleaner etc.

****

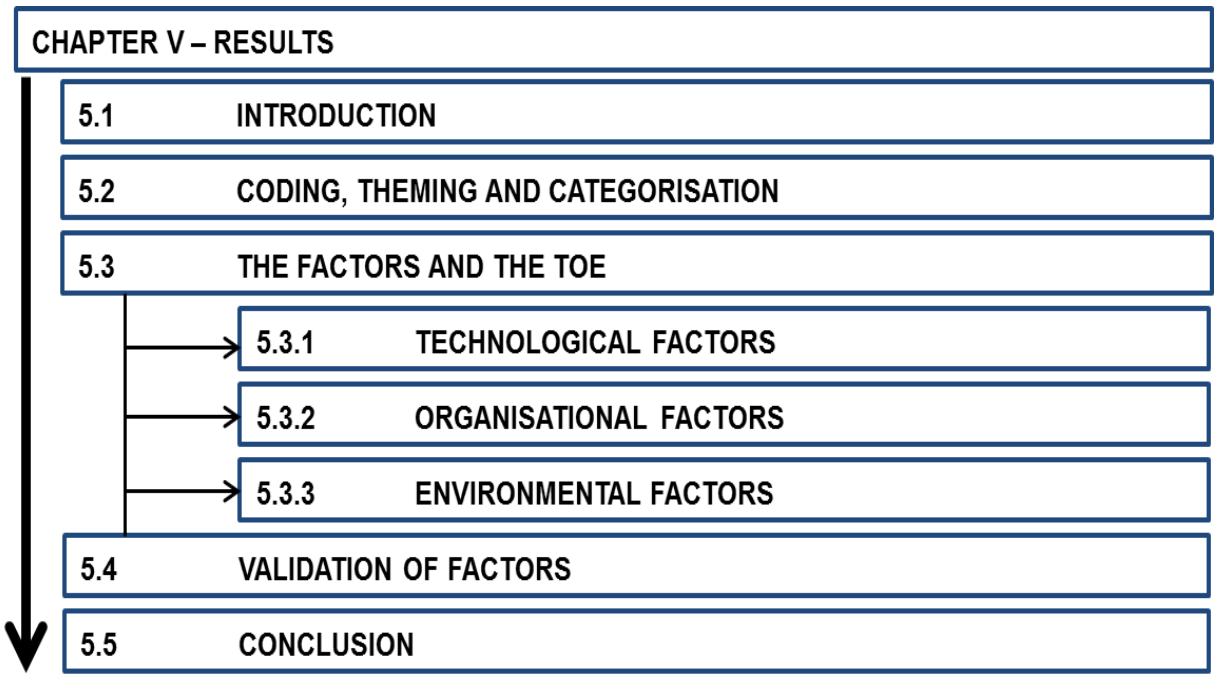
Many of these factors were mentioned in multiple interviews but some specific issues such as power outages and the handling of equipment were unique. It was indicated at the beginning of this section, that each factor is considered important for the purposes of this study regardless of its frequency or distribution.

4.5 Conclusion

Chapter IV presented the results from the interviews. Data-driven coding and open coding techniques were employed to highlight factors that were identified in the literature review and those that may have previously gone unnoticed. Chapter V begins with a table consisting of the combined factors from both literature review and the interviews. It discusses these factors in more depth. The final output of this

research (guidelines) is aimed at addressing the factors identified throughout the course of this study.

CHAPTER V: RESULTS



5.1 Introduction

In Chapter III, the results from the literature survey were presented. This was followed by the presentation of the results from the interviews in Chapter IV. This chapter collates the results and categorises them according to the TOE framework. Subsequently, a detailed discussion into each of the listed factors ensues.

5.2 Coding, Theming and Categorisation

It was established in Chapter II, that this study uses the theoretical framework components, namely technical, organizational and environmental to establish categories into which the raw data can be categorized. The factors identified in Chapter III were contextualized in broader terms and used to define the themes for the data analysis of interview transcripts. Both concept and data driven coding schemes were employed with the aim of identifying common factors and revealing any new, previously unidentified factors. These new factors were applied to the

theoretical framework to provide a concise list of factors as identified in both literature and interviews.

5.3 The Factors and the TOE Framework

The aim of the following sections is to list and briefly explain the factors identified during the study. As established, the TOE framework is employed to ascertain how the three dimensions affect the technological innovation decision making processes. The interaction of the three dimensions is taken into consideration when compiling the role-specific guidelines in Chapter VI. Sections 5.3.1, 5.3.2, and 5.3.3 commence with a tabular summary of factors affecting the adoption of telemedicine in Public Health care in resource constrained settings. These sections address the Technological, Organisational and Environmental factors respectively. Additionally, an indication of where the factor was primarily identified is provided in the “Literature” and “Interviews” columns.

5.3.1 Technological Factors

The Technological factors identified in the data collection phases of the study are presented in Table 5.1.

Technological Factors	Literature	Interviews
5.3.1.1 Inadequacy of information security measures	Y	Y
5.3.1.2 Slow and intermittent connectivity	Y	Y
5.3.1.3 Lack of equipment	Y	Y
5.3.1.4 Equipment theft	N	Y
5.3.1.5 High Equipment failure rates	N	Y
5.3.1.6 Lack of routine maintenance	Y	Y

Technological Factors	Literature	Interviews
5.3.1.7 Technological ownership and support	Y	N
5.3.1.8 Technological uniformity	Y	N
5.3.1.9 Complex deployment and procurement procedures	N	Y

Table 5.1: Technological Factors.

The above-mentioned Technological factors are further expounded as follows.

5.3.1.1 Inadequacy of Information Security Measures

The ever-present concern regarding the security of patient information is a significant technical challenge. A participant mentioned that basic authentication techniques are employed in some institutions. Additionally, there is a tendency to share a single user account and password which further compromises the system. Information is the life blood of any modern organisation and the protection of such information is of paramount importance.

5.3.1.2 Slow and Intermittent Connectivity

Poor telecommunication infrastructure development in rural areas generally hinders the portfolio of services as well as the quality of services that can be availed to these communities. Slow and intermittent connectivity make the system unreliable and frustrating to use at best. This significantly hinders the adoption of new systems and technologies as practitioners revert to their tried and tested old ways of doing things.

5.3.1.3 Lack of Equipment

The shortages of workstations make the accessibility of information gathered by the system difficult. As indicated by one of the participants interviewed, doctors have to walk longer distances to access the images on the system which consumes time and requires more effort on the part of the doctor. The

use of telemedicine should be seen to reduce the workload rather than add to it in order to be enthusiastically adopted and implemented.

5.3.1.4 Equipment Theft

Equipment and cable theft results in the interruption of system operations. This is a problem especially in rural areas where the technical staffs are generally unavailable and the time required to restore the system to an operational state is much longer. As a result, the availability of telemedicine services ceases to be reliable and quickly fall out of regular practice.

5.3.1.5 High Equipment Failure Rates

High rates of equipment failure result in both data loss and interruption of the service delivery system. Valuable information such as patient records and case files may be lost due to equipment failure. The failure of high cost equipment is particularly problematic in that higher level authorisation may be required to authorise a replacement and this could take up valuable time for which the system remains non-functional.

5.3.1.6 Lack of Routine Maintenance

The lack of a routine maintenance program poses a risk to the system functionality as well as hardware warranties and guarantees. Pro-active maintenance allows the detection of potential faults even before they occur thereby allowing for adequate preparation which in turn minimises down-time in the event of a failure. Equipment mishandling, as mentioned by one of the participants, affects the reliability of equipment and hardware thereby resulting in damage and unexpected failures which in turn will require attention outside of established schedules. Mishandling equipment effectively results in unwarranted downtime.

5.3.1.7 Technological Ownership and Support

The use of external service provides may result in the introduction of proprietary equipment and /or systems. As a result, the institutions are limited to being users of these systems and require the intervention of the service provider to effect major system changes.

5.3.1.8 Technological Uniformity

The engagement of different service providers at the institutions may result in the implementation of functional and yet disparate systems. This presents challenges in the public sector where staff rotation is not uncommon. Implementing uniform systems across the province would result in better collaboration and human resource distribution as the entire relevant staff become familiar with the system in use. Furthermore, challenges associated with human error are reduced and in unavoidable circumstances, are made more addressable.

5.3.1.9 Complex Procurement and Deployment Procedures

With persistent equipment failure and shortages, a smooth requisition process is required to ensure continuous system functionality. However, the procedures involved in procuring equipment in the public service tend to be complex and restrictive. Multiple levels of authorisation may be required thereby resulting in slow reactions to system incidents. As a result, Public Healthcare service delivery has limited flexibility.

5.3.2 Organisational Factors

The organisational factors identified in the data collection phases of the study are presented in Table 5.2.

Organisational Factors	Literature	Interviews
5.3.2.1 Skills availability and training	Y	Y
5.3.2.2 Clarity on services offered	N	Y
5.3.2.3 No clear-cut responsibility domains	N	Y
5.3.2.4 Resistance to change / change management	Y	Y
5.3.2.5 Finance and sustainability	Y	Y
5.3.2.6 Lack of Needs assessment planning	Y	N

Organisational Factors	Literature	Interviews
5.3.2.7 Lack of sound evaluation planning	Y	N

Table 5.2: Organisational Factors.

The organisational factors are discussed in the following sections.

5.3.2.1 Skills Availability and Training

The shortage of skilled workers has a negative effect on both the current and prospective services. Training strategies differ at each institution with some being proactive and others reactive. Few institutions have dedicated IT personnel and the few that do, in many cases, only have one. This problem is exacerbated in the rural institutions (which constitute the majority) where it is difficult to get IT personnel to visit and resolve any computer or network related problems. As a result, downtime can be for extended periods.

The practitioners themselves have experienced problems with opening multiple reports for cases with multiple exams and knowledge on manipulating images to clarify the display. Additionally, doctors seem to receive little training on using the system as cited by one respondent. Intern doctors typically have to learn how to use the system from doctors who have used the system previously.

5.3.2.2 No Clear-Cut Responsibility Domains

The different role-players involved in the delivery of teleradiology introduce a responsibility conflict. The PDOH owns the servers and connectivity equipment which are maintained by the in-house IT technicians (if available) and rely on supplier provided warranties in the case of hardware failure. However, the PACS software running on the systems is administered by a different entity. One of the participants indicates that there is no PACS administrator; a role he believes should be attended to. As a result, when a fault occurs, there is no direct line of responsibility and this may create confusion when it comes to maintenance.

5.3.2.3 Lack of Clarity on Services Offered

The information availed to the workforce on the implementation of telemedicine services was confined to the particular service in question. As a result, there is limited knowledge of the broader telemedicine and what it entails. This is particularly problematic because the recommendation is that telemedicine be driven from the bottom up.

5.3.2.4 Resistance to Change

The introduction of telemedicine related activity brings about changes to the daily operations of the system users. If not properly introduced, these changes may be deemed a nuisance by those who have to change or amend their style of work. Additionally, teleradiology needs to be seen as replacing some established methods and not introducing additional workloads. Enthusiasm seems to be high on the part of the practitioners; however, the various technical challenges frustrate the experience which causes doubt about the viability of teleradiology.

5.3.2.5 Finance and Sustainability

Finance and sustainability is both an environmental and organisational factor. The lack of resources for hospitals poses a barrier to the implementation of telemedicine. For the purposes of this study, finance and sustainability is discussed as an organisational factor because the primary budgeting responsibility lies within the organisation. It is as a direct result of inadequate planning for sustainability that the hospitals experience this lack of resources. In general, governments are only able to fund few telemedicine activities and as such, it is important for hospitals to have carefully developed sustainability plans for their projects to ensure the longevity of these projects. Furthermore, the lack of sustainability of projects is a result of failure to incorporate the telemedicine projects into the daily activities of the PDOH. It seems that the unsustainability of projects is seen as a major challenge for telemedicine in developing countries.

