DEVELOPING AN E-HEALTH FRAMEWORK THROUGH ELECTRONIC HEALTHCARE READINESS ASSESSMENT

by

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DECLARATION:

In accordance with Rule G 4.6.3, I hereby declare that the above- mentioned thesis is my own work and that it has not previously been submitted for assessment to another university or for another qualification.

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DATE: 13 October 2010

ABSTRACT

The major socio-economic development challenges facing most African countries include economic diversification, poverty, unemployment, diseases and the unsustainable use of natural resources. The challenge of quality healthcare provisioning is compounded by the HIV/AIDS pandemic in Sub Saharan Africa. However, there is a great potential in using electronic healthcare (e-health) as one of the supportive systems within the healthcare sector to address these pressing challenges facing healthcare systems in developing countries, including solving inequalities in healthcare delivery between rural and urban hospitals/clinics.

The purpose of this study was to compile a Provincial E-health Framework (PEHF) based on the feedback from electronic healthcare readiness assessments conducted in selected rural and urban hospitals/clinics in the North West Province in South Africa. The e-healthcare readiness assessment was conducted in the light of effective use of ICT in patient healthcare record system, consultation among healthcare professionals, prescription of medication, referral of patients and training of healthcare professionals in ICT usage.

The study was divided into two phases which were phases 1 and 2 and a qualitative design supported by a case study approach was used. Data were collected using different techniques to enhance triangulation of data. The techniques included group interviews, qualitative questionnaires, photographs, document analysis and expert opinions. The outcome of the assessment led to the compilation of the PEHF which was based on Service Oriented Architecture (SOA). SOA was chosen to integrate the hospitals/clinics' ICT infrastructure yet allowing each hospital/clinic the autonomy to control its own ICT environment. To assist hospitals/clinics integrate their ICT resources, this research study proposed an Infrastructure Network Architecture which clustered hospitals/clinics to share common ICT infrastructure instead of duplicating these resources. Furthermore, processes of the e-health services (e-patient health record system, e-consultation system, e-prescription system, e-referral system and e-training system) were provided to assist in the implementation of the PEHF. Finally, a set of guidelines were provided by the research study to aid the implementation of the PEHF.

Key words: *e-health readiness assessment, e-health framework, e-health solutions, e-patient health record system, e-consultation system, e-prescription system, e-referral system, e-training system and Service Oriented Architecture (SOA).*

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LIST OF ABBREVIATIONS

ATA: American Telemedicine Association

cf: Abbreviation used for referring to something that is connected with the subject

CIS: Clinical Information System

CMM: Center for Improvement Medication Management

DHIS: District Health Information System

DoC: Department of Communication

DoH: Department of Health

EHR: Electronic Health Record

ERISA: European Regional Information Society

HIS: Health Information System

HTA: Health Technology Assessment

HL7: Health Level 7

ICT: Information and Communication Technology

IOM: Institute of Medicine

IT: Information Technology

ITU: International Telecommunication Union

LMS: Learning Management System

NWP: North West Province

OPD: Out Patient Department

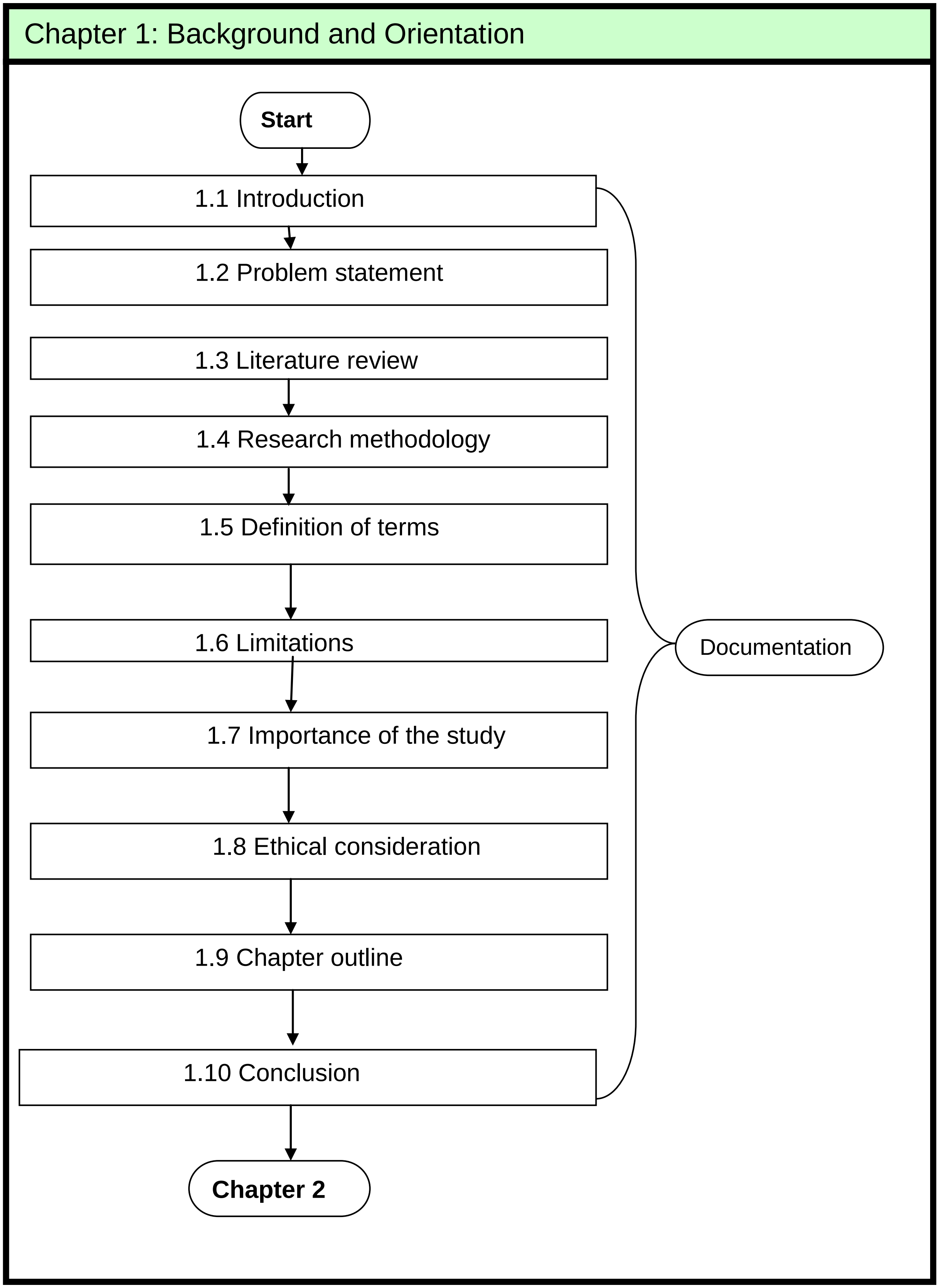
PDA: Personal Digital Assistant

PEHF: Provincial E-health Framework

PHRS: Patient Health Record System

TAM: Technology Acceptance Model

TAU: Technology Acceptance and Use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CHAPTER 1

BACKGROUND AND ORIENTATION TO THE STUDY

1.1 Introduction

Developing countries in the global south which have already introduced innovative technologies such as mobile banking need to drive the development of e-health, that is, the harnessing of ICT, to improve healthcare delivery systems in their countries (Brown, 2008). Brown (2008) further stresses that industrialized countries like the United States and Europe have many years of experience in the use of ICT in healthcare delivery. These industrialized countries have not only learned lessons and made mistakes, but have also achieved a lot of successes. Therefore, there is an opportunity for developing countries to use ICT in a more integrated way in the healthcare sector to improve the quality, safety and efficiency in delivering healthcare services to the people. E-health Initiative report (2008:2) further indicates that while there is a broad recognition of the need for health Information Technology (IT) to address many of the healthcare challenges, there is also a need for leadership coordinated actions and common agreements among the stakeholders on the steps needed to improve the quality, safety and efficiency of healthcare through IT.

In February 2004, all the stakeholders of the Interim Health Technology Assessment Committee in South Africa convened at Pretoria to discuss a framework for Health Technology Policies with a specific emphasis on Health Technology Assessment (HTA) in South Africa (SA Health Info, 2006: 2). The committee developed a strategy for future HTA in South Africa (SA Health Info, 2006: 2) and the members were further commissioned, among others, to:

- Study the HTA systems of different countries, together with the enabling structures which map to local HTA related activities;
- Suggest the relevant scope and the most suitable system for the enabling structures in South Africa;

- Make proposals relating to the legal status of the structure; and
- Establish guidelines for the promotion of HTA activities.