5.3.2.6 Needs Assessment Planning

There is need for assessment, before embarking on telemedicine projects, which helps with identifying the services resources and activities required for the project. The lack of a needs assessment planning poses as a barrier to the effective implication of telemedicine projects.

5.3.2.7 Evaluation Planning

The lack of trial and evaluation data and the lack of published results and shared experiences are challenges. This hampers the ability of future projects to benefit from the lessons learnt from previous projects. The propagation of successful telemedicine systems will be laden with barriers without a knowledgebase of lessons learnt and success factors identified.

5.3.3 Environmental Factors

The environmental factors identified in the data collection phases of the study are presented in Table 5.3.

Environmental Factors	Literature	Interviews
5.3.3.1 Cost of telecommunications	Y	N
5.3.3.2 Legal uncertainty	Y	N
5.3.3.3 Lack of policy and guidelines	Y	N
5.3.3.4 Inadequate power supply	Y	Y
5.3.3.5 Fly-by night service providers	N	Y

Table 5.3.3: Environmental Factors.

5.3.3.1 Cost of Telecommunications

The cost of telecommunications is an external factor which is complex to address. It has been suggested that mobile telecommunications infrastructure in Africa is too slow and expensive for internet connectivity. Furthermore, Telemedicine, by its very nature, is highly dependent on the

telecommunications infrastructure. The high cost of telecommunication has a definite impact on the overall cost of implementing telemedicine. Telecommunication costs alone, historically, have been known to render telemedicine projects unsustainable.

5.3.3.2 Legal Uncertainty

The legality surrounding the electronic transmission of sensitive information relating to patients may raise uncertainty among practitioners. The absence of legislative protection regarding the loss of unintentional distribution of sensitive information may have a stalling effect on wide use of telemedicine services.

5.3.3.3 Lack of Policy and Guidelines

Collaborative work in telemedicine activities raises many legal questions about the medical information being transmitted in multimedia form. Additionally, issues of malpractice liability and remuneration arise. The lack of a clear definitive policy regarding the legal aspects may result in increased uncertainty among both healthcare professionals and the consumers.

5.3.3.4 Inadequate Power Supply

The unreliability of power supply, especially in rural areas poses a big challenge. Effectively, scheduling becomes problematic and on-going activities are interrupted which wastes both time and resources. Additionally, the lack of power denies the communities the services they may require. This may result in losing the trust of the communities and of the system users.

5.3.3.5 Fly-By Night Service Providers

The use of fly-by night service providers results in the implementation of systems with short longevity. This effectively amounts to a waste of financial resources on systems that will not adequately provide for the needs of the institution. This is exacerbated when proprietary systems are implemented as these are more complicated to manage in-house in the event of loss of service providers.

5.4 Validation of Factors

Validity seeks to determine whether the research findings are true (Guion, Diehl, & Mcdonald, 2011). Methodological triangulation was conducted to validate the identified factors, as depicted in Figure 5.1 and subsequently discussed.

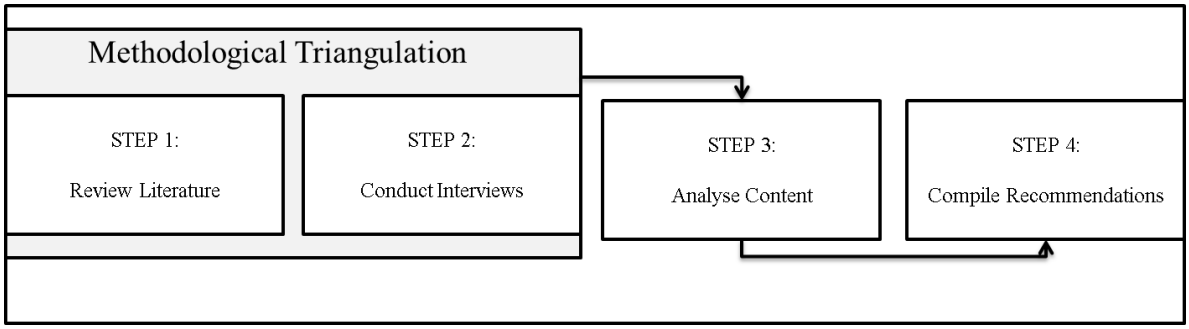


Figure 5.1: Methodological Triangulation

Risjord, Moloney, and Dunbar (2001) describe methodological triangulation as the use of two or more methods in a single line of inquiry. Factors and barriers were identified from both the literature survey and the interviews as presented in sections 5.3.1 – 5.3.3. To validate these factors, the following steps were conducted:

Step 1: A literature survey was conducted to establish the state of telemedicine or telemedicine related services in resource constrained settings. Additionally, the literature survey was used to identify the challenges already identified in preceding research related to the broader telemedicine arena. These challenges provided a foundation on which an interview questionnaire was drafted.

Step 2: Following the drafting of the questionnaires from Step 1, the five selected participants with collective experience in at least 25 institutions where teleradiology had been implemented using the PACS system, were approached for participation and interviews were conducted. The challenges that emerged from these interviews were triangulated against those identified in Step 1.

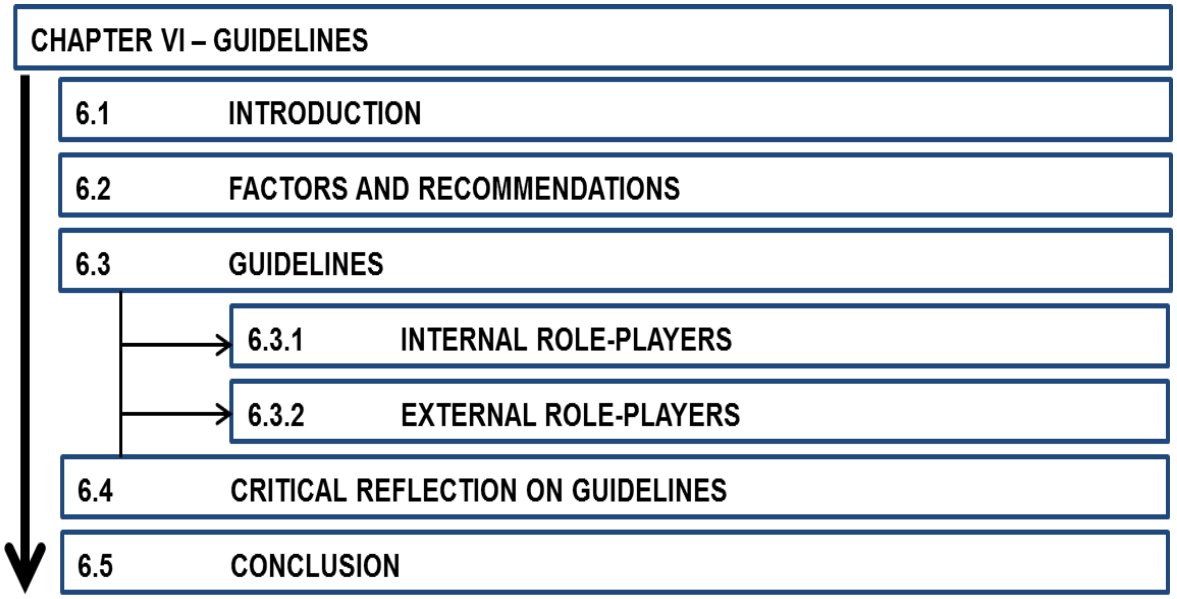
Step 3: The collected data was analysed and is presented in this Chapter.

Step 4: Recommendations on how to overcome or ease the impact of the barriers and challenges identified in steps 1 and 3 were compiled. These recommendations and guidelines are presented in Chapter VI.

5.5 Conclusion

This chapter presented the collective set of factors identified in Chapters III and IV. The factors were discussed in detail based on the researcher's own interpretation and guided by collected data. A distinction between Technical, Organisational and Environmental factors was made and this set the foundation for the development of specific guidelines that can be attributed to both a category and a specific role-player. Chapter VI identifies the relevant role-players, their typical responsibilities and the factors that fall within their domains, where-after, recommendations and guidelines are presented.

CHAPTER VI: GUIDELINES



6.1 Introduction

The primary research objective of this study is to develop guidelines for use as a source of reference when initiating and/or restructuring telemedicine projects to ensure the effective and continued use of telemedicine in Public Health in resource constrained settings.

The guidelines, to be effective, must acknowledge the capacity of each stakeholder involved and make practical recommendations accordingly. The guidelines proposed in this chapter are from a multi-stakeholder approach and are guided by the TOE framework. The following section consolidates the factors identified and presents them diagrammatically. The recommendations to address the factors are discussed and followed by an identification of the relevant role-players.

6.2 Factors and Recommendations

The use of the TOE framework enabled the broad categorisation of the identified factors. This categorisation facilitates the identification of the specific areas within the telemedicine ecosystem in which the different barriers lie and aids in identifying the role-players with influence over the specific domains. Figure 6.1 depicts the TOE framework which is populated with the consolidated list of factors from literature review and the interviews.

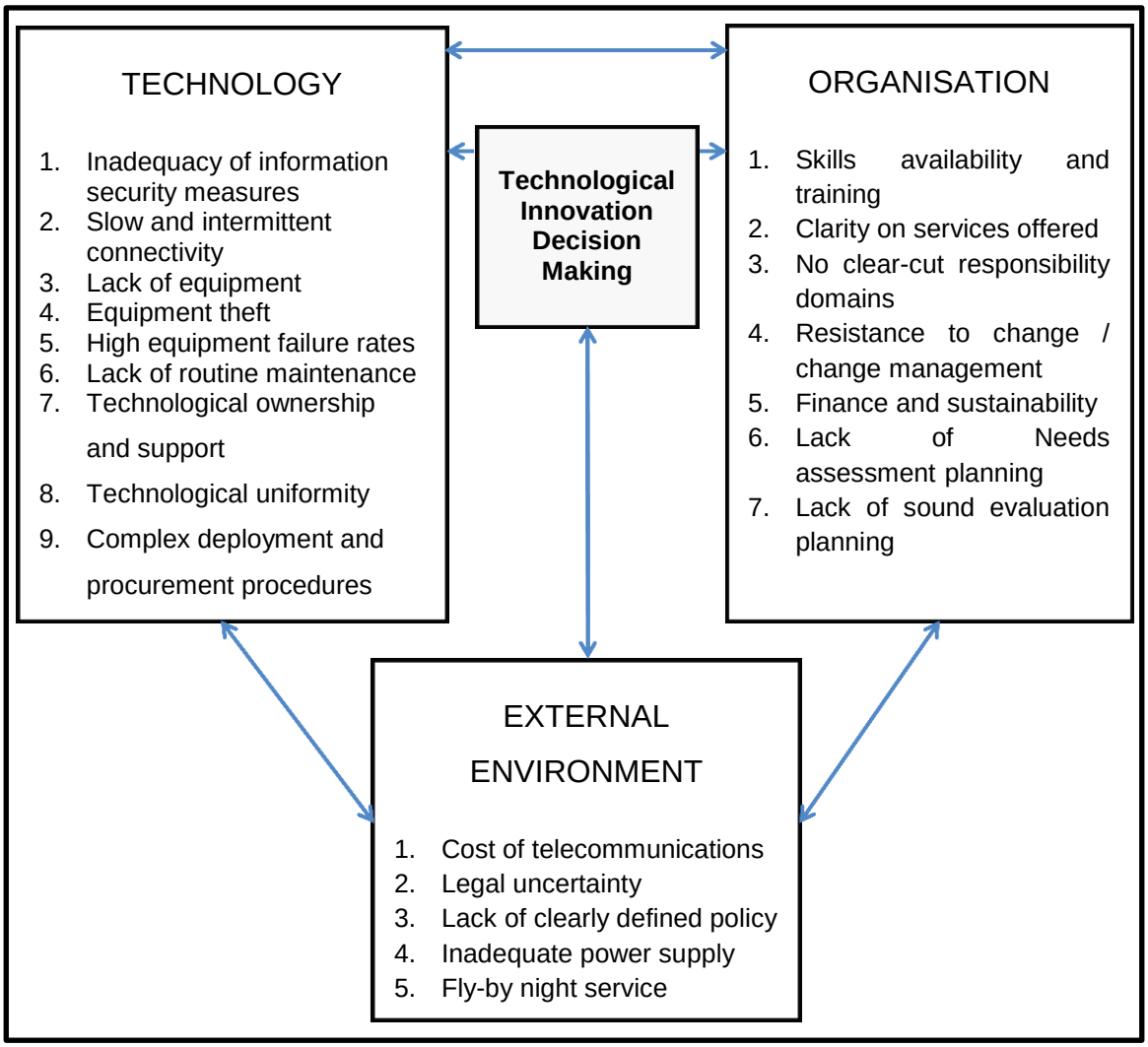


Figure 6.1: Consolidated list of factors affecting telemedicine

Table 6.1 summarises the compiled recommendations for each factor previously discussed in section 5.3 and presented in Figure 6.1. Additionally, the intent of the prescribed recommendation is detailed in the Aim column. These

recommendations may play a role in either overcoming or alleviating the impact of the challenges.