In the light of these tasks, the committee was given powers to function in accordance with the South African National Health Bill section 90 (1), which makes provision for the assessment and regulation of Health Technologies in South Africa (SA Health Info, 2006) and the implementation of e-healthcare services.

It has been emphasized (Ojo, Olugbara, Emuoyibofarhe, Adigun, Xulu, Kabanda, Zulu, Lalbahadur, Ndlovu, Nxele, and Ntshembeni, 2006) that there is a great potential in using e-healthcare as one of the supportive systems within the healthcare system to address the pressing challenges facing healthcare systems in developing countries, including clear inequalities in health status and the quality of healthcare and access. However, the recognition of health IT is not an end unto itself but a means to an end, which is a better quality, safer, more value-driven and accessible healthcare to all people (E-health Initiative, 2008: 2). Furthermore, the successful introduction of e-healthcare requires the examination of complex, political, organizational and infrastructural factors, which include the readiness factor (Jennett, Jackson, Healy, Ho, Kazanjian and Woollard, 2003). Ojo *et al*. (2006) define readiness factor as the degree to which a community is ready to participate and succeed in e-health adoption. The assessment of readiness for an innovation in healthcare can reduce the risk of failure after introduction (Jennett *et al*., 2003), and it is, therefore, important for e-health stakeholders to understand the readiness concept and to determine the readiness status of rural communities before implementing any costly e-health innovations.

In addition, Bozic, Pierce and Hermon (2004:1305) state that HTA, which includes e-readiness assessment, is a growing field which is concerned with the multidisciplinary evaluation of clinical data on the basis of safety and efficacy, as well as the economic aspect of technology acquisition and implementation. It is, therefore, important that appropriate evaluation criteria be used during assessment in order to obtain the required information.

The South African Interim Health Committee (2004:14) for health policy framework has defined healthcare technology in the South African context as the devices, drugs, medical and surgical procedures and the knowledge associated with these, used in the prevention, diagnosis and treatment of diseases, and the rehabilitation of all organizational and supportive systems within the healthcare system. Within this national framework, the North West Province in South Africa has adopted the definition and developed a Provincial Mission and Vision for Health Technology usage in the province which states as follows (South African Interim Health Committee, 2004):

- To ensure that Health Technology is harnessed to its fullest extent as one of the tools to improve delivery of health services and all the strategies that facilitate the appropriate utilization of Health Technology for the health system shall be devised.
- To create a unified and harmonious Health Technology system that ensures optimal distribution of the limited Health Technology resources and to facilitate equity in access, with the ultimate aim of improving the quality of health services and enhancing positive outcome.

1.2 Problem statement

According to Ojo *et al*. (2006), the major socio-economic development challenges facing most African countries include economic diversification, poverty, unemployment, diseases and unsustainable use of natural resources. Ojo *et al*. (2006) further point out that the challenge of quality healthcare services provisioning is compounded by the HIV/AIDS pandemic in sub-Saharan Africa. This pandemic has engendered strain on the various national healthcare systems, increased the number of orphans, reduced productive human capital and productivity, eroded knowledge and skills, put pressure on national budgets, increased poverty stricken populace and reduced the quality of life, health and wellness (Adigun, Ojo, Emuoyibofarhe and Dehinbo, 2006; Botswana Government, 2003).

In the South African context, the white paper on the transformation of the public healthcare system reveals that the majority of the South African population has inadequate access to basic healthcare services and that the greater percentage of this population live in rural communities (South African Government Department of Health, 2006). Rasmeni (2007:3) points out that the vast majority of South Africans, particularly those in the rural provinces like the North West, receive their medical care from government-run clinics and hospitals. The North West Health Department has therefore, invested substantial sums of money in the district and provincial health services, health facilities management and the healthcare support services in an effort to improve the quality of healthcare delivery in the province. For example, an amount of R3, 754,518,000 for the financial year 2007-2008 was allocated for this purpose (Rasmeni, 2007: 21).

The problem is, despite the high investment in the healthcare system and the objective of the Health Department to reduce the large levels of social inequalities in the healthcare services through overcoming the inadequacies of hospitals and clinics (Department of Health (DoH), 2005), many of the rural people who live in the North West Province do not receive the quality of healthcare services which Health Technology can provide.

1.2.1 Research question

With the above background perspective of the research problem, the following research question was formulated and addressed in this study:

How can an E-Health Framework with the objective of improving the delivery of electronic healthcare services to the people in the North West Province be compiled?

To answer this question, the following supporting sub-research questions need to be answered:

1. How can E-health Readiness Assessment Models be applied to identify the strengths and areas of improvement in a particular healthcare institution?

2. How can the identified outcomes of the e-health readiness assessment be used to compile an e-Health Framework for use in hospitals/clinics in the North West Province?

1.2.2 Aims and objectives of the research

The main aim of this research was to understand the e-health readiness situation in the North West Province and compile an e-health framework based on the feedback from case studies at various hospitals/clinics in the province. Current international E-health Readiness Assessment Models that are in place were scrutinized in order to develop a specific e-health readiness assessment tool to perform assessments in the North West hospitals/clinics. The e-health readiness assessments were conducted in the light of effective and efficient use of ICT considering:

- Patient record systems;
- Training of users of ICT in e-health;
- ICT infrastructure distribution; and
- Processes and procedures in consultation, prescription and referrals.

The figure below gives a brief indication of how this process was applied.

Source: Ljungburg (1999)

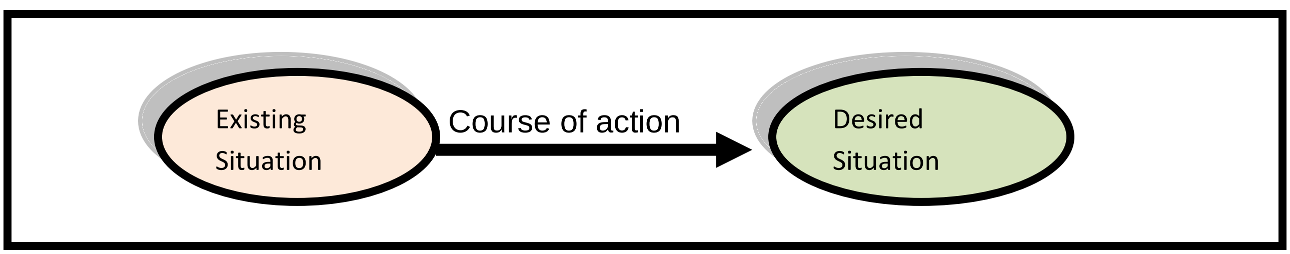


Figure 1.1: Improvement process

The new framework which was envisaged to be the greatest benefit of this study was compiled with the assistance of the North West Province Health Department and was reviewed by a panel of experts (from the North West Province Health Department) for applicability. Therefore, the specific objectives of this research were to:

- Obtain information on current Electronic Readiness Assessment Models around the world, and existing information on e-healthcare by means of a literature study;
- Use a specific Electronic Readiness Assessment tool in the North West hospitals/clinics with the guidance and support of experts in the North West Health Department;
- Conduct a comparative electronic readiness assessment between rural and urban hospitals/clinics in the North West Province; and
- Apply the assessment results to compile an e-health framework.

1.3 Literature review

The literature study consists of two chapters, namely chapters 2 and 3, which focus on the following headings:

Chapter 2: E-Health Literature

Chapter 3: E-Healthcare Readiness Assessment Models and Frameworks.

The selection of these headings for the literature review was guided by the broad guidelines for conducting systematic literature review as indicated by Fink's (2005) guide on systematic literature reviews (SLRs) in health sciences; Levy and Ellis' (2006) article on conducting literature reviews in information systems; and Webster and Watson's (2002) article on writing up literature reviews in information systems. Chapter 2 focuses on the following areas which are related to e-health:

- E-health definition and benefits;
- Evolution of Health Information Systems (HIS) and information needs;
- Pre-requisites for e-health initiatives;
- Privacy and security concerns regarding health information;
- The benefits and barriers of e-health;
- E-health records (EHR);
- E-prescription and its benefits;

- Telemedicine and telehealth care services;
- Characteristics of rural and urban areas in the North West Province; and
- Possible e-health architectures for implementation.