There are, within the context of this study, two environmental challenges that are complex to resolve, because the necessary authority, with the ability to effect meaningful changes, is removed from the internal organization. First, legal uncertainty is classified as a factor but the identified role-players do not have the ability to address this challenge directly. Second, the costs of telecommunications are fixed as a common characteristic of the general environment in which the institutions operate. Extensive changes would be beyond the scope of the institutions and the role-players identified in this study. Therefore, the recommendation to address these two challenges is indicated as “Out of scope” in Table 6.1.

Factors		Recommendations	Aim
5.3.1 Technological			
5.3.1.1	Inadequate information security measures	✓ Information security awareness campaigns	Alert staff to the importance of information, obligations and repercussions of mishandled information
5.3.1.2	Slow and intermittent connectivity	✓ Public-Private-Partnerships	Take advantage of Service Level Agreements to ensure high service levels
5.3.1.3	Lack of equipment	✓ Public-Private-Partnerships ✓ Lease rather than buy	Reduce start-up costs and maintenance burden while enjoying shorter upgrade cycles
5.3.1.4	Equipment Theft	✓ Secure infrastructure ✓ Access controls	Effective barring of unauthorised personnel and accountability for any equipment related movements.

Factors		Recommendations	Aim
5.3.1 Technological			
5.3.1.5	High Equipment failure rates	✓ Pre-emptive maintenance ✓ Redundancy	Ensure the availability of duplicate information in the event of a failure
5.3.1.6	Lack of routine maintenance	✓ Third party contracts	Abstraction of the maintenance burden onto third party or lessor
5.3.1.7	Technological ownership and support	✓ Avoid proprietary systems ✓ In-house system development	Implement flexible systems wholly owned and controlled by the PDOH
5.3.1.8	Technological uniformity	✓ Standardisation ✓ In-house system development planning	Allow for cross-institution inter-operability and eliminate training costs for different vendor implementations
5.3.1.9	Complex deployment and procurement procedures	✓ Decentralised decision making structures	Allow for quicker decision making and fund allocation regarding the procurement of equipment
5.3.2 Organisational			
5.3.2.1	Skills availability and training	✓ Decentralised staffing	Ensure the availability of adequate workers where most required
5.3.2.2	Clarity on services offered	✓ Telemedicine conceptual training	Allow for new ideas and initiatives to flow from the bottom-up while allowing the development of domain experts
5.3.2.3	No clear-cut responsibility domains	✓ Effective dissemination of structured organisational charts	Ensure every staff member can trace the service channel with ease and that support call is always logged with the correct entity

Factors		Recommendations	Aim
5.3.2 Organisational			
5.3.2.4	Resistance to change	✓ Change management strategies	Will gradually usher in new approaches and techniques whilst being sensitive to the learning process and role of established practice
5.3.2.5	Finance and sustainability	✓ Effective project business models	Ensure teleradiology projects make business sense and are not just an expense
5.3.2.6	Lack of Needs assessment planning	✓ Effective bottom-up requirements planning	Allow the requirements to filter up from the system users on the ground.
5.2.2.7	Lack of sound evaluation planning	✓ Establish a knowledge base from tried and tested projects	Reduce the duplication of previously identified errors and pre-empt previously identified challenges
5.2.3 Environmental			
5.2.3.1	Cost of telecommunications	Out of scope	
5.2.3.2	Legal uncertainty	Out of scope	
5.2.3.3	Lack of legislation, policy and guidelines	✓ Internal policy	The use of in-house policy based on internationally accepted practices
5.2.3.4	Inadequate power supply	✓ Backup alternative power sourced like UPS and generators	Will allow for proper shutdown in the event of a failure and generators can be used ad-hoc for critical cases when there is no power

Factors		Recommendations	Aim
5.2.3 Environmental			
5.3.3.5	Fly-by night service providers	✓ Standardized systems ✓ In-house system development	Eliminate down-time associated with system migrations or failure as a result of changes in circumstances of service providers

Table 6.1: Recommendations

6.3 Role-Players

Table 6.1 summarises the set of recommendations that can be generalised across all organisational levels. These recommendations do not explicitly provide direction for any role-player within the organisations. This section presents a summary of the organisational structure pertaining to telemedicine. The role-players are identified and their core activities are briefly outlined to define their operational scope.

Technological Category	
Description	Role-Players
The technological factors are those that are aligned with the communications infrastructure and the general availability of equipment. Factors such as the ease of use and user experience fall into this category.	• IT Managers are typically be responsible for ensuring adequate levels of equipment, evaluation of existing systems and compliance with the accepted standards. • IT Support technicians are responsible for the general maintenance and routine user support.

Organisational Category	
Organisational factors are those that apply to the day-to-day running of the institution. Decisions made within this category will typically have institution-wide effects thereby affecting the technological components.	• Heads of departments are responsible for ensuring that policies and prescribed activities are carried out accordingly within each department. They are responsible for ensuring that their department is aware of institution-wide programs and initiatives.
	• Hospital managers will oversee implementation of the various policies and procedures across all the departments. A cohesive collaborative relationship with the heads of departments ensures a seamless flow of information such as needs and requirements from the workforce in each department.
	• Clinical staff is responsible for identifying any shortcomings within the existing structures and propagating that information for assessment and / or addressing.
Environmental Category	
Environmental factors have a wide influence on all operations and as such, Role-players at this level are typically responsible for providing a blueprint for the overall operation within all three categories. Changes at this level will have a cascading effect.	• PDOH is responsible for the assimilation of national policy on a provincial level. Provincial policy is province-specific and guided by the National Policy. • NDOH is responsible for the development of a National policy.

Table 6.2: Role-players and the TOE

The role-players identified in Table 6.2 are depicted hierarchically in Figure 6.2, and labelled as Levels 1 - 5. The discussion separates the role-players into internal and external entities.

The internal role-players are those whose activities are confined to the internal structures of the organisation. External role-players are typically central points of authority that manage several institutions. The distinction between the internal and external role-players serves to categorise the recommendations according to those addressable from within the institution and those external to the institution. The structure depicted in Figure 6.2, is subsequently used in Section 6.4 to present the guidelines for the role-players shown at each level.

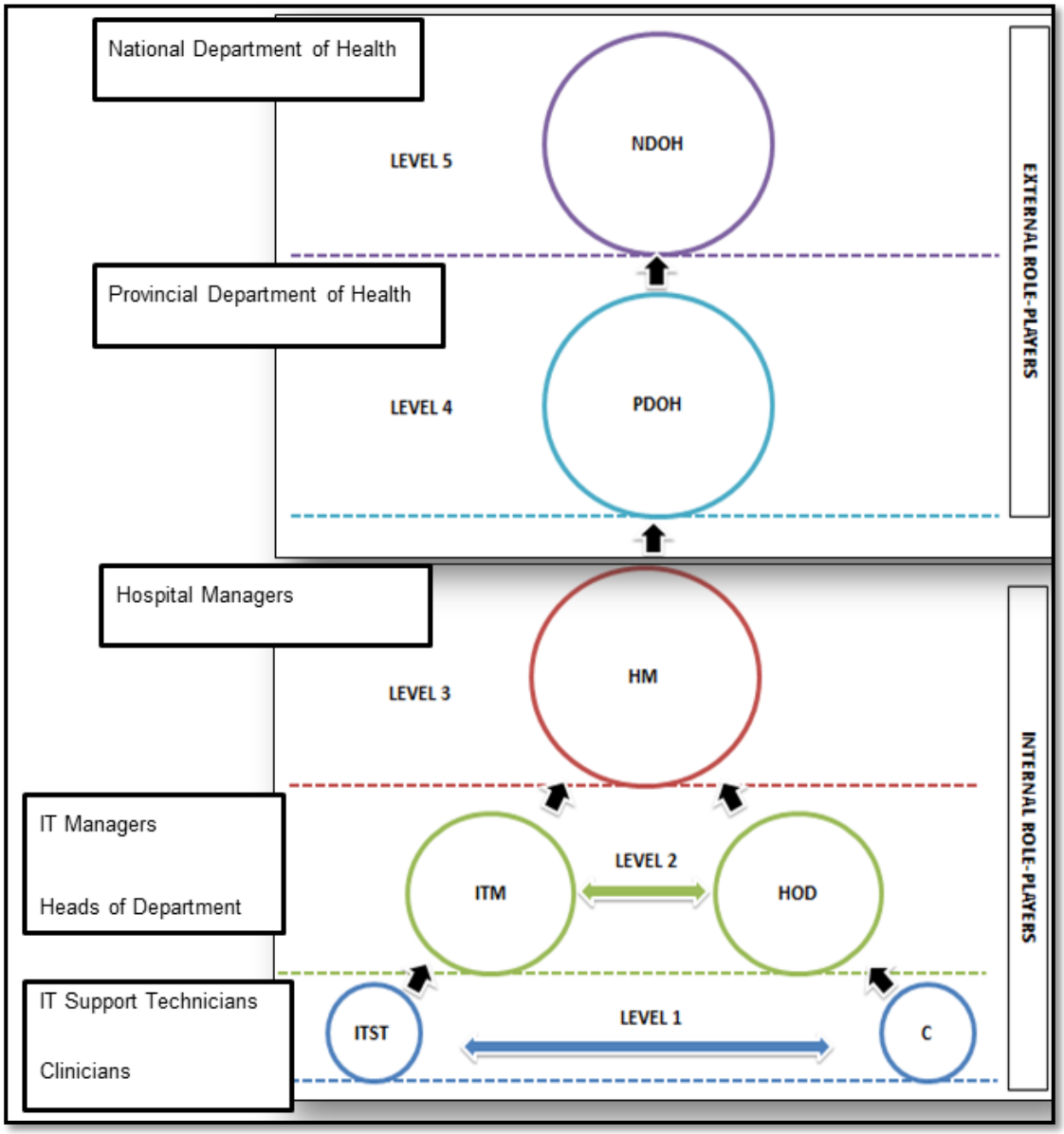


Figure 6.2: Role-players hierarchically

6.4 Guidelines

This section discusses the guidelines which are derived from the research input. Prior to presenting the guidelines, a recap of the research journey to this point may prove to be beneficial in the interpretation of the following sections. A literature review was conducted as a preliminary study to identify the factors that were previously observed in other studies. These factors are categorised according the TOE framework which guided the drafting of the interview questions.