Chapter 3 explores e-healthcare readiness assessment in the following areas:

- Service quality and productivity in healthcare;
- Service quality and productivity in healthcare services;
- Evolution and definitions of HTA;
- Conceptual framework for assessment models;
- Definitions of e-healthcare readiness assessment;
- Types of e-healthcare readiness assessment models that are used in healthcare services;
- Identification of the components for e-health readiness assessment;
- Current e-healthcare readiness assessment models that are employed in developing countries;
- Community involvement in e-health readiness assessment; and
- Overall e-health readiness assessment construct to be applied.

1.4 Research methodology

This section briefly expounds on some philosophical assumptions that underline valid research. This is followed by a discussion on the research design, data collection methods, and the research process. All research (whether quantitative or qualitative) is based on some underlying assumptions about what constitutes 'valid' research and which research methods are appropriate (Myers, 1997). In order to conduct and evaluate a case study research, it is important to know what these (sometimes hidden) assumptions are. In this research, the most pertinent philosophical assumptions are those which relate to the underlying epistemology which guides the research. Epistemology, according to Hirschheim (1992), refers to the assumptions about knowledge and how it can be obtained. Orlikowski and Baroudi (1991) suggest three underlying research epistemologies, namely, positivist, interpretive and critical. This implies that a case study research can be positivist in nature (Yin, 1994); interpretive (Walshham, 2006), or critical (Car and Kemmis, 1986). Closely related to and supporting interpretivism is hermeneutics philosophy. Hermeneutics is defined as a theory or philosophy of the interpretation of meaning (Bliecher, 1980). In this research study, the interpretive epistemology is used. This is described in detail in chapter 4 together with the research design used.

Mouton (2003: 8) contends that a research design is a blue-print that needs to be followed to achieve the research objectives. Burns and Grove (2003: 195) explain that a research design is a blue-print for conducting a study to maximize control over factors that could interfere with the validity of the findings. The control provided by the design increases the probability that the study results will be an accurate reflection of reality. Therefore, the researcher must select the most appropriate design to meet the aims and objectives of the study (Parahoo, 1997:143). In this research study, a qualitative research design employing a multiple case study approach was used. Data collection instruments used included group interviews, questionnaires, document analysis, expert opinion and photographs. A questionnaire instrument was used in addition to the qualitative research instruments (group interviews, document analysis and photographs) because it promoted reliability and the validity of the data. Creswell (2009:15) supports this by indicating that it is appropriate to use a combination of both instruments because they reinforce each other.

1.4.1 Research process

The research was conducted in two phases, namely, the first phase and the second phase. The first phase consists of five steps which start with the literature study and end with the data collection, while the second phase utilizes three steps, beginning with the compilation of an e-health framework based on the first phase and ending with the e-health framework for the North West Province. The two phases utilize eight steps as shown in Figure 1.2 below.

Adapted from Jacobs (2005)