Semi-structured interviews were conducted based on the open-ended questions aimed at both confirming the factors identified in literature and to reveal any new, previously unidentified issues of significance. These factors were categorised into the TOE framework to provide a concise list of factors. Recommendations were made following the identifications of the factors. The recommendations are global in their organisational scope and to narrow their focus, specific role-players needed to be identified. Following their identification, role-specific guidelines could be drafted.

The guidelines are structured sequentially using a bottom-up hierarchical approach to the role-players. The subsequent discussion provides the guidelines structured according to the defined role-player Levels 1-5 as depicted in Figure 6.2.

Table 6.3 lists the factors, affected role-players and the specific guidelines that directly or indirectly address each of the factors. It is followed by a detailed discussion of the guidelines. The acronyms used in Table 6.3 are as follows:

NDOH	National Department of Health
PDOH:	Provincial Department of Health
HM:	Hospital Manager
HOD:	Head of Department
ITM:	Information Technology Manager
ITST:	Information Technology Support Technician
C:	Clinician
GL:	Guidelines

Factors	AFFECTED ROLE-PLAYERS							GL
	NDOH	PDOH	HM	HOD	ITM	ITST	C	
Inadequate information security measures				x	x	x		6.4.1.1.4
Slow and intermittent connectivity					x	x		6.4.1.1.6
Lack of equipment		x	x	x	x	x	x	6.4.1.1.1 6.4.1.2.8
Equipment Theft					x	x	x	6.4.1.1.4 6.4.1.2.8
High Equipment failure rates					x	x		6.4.1.1.5
Lack of routine maintenance					x	x		6.4.1.1.5
Technological ownership and support		x	x	x	x	x		6.4.1.2.9
Technological uniformity		x	x	x	x	x		6.4.2.1.2
Complex deployment and procurement procedures	x	x	x	x	x			6.4.2.1.3
Skills availability and training			x	x	x			6.4.1.2.5 6.4.2.1.2
Clarity on services offered			x	x	x			6.4.1.2.7
No clear-cut responsibility domains			x					6.4.1.2.7
Resistance to change	x	x	x					6.4.1.3.1 6.4.1.3.3
Finance and sustainability	x	x	x	x	x			6.4.1.2.2 6.4.1.2.3 6.4.1.3.2
Lack of Needs assessment planning		x	x					6.4.1.2.1
Lack of sound evaluation planning			x	x	x			6.4.1.1.2 6.4.1.2.4 6.4.1.2.6
Cost of telecommunications	-	-	-	-	-	-	-	-
Legal uncertainty	-	-	-	-	-	-	-	-
Lack of policy and guidelines	x	x						6.4.2.1.1 6.4.2.2.1
Inadequate power supply			x		x	x		6.4.1.1.7
Fly-by night service providers		x	x					6.4.2.1.4

Table 6.3: Summarised Activity Map for Internal Role Players

6.4.1 Internal Role-Player Guidelines [Levels 1-3]

The following guidelines are applicable to the internal role-players. These are individuals and groups. Fittingly, internal role-players have the ability to address the factors and/or barriers listed in section 5.2 of Chapter V which are categorised as internal to the organisation.

6.4.1.1 Level 1: [IT Support Technicians and Clinicians]

The primary level of input and interaction, following the bottom-up hierarchical approach, is the clinicians at the service delivery side and the IT support technician on the IT infrastructure support side. The technological orientation of telemedicine results in a direct dependency on the operation of the IT infrastructure. IT support staff are essential in ensuring the continued operation of the system while the clinical staff are responsible for the direct delivery of healthcare services to the population. Guidelines pertaining to these roles are discussed.

6.4.1.1.1 Communication of issues and incidents. The clinical staff must be made aware of their responsibility to identify the challenges they may face with the system. The issues identified must be consolidated and reported to the HOD's using the appropriate channels.

6.4.1.1.2 Effective documentation. Issues regarding the operation of the equipment, availability of supplies and usability of the systems must be documented and reported to enable the identification of trends and assist in the evaluation process following prescribed changes.

6.4.1.1.3 Effective Reporting. The IT technicians, like the clinicians, should provide consolidated feedback to the IT managers.

6.4.1.1.4 Information security. The technicians are responsible for the operation of the IT infrastructure that supports the telemedicine services and as such, they should maintain adequate levels of both physical and logical security. Stringent access controls such as secure passwords and user account monitoring may assist in detecting threats that may compromise the system, and violate the privacy and confidentiality of patient information. In addition to enforcing the security measures, information

security awareness campaigns should be conducted to disseminate the information to all the relevant technology users.

6.4.1.1.5 Routine Maintenance. Maintenance is an essential component of any technology dependent service. The technical department should advocate the establishment of routine maintenance exercises and define the upgrade cycle intervals from a technical perspective. This should be done regardless of the financial implications or feasibility to ensure that the need for upgrades is noted.

6.4.1.1.6 Benchmarking. Establishing a benchmark is essential in ensuring acceptable levels of service. The IT support technicians should benchmark the data and infrastructure needs of the institution. This information is used when establishing service level agreements with service providers to ensure that adequate service levels are guaranteed by the service providers.

6.4.1.1.7 Alternative power sources. An essential component of any technological system is the availability of power. The systems put in place should, as far as possible, have alternative power sources. This alleviates any down-time experienced due to the loss of power. The installation of Uninterruptable power sources (UPS) and backup generators can ensure that the system remains functional or can be used in times of emergency.

The clinical staff and IT support technicians provide feedback that is used as input by the relevant senior role-players in the organisational hierarchy. The senior role-players are responsible for the first level of analysis based on the feedback reports generated.

6.4.1.2 Level 2 [Heads of Department / IT Managers]

These role-players are responsible for overseeing the operation of their respective departments. IT support technicians usually will report directly to the IT managers and similarly, the clinical staff report to the HOD's. In general, the same guidelines apply to both role-players as they operate at the same hierarchical level. However, the IT manager may have additional responsibilities that pertain to the IT

infrastructure. The guidelines for the first level of analysis in the hierarchy are discussed below.

6.4.1.2.1 Needs assessment. The issues raised by the clinicians and IT support technicians should be evaluated. Issues affecting basic service delivery should be appropriately prioritised and addressed accordingly. These role-players, in liaison with the hospital managers, should develop short-term and long term plans according to the urgency of the issues raised. This allows for the development of budgets based on prioritised needs with the aim of ensuring the continued, uninterrupted operation of basic health service delivery.

6.4.1.2.2 Feasibility assessments. This will aid in differentiating between remedial solutions that can be applied with little effort and impact on the overall operation of the department; against those that may require more effort and have a more global effect on the operations of the organisation. Issues with high feasibility must be addressed in a timely manner, while the less feasible can be tabled for further discussion and deliberation. The distinction between the feasible (easily attainable) and the less feasible (more complex) challenges must be made. Decisions regarding the use of external service providers to address some challenges will rely on the feasibility of the proposal and as such, feasibility assessments must be conducted to determine the long term implications of either decision.

6.4.1.2.3 Development of the business model. Public healthcare institutions are funded by the Government and, therefore, are not profit oriented. However, as already established, these institutions tend to be resource constrained. The careful development of business models for the implementation or continual operation of telemedicine services will likely reduce both setup and operational costs, thereby, improving its sustainability.

6.4.1.2.4 Evaluation planning. is important to ensure that measures instituted, either to address prevailing challenges or ensure the sustainability of activities, are indeed effective. Frequent evaluation exercises should be conducted to identify misaligned activities and goals which allow prompt

action. Evaluation is a key process in the development of a knowledgebase of successful solutions. Evaluation reports can be channelled downstream in the form of appraisals to prompt either a drastic change, or an improvement in operation or a revised approach.

6.4.1.2.5 Skills requirements assessment and development. Assessing the skills availability will cross multiple levels of the hierarchy. However, the first level of assessment will be at the departmental level. Each department should identify vacant posts and the need for skills development. Vacancies may have an adverse effect on the effective flow of information and reports and may result in a communication break. Training programs should be conducted before and during the introduction of new systems and procedures to improve the adoption of the new systems and reduce the error rates.

6.4.1.2.6 Developing a knowledgebase. A knowledgebase is essential in reducing time wasted. Solutions that have failed to produce the desired outcome should be documented to avoid their repetition. Effective solutions can quickly be referenced and applied with a low risk of failure.

6.4.1.2.7 Information dissemination and awareness. The recommended guidelines will remain ineffective if the relevant persons are not aware of their responsibilities. The HOD’s and IT manager should ensure all downstream employees are aware of the institutional activities and the general daily policies such as the need for documentation and due diligence regarding information security. The effective dissemination of such information fosters compliance and provides a basis for accountability on the part of the technology user. Activities such as regular awareness campaigns may provide an interactive platform for discussions surrounding the daily activities within the institution.

6.4.1.2.8 Ensuring adequate equipment levels. IT managers are responsible for the establishment of public-private partnerships with equipment and service providers to reduce the workload on the internal organisation, while possibly benefiting from the resource leverage of private sector organisations. Strategic use of external service providers will allow the organisation to take advantage of service level agreements to develop a

baseline from which operations can be established. Leasing equipment reduces set-up costs and shortens the upgrade cycle, thereby, maintaining an up-to-date infrastructure within the organisation.

6.4.1.2.9 Promote the use of open systems. Vendor specific technological implementations tend to be costly. Additionally, the continued operation of the technology is tied to the support from the vendor. Implementing in-house or open systems reduces the cost burden and allows greater flexibility in system operation. In-house systems can be tailored to suit the institutions dynamic needs while benefiting from the support of the technical support from the in-house staff.

6.4.1.3 Level 3 [Hospital Managers]

Level 3 relies on the consolidated input from the HOD's and IT managers. Analysis is conducted at a high level and the role-players represent the highest authority within the organisation. After the analysis process, these role-players have the authority to give the permission for organisational activities.

The hospital managers, in addition to carrying similar responsibilities as the HOD's and IT managers, albeit at a higher level, are also the gatekeepers for the institution. They are responsible for integrating both internal and external policy objectives into the daily activities of the institutions they manage. Furthermore, hospital managers are at the top of the hierarchy and thus, should have a detailed awareness of the organisational structures and chain of delegation. The following list prescribes measures that if adopted at this level, will have a higher success rate:

6.4.1.3.1 Change management. The introduction of innovations or new ways of operating brings about new challenges for the established personal. Often times, new skills are required to effectively use the new systems. This may prove to be daunting, especially in a busy environment. It is important for the change to be managed effectively to allow for a seamless transition to the new system. Change issues must be addressed from the top-down. Management should be seen to be pioneering the new systems and their influence can affect the

enthusiasm about how these changes are received at the lower levels.

6.4.1.3.2 Sustainability planning. The introduction of new services creates budgetary challenges. Ensuring existing services continue to operate uninterrupted and the new services can operate sustainably is one of the responsibilities of the hospital manager. The institutional budget is a composite of departmental budgets; therefore, the budgeting process needs to collaborative to ensure fringe expenses are not overlooked, which may render the services unsustainable. Feasibility assessments must be performed vigorously to ensure that adequate resources are available for the successful operation of the proposed projects. Public-private partnerships may help in reducing the financial burden associated with the introduction or continued operation of specific services

6.4.1.3.3 Defining responsibility domains. The clear definition of responsibility domains is a significant factor. These ensure the correct and timely flow of information within the organisation and ensure that the reporting mechanisms operate effectively. Additionally, clearly defined responsibility domains result in the quicker resolution of problems detected through the accurate direction of queries.

6.4.1.3.4 Establish Public-Private partnerships. The establishment of such partnerships allow the public service institutions to leverage the experience from the private sector. The public sector may benefit from the flexibility and efficiency associated with profit-driven organisations and service providers. Development and turnaround times tend to be much shorter in the private sector, hence, the time from planning to implementation is greatly reduced.

6.4.2 External Role-player Guidelines

External role players are typically central points of authority managing several institutions. They are responsible for the development of policies and guidelines that can be effected across several institutions.

6.4.2.1 Level 4 [Provincial Department Of Health]

The role of the PDOH is to manage the institutions within the province and oversee the development and implementation of policy. They are responsible for the allocation of resources to each institutions and the growth and development of health services within the province. The roles of the PDOHs are as follows:

6.4.2.1.1 Conducive internal policy. The role-players must ensure the policies developed are aligned to with the current goals within the province. They must be pro-development and subject to frequent evaluation and revision where necessary. Interaction with the institutions in important to ensure that the policies are not imposed but rather developed collaboratively, that they take recognise the input from all levels within the organisational hierarchy. Policy that favours the development and use of telemedicine will have a cascading effect through all the levels, thereby, rousing enthusiasm and ensuring that the necessary support structures are in place. Provincial departments are responsible for communicating the consolidated needs of the institutions and the overall needs of the province to the national department.

6.4.2.1.2 Standardisation across the province. The systems implemented within the province must be standardised to simplify administration and staff rotation. This may allow specific staff members to be rotated or temporarily deployed to institutions in need and still be fully productive with the systems available.

6.4.2.1.3 Decentralised decision making. The decision making hierarchy regarding the procurement and deployment of equipment must be flexible to allow the timely responses to the equipment needs of the institution. This reduces down-time associated with pending requests for equipment.

6.4.2.1.4 Evaluation of service providers. The PDOH should have the mandate of ensuring that the service providers granted contracts; to provide service to the institutions; are legitimate. Additionally, the service history of such providers should be scrutinised to ensure that they have the capacity to provide the required services. Evaluation at

this level allows all the downstream institutions to benefit from the exercise rather than having each institution perform the time consuming evaluations.

6.4.2.2 Level 5 [National Department Of Health]

The NDOH presents the final authority:

6.4.2.2.1 Conducive National policy. Their sole role is to ensure that national policy is aligned with international standards and targets. The Millennium Development Goals 4, 5 and 6 are aligned with healthcare. NDOH are responsible for developing a national document from which the provincial departments can base their own policy, which is customised for their particular environments. The national department is responsible for relaying the needs of the provinces to government for allocation of resources.

6.5 Critical Reflection on Guidelines

The guidelines provided in this study are not exhaustive and are presented here in an academic context. They are untested and, therefore, the researcher cannot conclusively attest to their functionality.

Some of the guidelines presented are a component of larger systemic issues and may require the further application of measures not discussed in this study. As a result, the implementation of such guidelines may prove to be more complex and resource consuming than suggested in this study.

6.6 Conclusion

The guidelines presented in this chapter are not exhaustive, however, an effort has been made to identify as many factors as reasonably possible and compile a concise list. These factors were used as input into the compiling of

recommendations whereafter guidelines were drafted per the role-players identified in section 6.3.

Chapter VII summarises the study as a whole and presents some of the limitations and future study prospects stemming from this research.

CHAPTER VII: CONCLUSION

7.1 Introduction

Chapter VI presented a set of recommendations and role-player specific guidelines as the major contribution of the study. This chapter aims to conclude this research journey by discussing the validity of this study, followed by a summary of the modular relevance of each chapter in meeting the research objectives. This is followed by a discussion of the contribution of the study. The chapter concludes with a brief discussion of the limitations of this research and future research opportunities.

7.2 Summary of Chapters

A brief description of the areas addressed by each chapter in the dissertation is provided below to conclude this research.

7.2.1 Chapter I

Chapter I introduced the health worker crisis and its effects in resource constrained settings. Telemedicine as a technology-based, health-service delivery system was introduced followed by the identification of the problem areas and the research outcomes.

7.2.2 Chapter II

Chapter II discussed the research strategy and methodology employed to meet the outcomes of the study. The qualitative survey was identified as a suitable strategy, a literature review and interviews selected as appropriate research methods, content analysis and logical argumentation chosen as applicable analysis techniques. The TOE framework was identified and applied throughout the study for suitable theoretical grounding.

7.2.3 Chapter III

Chapter III discussed telemedicine in depth. The various transmission techniques and applications were described, followed by an identification of factors and barriers to the effective adoption of telemedicine from the literature review. These factors were categorized according to the TOE framework which established a theme against which the interview questions could be drafted.

7.2.4 Chapter IV

Chapter IV presented and discussed the results from the interviews conducted. A list of factors emerged which was collated together with the list of factors identified in Chapter III to create a concise list of factors for use in the development of the guidelines.

7.2.5 Chapter V

Chapter V discussed the factors identified in chapters III and IV in depth. This discussion laid the foundation for the development of the recommendations and guidelines in Chapter VI.

7.2.6 Chapter VI

Chapter VI discussed the development process of the guidelines and presented a set of recommendations and role-player specific guidelines as the major contribution of this study.

7.2.7 Chapter VII

Chapter VII concludes the research journey by discussing the research objectives and outcomes and describes the limitations and prospects for future research stemming from this study.

7.3 Research Objectives Re-Visited

Research Question 1	Research Objective 1
How can telemedicine contribute to an improved health service delivery system?	Investigate the contribution of telemedicine to an improved health delivery system.
Chapter III discussed the impact of telemedicine in resource constrained settings. The various applications and their contribution to improved healthcare were highlighted together with a discussion of successful implementations of telemedicine.	

Research Question 2	Research Objective 2
What are the factors that pose a barrier to the effective adoption and sustenance of telemedicine in a resource constrained settings	Identify the possible barriers to the effective adoption and propagation of telemedicine in resource constrained settings.
Chapter III concluded by identifying barriers to the effective adoption of telemedicine as identified in the literature review. These factors were corroborated and supplemented by the results from the interviews as presented in Chapter IV. Chapter V consolidated the identified factors and presented them as categorised according to the TOE framework.	

Research Questions 3	Research Objective 3
What guidelines can be implemented to support the effective and sustained use of telemedicine within the abovementioned context?	Establish guidelines and recommendations that can be implemented to enhance the prospects of a sustainable telemedicine implementation in resource constrained settings.
Chapter VI presented recommendations aimed at alleviating the challenges facing telemedicine. These were further narrowed to guidelines tailored for specific role-players	

Table 7.1: Research Objectives Re-visited

7.4 Validity

A variety of approaches to judge the credibility of qualitative research findings have been developed (Cutcliffe & McKenna, 1999). This is because qualitative researchers believe the primarily quantitative concepts of validity and reliability cannot be addressed in the same way in qualitative studies. Methods and terminologies to establish the trustworthiness of qualitative studies have subsequently been developed. According to Lincoln and Guba (2005), trustworthiness involves establishing credibility, transferability, dependability and confirmability. The measures taken to address these are subsequently discussed.

7.4.1 Establishing credibility

Shenton (2004) suggests several methods to establish credibility. This study adopts research methods that are well established both in qualitative investigation in general and in information science in particular. Chapter II details the research process and methods applied in this study.

7.4.2 Establishing Transferability

Transferability seeks to demonstrate the applicability of the research findings to different situations. The study was conducted in the Eastern Cape province of South Africa which was identified as a resource constrained setting in Chapter I section 1.7. The prevailing characteristics within the province are similar to other resource constrained settings and hence, provide a suitable context from which to establish a baseline. Based on this information, the findings from this study should be transferable to other resource constrained settings with similar characteristics.

7.4.3 Dependability

Dependability seeks to verify that if the study was to be repeated using the same methods, similar results would be produced. To establish the dependability of this study, Shenton (2004) suggests that the researcher details the research design and its implementation. This would aid future researchers to repeat the work and allow for the assessment of the research practices used.

7.4.4 Confirmability

Confirmability aims to establish the role of the researchers as neutral throughout the study. Confirmabiity was established by using methodological triangulation of findings from the literature review and the interviews was conducted to ensure the factors identified would be generally consistent across the data sources. Shenton (2004) emphasises the role of triangulation in promoting confirmability.

7.5 Significance & Contribution of Study

Telemedicine harnesses great potential to address the inequitable access to health care, a problem which is prominent in resource constrained setting in developing countries. Telemedicine has generally been identified as eHealth implementations using ICT’s to provide healthcare and health-related services where the patient and practitioner are separated by geographical distance. Telemedicine has the potential

to ease the health worker shortage crisis in resource constrained settings through the wide distribution of scarce services from a central point.

Various measures have been instituted by local governments under the guidance of the United Nations to improve the access to healthcare with limited success. An emphasis on the need for technologies to bridge the growing divide in health service delivery between the rural / remote and urbanized centres has been repeatedly highlighted.

Telemedicine is one such technological instrument, however, its adoption and sustainable implementation has not been effective. This results in a few standalone success stories while the majority of the projects fail to proceed past the pilot phase. This led to the development of the research questions and the definition of the outcomes envisaged for this research.

The research output from this study may play a role in guiding the creation of a conducive ecosystem that is accommodating to the role that ICT's have to play in allowing for the growth and development of telemedicine related services. This study views this ecosystem as consisting of three categories, namely, Technical, Organisational and Environmental. Factors and barriers within each category have been identified and duly addressed in the form of recommendations and guidelines presented in Chapter VI.

With many developing countries facing challenges in meeting the MDGs targets, guidelines to support the effective implementation, adoption and sustainable use of telemedicine may become a catalyst from which telemedicine may offer a new avenue from which the health related MDGs 4, 5, and 6 can be addressed with increased urgency.

Telemedicine has the potential to alleviate the human resource related shortages in resource constrained settings, however, a more concerted effort from all stakeholders is required if telemedicine is to make significant gains in terms of growth and sustainability.

The existing environment is conducive; the technology exists and has been shown to work in developed countries. The question is not whether telemedicine can be implemented productively but how.

The contribution of this research is a set of specific guidelines based on the accounts from individuals with experience working with telemedicine and from empirical evidence collected during the literature review. As mentioned, the factors and guidelines presented are not exhaustive, however, based on the evidence presented, the role-specific guidelines may serve to align the delegation and accountability hierarchy pertaining to the barriers identified.

7.6 Limitations to this Research

The Eastern Cape was selected as a general template to represent resource constrained settings, and as such, the data collected, although valid in the Eastern Cape context, may be location specific. This may result in the identification of location specific challenges which may or may not be applicable in other resource constrained settings.

The scope of telemedicine services within the Eastern Cape was limited to teleradiology, as a result, the participants made their comments based on their exposure to teleradiology.

The views from the participants were based on their historical experience working with telemedicine whilst it was still operational in the Eastern Cape. The primary data gathered is dependent on the accurate recollection of historical events by the participants.

7.7 Future Research

The field of telemedicine is still in its infancy in developing countries. Research in areas pertaining to sustainability and development of business models may prove to be fruitful in developing systems with good longevity.

Extending the scope of this study to more provinces and getting a wider participation may result in a larger and perhaps more concise list of factors allowing for greater precision in addressing the challenges that befall the adoption and sustainable use of telemedicine in resource constrained settings.

The recommendations and guidelines presented in this study are from an academic view point. Further research areas exist in the application of these recommendations and evaluating the utility of these guidelines.

7.8 Epilogue

On September 8 2000, world leaders gathered at the United Nations summit and resolved to help citizens in the world's poorest countries to achieve a better life by the year 2015. This resolve was outlined in the MDG that were subsequently published. MDGs 4, 5 and 6 are aligned with healthcare. At present, few developing countries are on target to meet these goals by 2015, in parallel, broadband penetration has increase more than ten-fold in these same countries.