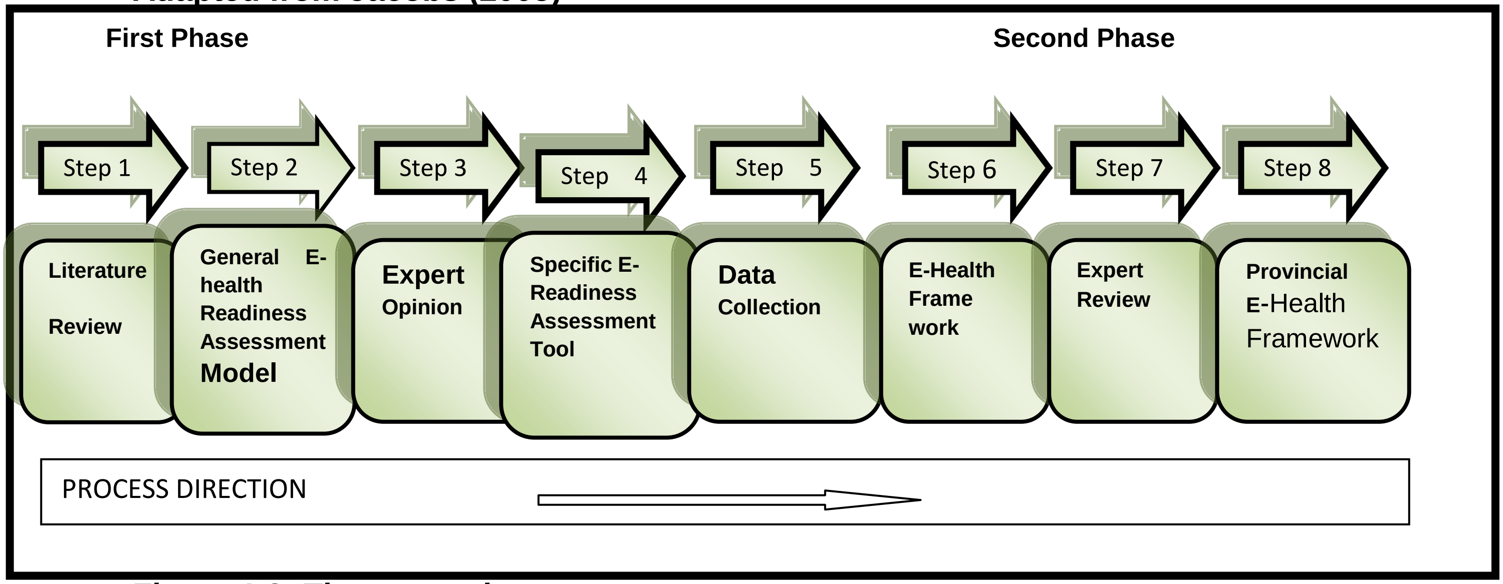


Figure 1.2: The research process

A detail of the e-health model process is discussed in chapter 4.

1.5 Definition of terms

The following terms are used in this research study and are therefore defined below:

- **Health Technology Assessment (HTA)**: Is a systematic evaluation of supportive systems, that is, healthcare information technology systems, in healthcare institutions;
- **Technology readiness assessment:**: refers to the evaluation of people's propensity to embrace and use new technology to accomplish goals in life and at work;
- **E-health**: It is an emerging field of medical informatics, which refers to the delivery of health services and information by using the Internet and related technologies. The European Commission (EC) has defined e-health as the use of modern ICT to meet the needs of citizens, patients, healthcare professionals, healthcare providers and policy makers (Open Clinical, 2007);
- **Health Information System (HIS)**: Is a system that integrates data-collection, processing, reporting and use of the information necessary for improving health

service effectiveness and efficiency through better management at all levels of health services (World Health Organization (WHO), 2004);

- **Electronic health record (EHR)**: Is a repository of information regarding the health status of a subject of care (patient or consumer) in computer processable form (ISO Technical Report, 2007). Again it is defined by the Institute of Medicine (IOM, 2001) as the set of components that form the mechanism by which patient records are created, used, stored, and retrieved;
- **Electronic prescribing or "e-prescribing"**: It is a computer-based electronic generation, transmission and filling of a prescription, which replaces paper and faxed prescriptions (E-health Initiative, 2008);
- **Telemedicine**: Is electronic communication and information technologies to provide and support clinical care at a distance (Dates, 2008);
- **E-consultation**: It is a remote specialist consultation which includes doctor-to-doctor, doctor to specialist and doctor to other healthcare professionals consultations which use asynchronous or synchronous computer-mediated communication tools;
- **E-referral**: E-referral in this research means the communication, with the intention of initiating care transfer, from the provider making the referral to the receiver, using the Internet. An electronic document, such as text document or PDF, is transmitted in support of the referral (Department of Human Services (DHS), 2006); and
- **E-training**: In this research e-training means a set of applications and processes which use available electronic media to deliver e-health application training to healthcare professionals.

1.6 Limitation

The following are the limitations of this study:

- Only one province was used for the research. However, it typifies all other provinces in South Africa in terms of healthcare professionals ((doctors, nurses, ward attendants and hospital administrators).

- The e-health readiness assessment did not cover e-health readiness assessment pertaining to health financial, administrative systems, electronic devices and patient portals.
- The Provincial E-health Framework (PEHF) which was compiled in this study was not tested in an operational setting. However, it was verified by a panel of health experts from the North West Health Department for its applicability (*cf* Appendix H).