Telemedicine is an ICT-driven, health service delivery instrument that can be adopted to improve access to healthcare in the resource constrained setting. It is the hope of this researcher that this study can contribute to the effective adoption and sustainable implementation of telemedicine in these settings.

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9. APPENDICES

1.12 APPENDIX I: Institution Ethics Approval

• PO Box 77000 • Nelson Mandela Metropolitan University

Nelson Mandela Metropolitan University
for tomorrow

Summerstrand North Campus
Faculty of Engineering, the Built Environment and Information Technology

Tel : +27 (0)41 504 3646 Fax: +27 (0)504 9646
Annette.Leonard@nmmu.ac.za

Ref: H12-Eng-ITe-002
6 December 2012

Mr. Kevin Kativu (s207059581)
School of ICT

Dear Kevin

GUIDELINES FOR THE EFFECTIVE USE OF TELEMEDICINE IN PUBLIC HEALTH CARE IN RESOURCE CONSTRAINED SETTINGS

Your above-entitled application for ethics approval served at the Faculty RTI Committee of the Faculty of Engineering, the Built Environment and Information Technology.

We take pleasure in informing you that the application was approved by the Committee.

The Ethical clearance number is H12-Eng-ITe-002 and is valid for three years, from 5th December 2012 – 5th December 2015. Please inform the RTI-HDC, via your supervisor, if any changes (particularly in the methodology) occur during this time. An annual affirmation to the effect that the protocols in use are still those, for which approval was granted, will be required from you. You will be reminded timeously of this responsibility.

We wish you well with the project.

ANNETTE LEONARD
FACULTY RESEARCH ADMINISTRATOR

1.13 APPENDIX II: ECDOH Permission to Conduct Research

From: To:0415043313 20/02/2013 18:06 #375 P.001/001

Eastern Cape Department of Health

Enquiries:	Zonwabele Merile	Tel No:	083 378 1202
Date:	08th February 2013	Fax No:	043 642 1409
e-mail address:	zonwabele.merile@impilo.ecprov.gov.za		

Dear Mr Kevin Kativu

Re: Guidelines for the effective use of telemedicine in public health care in resource constrained settings

The Department of Health would like to inform you that your application for conducting a research on the abovementioned topic has been approved based on the following conditions:

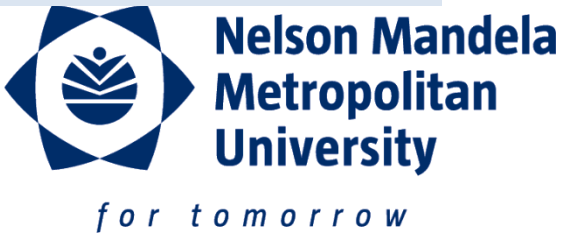
1. During your study, you will follow the submitted protocol with ethical approval and can only deviate from it after having a written approval from the Department of Health in writing.
2. You will observe and respect the rights and culture of your research participants and maintain confidentiality of their identities and shall remove or not collect any information which can be used to link the participants. You will not impose or force individuals or possible research participants to participate in your study. Research participants have a right to withdraw anytime they want to.
3. The Department of Health expects you to provide a progress on your study every 3 months (from date you received this letter) in writing.
4. At the end of your study, you will be expected to send a full written report with your findings and implementable recommendations to the Epidemiological Research & Surveillance Management. You may be invited to the department to come and present your research findings with your implementable recommendations.
5. Your results on the Eastern Cape will not be presented anywhere unless you have shared them with the Department of Health as indicated above.

Your compliance in this regard will be highly appreciated.

DEPUTY DIRECTOR: EPIDEMIOLOGICAL RESEARCH & SURVEILLANCE MANAGEMENT

PGDP EASTERN CAPE

1.14 APPENDIX III: Request for Permission to Conduct Research



• PO Box 77000 • Nelson Mandela Metropolitan University

• Port Elizabeth • 6031 • South Africa • www.nmmu.ac.za

Department of Health: Head
Private Bag X0038, BISHO, 5605
Fax: 086 666 7760
For attention:

REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN PUBLIC HEATH INSTITUTIONS

Dear

My name is Kevin Kativu, and I am a Masters student in the faculty of Engineering, the Built Environment and Information Technology at the Nelson Mandela Metropolitan University in Port Elizabeth. The research I wish to conduct for my Master's dissertation involves the effective use of telemedicine in resource constrained settings, particularly in the public health sector. This project will be conducted under the supervision of Professor Dalenca Pottas (NMMU, South Africa).

I am hereby seeking your consent to approach a number of public health institutions involved with telemedicine to provide participants for this project.

I have provided you with a copy of my dissertation proposal which includes copies of the measure and consent and assent forms to be used in the research process, as well as a copy of the approval letter which I received from the NMMU Research Ethics Committee (Human).

Upon completion of the study, I undertake to provide the Department of Health as well as the hospital manager with a bound copy of the full research report. If you require any further information, please do not hesitate to contact me on cell: 076 163 4286, and email address kevin.kativu@live.nmmu.ac.za.

Thank you for your time and consideration in this matter.

Yours sincerely,
Mr. Kevin Kativu

1.15 APPENDIX IV: Request to Participate

• PO Box 77000 • Nelson Mandela Metropolitan University

• Port Elizabeth • 6031 • South Africa • www.nmmu.ac.za

Nelson Mandela Metropolitan University

for tomorrow

Faculty of Engineering, the Built Environment and Information Technology
NMMU

Date: 2012-11-13

Ref: (Reference Number supplied upon granting of ethics approval)

Contact person: Mr Kevin Kativu

Dear Participant

You are being asked to take part in a research study. We will give you the necessary information to help you to understand the study and explain what would be expected of you (participant). The information that will be given to you will include the risks, benefits, and your rights as a participant in this research. Please feel free to ask the researcher to explain anything that is not clear to you.

To participate, it will be required that you provide written consent that will include your signature, date and initials to verify that you understand and agree to the conditions.

You have the right to mention concerns regarding the study at any time. Immediately report any new problems during the study, to the researcher. Telephone numbers of the researcher are provided. Please feel free to call these numbers.

It is important that you are aware of the fact that the ethical integrity of the study has been approved by the Research Ethics Committee (Human) of the university. The REC-H consists of a group of independent experts that has the responsibility to ensure that the rights and welfare of participants in research are protected and that studies are conducted in an ethical manner. Studies cannot be conducted without REC-H's approval. Queries with regard to your rights as a research subject can be directed to the Research Ethics Committee (Human), Department of

Research Capacity Development, PO Box 77000, Nelson Mandela Metropolitan University, Port Elizabeth, 6031.

If no one could assist you, you may write to: The Chairperson of the Research, Technology and Innovation Committee, PO Box 77000, Nelson Mandela Metropolitan University, Port Elizabeth, 6031.

Participation in research is completely voluntary. You are not obliged to take part in any research. If you do take a part, you have the right to withdraw at any given time during the study, without punishment or loss of benefits.

It should be noted that the study may be ended at any time by the researcher, the sponsor or the Research Ethics Committee (Human).

Although your identity will at all times remain confidential, the results of the research study may be presented at scientific conferences or in specialist publications. The researcher intends to utilise a voice recorder during the interviews and your voice will be recorded. If this poses a privacy concern, you may choose to have your voice digitally distorted. This process is explained in the consent form.

This informed consent statement has been prepared in compliance with current statutory guidelines.

Yours sincerely

Mr. Kevin Kativu
RESEARCHER

1.16 APPENDIX V: Hospital Manager /IT Interview Questions

HOSPITAL MANAGER / IT

Basic Information (to be completed)

Department			
Years of experience		Total	Telemedicine
Institutions	1.	Roles	1.
	2.		2.
	3.		3.
	4.		4.

SPECIFIC QUESTIONS

1. Which telemedicine services does your institution offer?
2. Can you describe the equipment you use to provide these services?
3. Is the equipment serviced regularly or is maintenance conducted only after a fault is detected?
4. Are there additional costs levied onto the patients who make use of telemedicine services?
5. Of all the services you offer, which do you feel are not being optimally utilized? , are there measures in place to mitigate against this?
6. Does the institution have specifically trained staff to deal with telemedicine services?
7. Is training offered on a regular basis? Explain?
8. Is staff turnover problematic? Explain?
9. Please indicate the availability of policy/guidelines/procedures on a national, provincial or institutional level that your institution can make use of.
10. Do you feel there is room for growth into new or specialist areas of telemedicine such as telesurgery and teleproctoring? Please explain.
11. What benefits do you think the South African healthcare landscape will gain from the further development of telemedicine? Please motivate.

GENERIC QUESTIONS (TO BE ASKED TO BOTH SETS OF PARTICIPANTS)

12. To the best of your knowledge, is the system in use a uniform system within the department and across institutions?
13. What is your view of the facilities (equipment) in your institution?
14. During your time at the telemedicine facility, have there been any further developments or improvements with regards to the equipment or services offered?
15. Do you feel there is adequate enthusiasm surrounding telemedicine in your institution? Please motivate your response.
16. Are you aware of any strategic or developmental plans to improve or further develop telemedicine within your hospital? To the best of your knowledge, please describe any such plans.

1.17 APPENDIX VI: Telemedicine Practitioner Interview Questions

TELEMEDICINE PRACTITIONER

Basic Information (to be completed)

Department			
Years of experience		Total	Telemedicine
Institutions	1.	Roles	1.
	2.		2.
	3.		3.
	4.		4.

SPECIFIC QUESTIONS

1. 1. Describe your day to day interaction with telemedicine and please give a description of the services rendered throughout the day.
2. Which services do you feel are:
    a. Not being utilized to their full potential?
    b. Over-utilized?

* In your opinion, what are the reasons?

3. To the best of your knowledge, what support structures have been put in place for institutions practicing telemedicine (e.g., workshops, training days, visitations etc.)?
4. What is the general availability of the remote consulting practitioner?
    a. Ad-hoc
    b. Scheduled.
5. Describe your interaction with practitioners from other institutions in order to provide the telemedicine services?
    a. Is this interaction a requirement for the services that you render?
    b. Explain why?
6. In your use of telemedicine, do you find any parts of the overall system frustrating? Please explain.
7. How do you go about resolving any problems you may have with the system?

8. Is there a set procedure for problem solving or is this based purely on your interpretation and skill? Please elaborate.
9. Do you feel there is room for growth into new or specialist areas of telemedicine such as telesurgery and teleproctoring? Please explain.
10. What benefits do you think the South African healthcare landscape will gain from the further development for telemedicine? Please motivate.

GENERIC QUESTIONS (TO BE ASKED TO BOTH SETS OF PARTICIPANTS)

11. To the best of your knowledge, is the system in use a uniform system within the department and across institutions?
12. What is your view of the facilities (equipment) in your institution?
13. During your time at the telemedicine facility, have there been any further developments or improvements with regards to the equipment or services offered?
14. Do you feel there is adequate enthusiasm surrounding telemedicine in your institution? Please motivate your response.
15. Are you aware of any strategic or developmental plans to improve or further develop telemedicine within your hospital? To the best of your knowledge, please describe any such plans.

10 PUBLICATIONS

1.18 Challenges Facing Teleradiology in the Eastern-Cape Public Health Service: An IT Technician Perspective

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Abstract

Telemedicine has made great strides in the developed world with remote populations benefiting from the improved access to healthcare. In particular, the sub- field of teleradiology has shown great promise for enabling the wider delivery of specialist services. However, in resource constrained settings such as developing countries, telemedicine has had limited success and as a result, the equitable access to healthcare for remote populations remains inconceivable. This is exacerbated by the migration of healthcare professionals both domestically and internationally. The public sector has suffered the most with acute staff shortages in the public healthcare institutions, more so in rural and remote areas. This paper presents the challenges facing the adoption and growth of teleradiology, a sub component of telemedicine, in resource constrained settings from the perspective of the IT technicians involved in the service delivery. Four IT technicians from different institutions and operating backgrounds within the Eastern Cape were selected for participation in semi-structured interviews and a methodological triangulation with literature was conducted. The results thus far point to an enthusiastic environment coupled with a semi-capable infrastructure but however hampered by staff shortages and a general lack of propulsion to adequately encourage the wider use of teleradiology.

Keywords: *Teleradiology, Eastern-Cape, Technical Perspective*.

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1. Introduction

The recent advances in the Information and Communications Technology (ICT) field have had a profound effect on the accessibility of medical services, primarily in previously remote and disadvantaged areas. However, South Africa, and the rest of Sub-Saharan Africa face a critical shortage of medical practitioners and specialists. [1]. This problem is most persistent in Africa and its effects are particularly severe in the public sector. The shortage of health workers and medical practitioners can be attributed to a large range of factors including the persistent movement or 'brain drain' of health workers from the less developed countries [2]. The public sector employs the majority of the health workers in developing countries and as a result, factors such as budgetary constraints and poor working conditions usually associated with the public sector are a significant contributor to the migration [3]. The migration flow of health professionals can be summarized by the push, pull and stick effects as illustrated below [4]

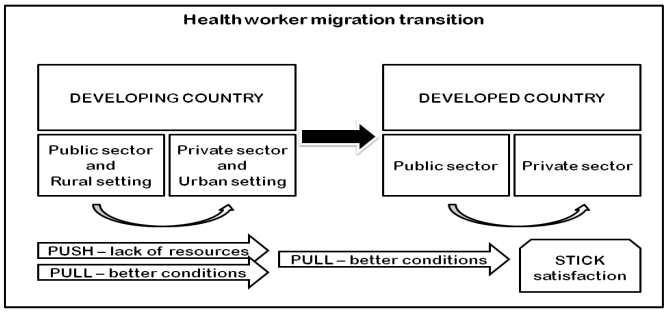


Figure 1. Push and pull factors driving migration.

As an indication of the scale of this problem, in 2010, the WHO adopted a global code of practice on the international recruitment of health personnel with a focus on ethics and protecting less-developed countries from the open-ended migration cycle [5]. In 2006, the World Health Organization identified 57 countries with a critical health worker shortage and of these, 36 were from sub-Saharan Africa [6]. The shortage of health care practitioners particularly in resource constrained settings has resulted in a growing demand of service delivery alternatives to supplement the existing service delivery channels. Telemedicine is an ICT based service that can be used for the remote delivery of healthcare thereby allowing for wider access to medical specialist services such as radiology. Teleradiology has been used in an excess of 20 sites in the Eastern Cape which is known to be the poorest province in South Africa. These services have the potential to deliver both economic and healthcare wins in rural communities, however, capacity problems and the general lack of support for telemedicine as a whole has had a negative bearing on the success of teleradiology in the Eastern Cape. In this paper, teleradiology and the challenges faced in its deployment and use in the Eastern Cape are explored. In Section 2 of the paper telemedicine and teleradiology are discussed and the various applications and typical use scenarios are identified. This is followed by a brief discussion of the theoretical grounding and methodological approach of the study in Section 3. The results of the study are presented in Section 4. The paper ends with a discussion of the results in Section 5 and a set of recommendations going further in Section 6. Telemedicine and teleradiology are further discussed in the following section.

2. eHealth, Telemedicine and Teleradiology

EHealth can be defined as "*the cost-effective and secure use of information and communications technologies in support of health and health-related fields, including health-care services, health surveillance, health literature, and health education, knowledge and research*" [7]. Telemedicine is a constituent of eHealth and teleradiology is a sub-service of telemedicine. Narrowing down from the definition of eHealth, telemedicine can be described as the use of telecommunications technology for medical diagnostic, monitoring, and therapeutic purposes where distance and/or time separate the patient and health care provider [8].

Telemedicine emerges as a potential solution for the shortage of heath care workers and specialists by providing a means for the delivery of health related services to isolated rural areas [9]. Telemedicine has also been noted to have an economic impact on rural communities resulting from reduced travel (lower transportation costs) and

greater productivity due to the decrease in missed work time, additionally; it offers employment opportunities within the communities stemming from the increased local laboratory and pharmaceutical activity [10].

Presently, telemedicine has applications in clinical, educational and administrative services. The table below provides a general overview of these applications.

APPLICATION	STORE AND FORWARD	REAL-TIME	SERVICES
CLINICAL	Digital images may be sent via e-mail direct to the specialist for diagnosis and management advice	Videoconferencing may be used for clinical consultations involving the patient, Primary care provider (General Practitioner) and specialist at a tertiary hospital	Telepathology Telepaediatrics Teledermatology Teleradiology Teleultrasound Teleophthalmology Teledentistry
EDUCATIONAL	Educational material can be sent by mail in the form of tutorial notes, audio or video resources	Lectures can be transmitted via videoconference to multiple sites simultaneously	Teleproctoring Telementoring
ADMINISTRATIVE	Memo and meeting notes may be mailed by post or fax for perusal at a time that is convenient for the recipient	Telephone conferencing may be used for interactive discussions between participants	Teleconferencing Tele-collaboration

Table 2. Applications of telemedicine [9].

Teleradiology is a Store and forward application of telemedicine. These applications typically have low infrastructure and connectivity requirements that render them particularly suitable for the delivery of rural and remote health care. Teleradiology can be described as the ability to obtain images in one location, transmit them over a distance for diagnosis at a different location and has been cited as one of the most technologically and clinically advanced areas for telemedicine applications [11].

Teleradiology projects have been attempted in South Africa and were one of the primary focus areas in the telemedicine strategy [12]. A number of research projects have been conducted in the Eastern Cape with the aim to determine the development of, and challenges facing eHealth and telemedicine. The focus of this paper is to determine the specific challenges facing teleradiology as a service in the Eastern Cape public health sphere.

3. Methodology

This study took a qualitative approach so as to obtain an in-depth understanding of the day-to-day activities surrounding teleradiology from the perspective of the IT Technicians. Interviews were deemed as an appropriate method of obtaining an open, real-world view from the participants'.

3.1. THEORETICAL GROUNDING

The Technical, Organisational, Environmental framework (TOE) is an organisational level theory that explains how the three elements (Technology, Organisation, Environment) may influence a firm's technological adoption decisions [13] and is depicted in figure 2.1. It has further been described as a useful analytical framework that can be used for studying the adoption and assimilation of different types of IT innovation [14]. The framework was used in this research as a template on which the interview questions were structured. The TOE framework is additionally used in the process of identifying the challenges and barriers associated with each dimension of the assimilation process.

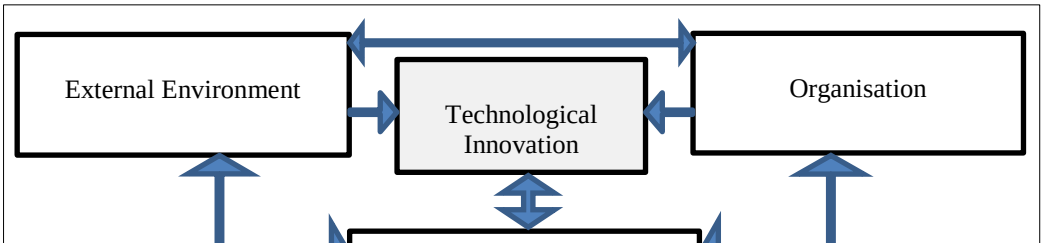


Figure 2. T.O.E Theoretical framework

3.2 RESEARCH PROCESS

The research process is depicted in figure 2.3 and is explained in detail thereafter.

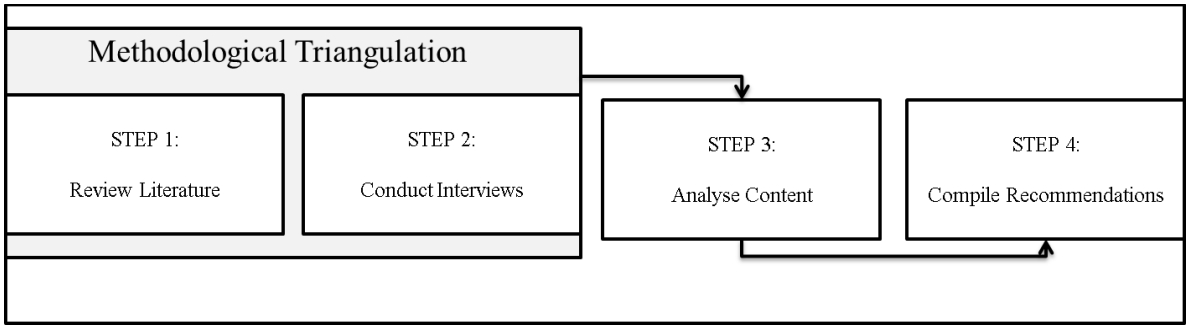


Figure 3: Research Process

In Step 1: A literature review was conducted to establish the state of telemedicine or telemedicine related services within the Eastern-Cape. Additionally, the literature review was used to identify the challenges that have already been identified in preceding research findings relating to the broader telemedicine. These challenges provided a foundation on which an interview questionnaire was drafted.
In Step 2: Following the drafting of the questionnaires from step 1, the four IT Technicians who had collective experience in at least 25 institutions where teleradiology had been implemented using the PACS system, were approached for participation and interviews were conducted.
In Step 3: The collected data was then analysed and challenges pertaining to teleradiology identified.

In Step 4: Recommendations on how to overcome or ease the impact of the barriers and challenges identified in steps 1 and 3 were compiled.

4. Results

The table below summarises the results from the interviews and also provides an indication of whether the identified barriers have been cited in the literature surveyed for this study.

Factors	Literature	1	2	3	4
5.1 Technological					
5.1.1 Inadequate information security measures	N	N	N	N	Y
5.1.2 Telecommunications infrastructure	Y	Y	N	N	Y
i. Slow and intermittent connectivity	Y	N	N	N	Y
ii. Lack of equipment	Y	Y	N	Y	Y
iii. Equipment Theft	N	Y	Y	Y	Y
iv. High Equipment failure rates	N	N	N	N	Y
v. Lack of routine maintenance	Y	N	Y	Y	N

5.2 Organisational					
5.2.1 Skills availability and training	Y	Y	Y	Y	Y
5.2.2 No clear-cut responsibility domains	Y	N	Y	N	Y
5.2.3 Resistance to change	Y	N	N	N	N
5.2.4 Finance and sustainability	Y	N	N	N	N
5.2.5 Lack of Needs assessment planning	Y	N	N	N	N
5.2.6 Change management issues	Y	N	N	N	N
5.2.7 Lack of sound evaluation planning	Y	N	N	N	N
5.3 Environmental					
5.3.1 Cost of telecommunications	Y	N	N	N	N
5.2.2 Lack of legislation, policy and guidelines	Y	N	N	N	N
5.3.3 Inadequate power supply	Y	N	N	N	Y

Table 2. Challenge identification by participants

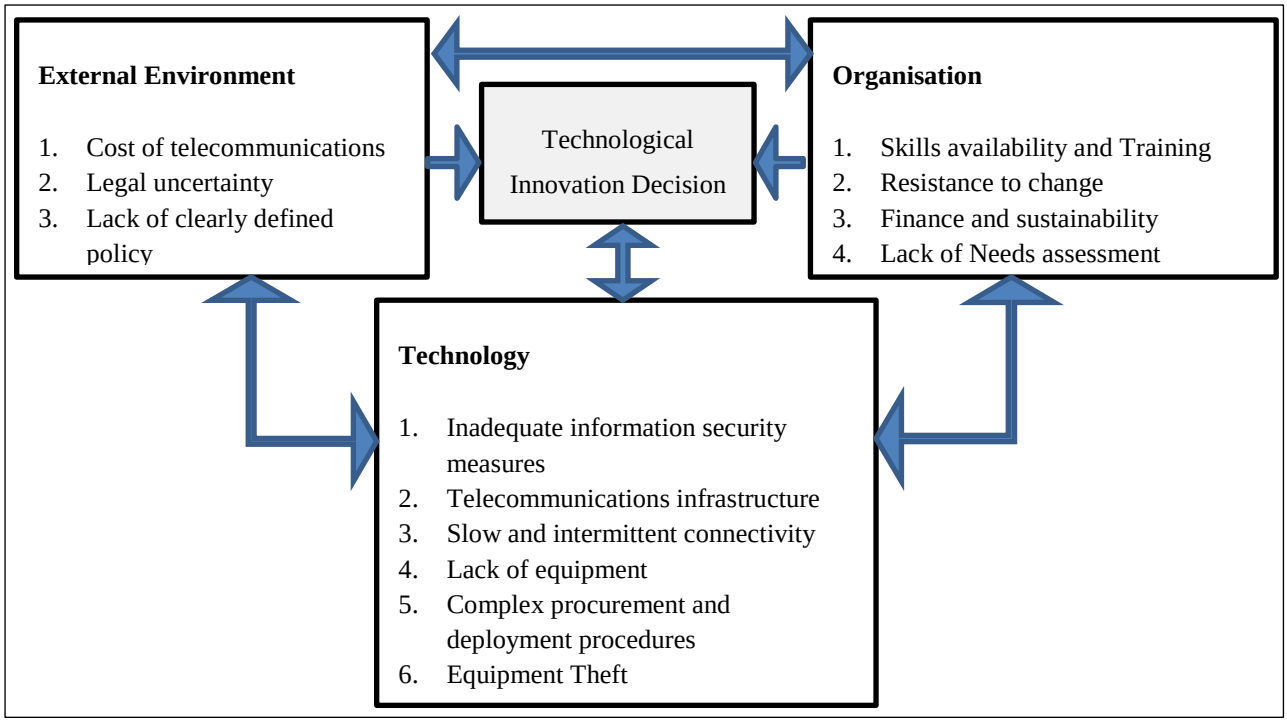
The results summarise the individual perspectives of the participants and indicate the prevailing challenges in each of their operating environments. The prevalence of technological barriers may be attributed to the sample group selected for interviews. The technicians are likely to be more technologically inclined and hence more aware of challenges specific to their area of expertise.

5. Discussion

The challenges identified have been categorized accordingly in the TOE framework as shown in figure 4. The framework further displays the interaction of the different factors.

5.1 TECHNOLOGICAL FACTORS

5.1.1 Inadequacy of information security measures - The ever-present concern regarding the security of patient information is a significant technical challenge. A participant mentioned that basic authentication techniques are employed in some institutions. Additionally, there is a tendency to share a single user account and password which further compromises the system.



5.1.2 Telecommunications and infrastructure – Poor telecommunication infrastructure development in rural areas generally hinders the portfolio of services as well as the quality of services that can be availed to these communities. The following are challenges associated with telecommunications and infrastructure:

i. Slow and intermittent connectivity introduced frustrating levels of latency.
ii. One of the participants cited a shortage of workstations in the wards which results in doctors having to walk longer distances to access the images on the system thereby consuming time and requiring more effort on the part of the doctor.
iii. Equipment and cable theft, especially in rural areas may leave systems non-functional for extended periods due to the unavailability of technical staff, thereby resulting in a halt in service delivery
iv. High rates of equipment failure were cited to be partially responsible for the loss of data.
v. Maintenance and handling issues were also identified, the mishandling of equipment in some institutions results in unnecessary and unwarranted down time.

5.2 ORGANISATIONAL FACTORS

5.2.1 Skills availability and training - The shortage of skilled workers has a negative effect on both the current and prospective services. Training strategies differ at each institution with some being proactive and others reactive. Few institutions have dedicated IT personnel and the few that do in many cases only have one. This problem is exacerbated in the rural institutions (which constitute the majority) where it is difficult to get IT personnel to visit and resolve any computer or network related problems; as a result, downtime can be for extended periods.

On the other hand, the practitioners themselves have experienced problems with opening multiple reports for cases with multiple exams as well as knowledge on manipulating images to clarify the display. Additionally, doctors seem to receive little training on using the system as cited by one respondent. Intern doctors typically have to learn how to use the system from doctors who have made use of the system previously.

5.2.2 No clear-cut responsibility domains - The different role-players involved in the delivery of teleradiology introduce a responsibility conflict. The department of health owns the servers and connectivity equipment which are maintained by the in-house IT technicians (if available) and lean on supplier provided warranties in the case of hardware failure. However, the PACS software running on the systems is administered by a different entity. One of the participants indicates that there is no PACS administrator; a role he believes should be attended to. As a result, when a fault occurs, there is no direct line of responsibility and this may create confusion when it comes to maintenance.

5.2.3 Resistance to change - The introduction of telemedicine related activity brings about changes in the day-to-day operations of the system users. If not properly introduced, these changes may be deemed a nuisance by those who have to change or make amendments to their style of work. Additionally, teleradiology must be seen to be replacing some established methods and not introducing additional workloads. Enthusiasm seems to be high on the part of the practitioners; however, the various technical challenges frustrate the experience thereby casting doubt on teleradiology.

5.2.4 Finance and sustainability - Finance and sustainability is both an environmental and organisational factor and the lack of resources for hospitals pose as a barrier for the implementation of telemedicine. It is as a direct result of inadequate planning of sustainability that the hospitals have lack of resources. Governments are only able to fund for a few African telemedicine activities and as such, it is important for hospitals to have careful sustainability plans for their projects to ensure the longevity of these projects. Funding for the public health sector in South Africa is received through government provisional departments of health and this leads to lack of human and financial resource commitments to hospital projects. Furthermore, the lack of sustainability of projects is a result of failure to incorporate the telemedicine projects into the daily activities of the department of health. It seems that the unsustainability of projects is seen as a major challenge for telemedicine in developing countries.

5.2.5 Needs assessment Planning - Before embarking on telemedicine projects, there is need for assessment which helps with identifying the services resources and activities required for the project. The lack of needs assessment planning poses as a barrier to the effective implication of telemedicine projects.

5.2.6 Evaluation Planning - The lack of trial and evaluation data as well as the lack of published results and shared experiences as a challenge. This hampers the ability of future projects to benefit from the lessons learnt from those that precede. Without a knowledgebase of lessons learnt and success factors identified, the propagation of successful telemedicine systems will be laden with barriers.

5.3 Environmental Factors

5.3.1 Cost of Telecommunications – This is an external factor which is complex to address. It has been suggested that mobile telecommunications infrastructure in Africa is too slow and expensive for internet connectivity. Furthermore Telemedicine is highly dependent on the telecommunications infrastructure. The high cost of telecommunication has a definite impact on the overall cost of implementing telemedicine. Telecommunication costs alone historically have been known to render telemedicine projects unsustainable.

5.3.2 Lack of policy, legislation and guidelines – Collaborative work in telemedicine activities may raise many legal questions with regards to the medical information transmitted in multimedia form. Additionally, issues of malpractice liability and remuneration crop up. The lack of a clear definitive policy regarding the legal aspects may result in increased uncertainty among both healthcare professionals and the consumers.

5.3.3 Inadequate power supply – The unreliability of power supply, especially in rural areas poses a big challenge. Effectively, scheduling becomes problematic and on-going activities are interrupted thereby wasting time and resources. Additionally, the lack of power denies the communities of the services they may require thereby losing the trust of the communities as well as that of the system users.

6. Recommendations

The table below shows a summary the compiled recommendations for each factor identified. Additionally, the intent of the prescribed recommendation is detailed in the aim column. These recommendations may play a role in either overcoming or alleviating the impact of the challenges. However, the environmental challenges are complex to resolve as the authority with the ability to effect changes is removed from the internal organization. Other environmental factors are fixed as a common characteristic of the general environment in which the institutions are established. Changes would have to be far reaching beyond the scope of the institutions.

CHALLENGES	RECOMMENDATIONS	AIM
5.1 Technological		
5.1.1 Inadequate information security measures	Information security awareness campaigns	Alert staff on the Importance of information, obligations and repercussions of mishandled information.
5.1.2 Telecommunications infrastructure:		
i. Slow and intermittent connectivity	Public-Private-Partnerships	Take advantage of Service Level Agreements to ensure high service levels
ii. Lack of equipment	Public-Private-Partnerships Lease rather than buy	Reduce start-up costs and maintenance burden while enjoying shorter upgrade cycles
iii. Equipment Theft	Secure infrastructure Access controls	Effective barring of unauthorised personnel and accountability for any equipment related movements
iv. High Equipment failure rates	Pre-emptive maintenance Redundancy	Ensure the availability of duplicate information in the event of a failure
v. Lack of routine maintenance	Third party contracts	Abstraction of maintenance burden onto third party or lessor
5.2 Organisational		
5.2.1 Skills availability and training	Decentralised staffing	Ensure the availability of adequate workers where most required
5.2.2 No clear-cut responsibility domains	Effective dissemination of	Ensure every staff member can trace the

	structured organisational charts	service channel with ease and that support call is always logged with the correct entity
5.2.3 Resistance to change	Change management strategies	Will gradually usher in new approaches and techniques whilst being sensitive to the learning process and role of established practices
5.2.4 Finance and sustainability	Effective project business models	Ensure teleradiology projects make business sense and are not just an expense
5.2.5 Lack of Needs assessment planning	Effective bottom-up requirements planning	Allow the requirements to filter up from the system users on the ground.
5.2.6 Lack of sound evaluation planning	Establish a knowledge base from tried and tested projects	Reduce the duplicity of previously identified errors and pre-empt previously identified challenges
5.3 Environmental		
5.3.1 Cost of telecommunications	Difficult to address this factor	
5.3.2 Lack of legislation, policy and guidelines	Internal policy	The use of in-house policy based on internationally accepted practices
5.3.3 Inadequate power supply	Backup alternative power sourced like UPS and generators	Will allow for proper shutdown in the event of a failure and generators can be used ad-hoc for critical cases when there is no power

7. Conclusion

In conclusion, teleradiology is an essential service that has the potential to address a vast amount of the radiology needs in the Eastern-cape public sector. Teleradiology typically has lighter requirements on the telecommunications infrastructure and has been cited to work well in rural settings with minimal connectivity. However, in addition to budgetary constraints, a host of technical challenges have been identified. These challenges had a constricting effect on the satisfactory use of teleradiology. Although teleradiology is expected to have lighter requirements on the communications infrastructure, the prevailing conditions have not been adequate for the effective management of the high image volumes. Technicians have cited the slow connections, power availability, equipment availability and theft as well as maintenance problems as major technical barriers. Staff shortages along with blurred lines of responsibility emerge as organizational constraints while the availability of a stable power supply is an external factor that has a crippling effect on service delivery. Awareness campaigns have the potential to address some information security concerns by cultivating a culture of awareness and accountability. In addressing the technological and infrastructural concerns, the private sector may have a role to play. A more flexible budget in the private sector will allow for more targeted spending and development. Strategic equipment procurement may result in lower setup, maintenance and upgrade costs thereby reducing the burden on an already overstretched staff complement. Well defined organizational structures coupled with effective organizational planning will certainly see the prospects of successful teleradiology projects grow in the Eastern Cape.

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