1.7 Importance of the study

The major socio-economic development challenges that face most African countries include economic diversification, poverty, unemployment, diseases and the unsustainable use of natural resources. The provision of better healthcare to citizens has shown to be a major step towards poverty alleviation. However, the majority of South Africans live in rural areas where healthcare provision is a major problem. The public healthcare system reveals that the majority of the South African population has inadequate access to basic healthcare services and that the greater percentage of this population lives in rural communities (South African Government Department of Health, 2006). The vast majority of South Africans, particularly those in the rural provinces like the North West Province receive their medical care from government-run hospitals/clinics that are faced with many challenges such as shortage of healthcare professionals, inadequate health education, outdated clinical treatment, lack of specialized skills and the lack of access to accurate and timely health information, which result in increased medical errors, loss of patient files, delays of patient referrals and the long queues of patients in the hospitals/clinics.

E-health has the potential to overcome many of the challenges that are faced by these rural hospitals/clinics. However, the provision of any e-health solution needs a proper assessment that is based on the existing literature and the current situation that is found in the hospitals/clinics. Yet in the available literature, the phenomenon of e-health for rural hospitals/clinics in developing countries is not fully addressed. The literature contains limited published work that reports on a single e-health solution or framework for developing countries which incorporates e-consultation, e-prescription, e-referrals and e-training systems.

This research study deals with the issues relating to the development of an e-health framework through e-healthcare readiness assessment for hospitals/clinics in the North West Province. In order to achieve this, different e-health readiness assessment models were considered and a specific e-health readiness assessment model was constructed to assess or measure the e-health readiness of selected rural and urban hospitals/clinics in the province. The outcome of the e-health readiness assessment led to the compilation of an e-health framework called Provincial E-health Framework (PEHF) which can effectively aid a successful e-health solution in these rural hospitals/clinics. In developing the PEHF, consideration was given to the complexities that differentiate the context of rural hospitals/clinics from urban hospitals/clinics, as well as the circumstances which differentiate developing nations from developed nations. The PEHF does not only aid successful e-health solution, but it also provides processes for e-patient health records, e-consultation, e-prescription and e-referral systems' usage to assist healthcare professionals in the delivery of quality and efficient healthcare services in these rural and urban hospitals/clinics.

Furthermore, this study provides an ICT infrastructure network architecture which clustered hospitals/clinics to use common ICT infrastructure, yet allowing the participating hospitals/clinics to maintain their autonomy, in order to promote the effective reuse of resources rather than duplicating such resources. This bridges the rural/urban equity divide of ICT infrastructure between rural and urban hospitals/clinics in the healthcare sector. The study also provides guidelines for future implementation of the PEHF.

In conclusion, the most important aspect of this study is the PEHF, the ICT infrastructure network and the associated processes which provide e-health solution for the improvement of quality healthcare delivery in rural hospitals/clinics. In addition, there is limited information in the literature on a single e-health framework on Africa, especially for rural hospitals/clinics, which is sufficiently comprehensive to incorporate all the components that this PEHF has. Therefore, with this e-health framework (PEHF) as a tool to assist in addressing the challenges that are experienced in the rural and urban hospitals/clinics (as a starting point to resolve the challenges experienced in rural and urban hospitals/clinics), this study provides a new knowledge to the area of e-health.

1.8 Ethical consideration

Welman and Kruger (2005) state that ethical considerations arise at three stages of a research project, namely:

- When participants are recruited ;
- During the intervention or measurement procedure to which they are subjected; and
- In the release of the results.

Participation in this research was voluntary and the participants could withdraw at any time. Olivier (2004:23) indicates that a research which involves human participation should be reviewed by an ethics committee to determine whether the research should be allowed to continue or not. The research protocol was reviewed and approved by Nelson Mandela Metropolitan University senate (*cf* Appendix D) and by the North West Health Department (cf Appendix E). Informed consent was also requested from individual participants with regard to participation and release or publication of the thesis at scientific conferences (cf Appendix G).

The data was collected in such a way that it interfered neither with the normal activities of the participants nor the routine activities of the hospitals and clinics. Above all, the hospital authorities at the district levels were informed and permission was obtained from them before conducting the research (cf Appendix F). The participants were ensured of the confidentiality of the information they provided. Finally, the results of this research will be made available to the hospitals and clinics through the Nelson Mandela Metropolitan University.

The chapter outlines of this research study are briefly discussed in the next section.

1.9 Chapter outlines

Figure: 1.3 below illustrates how the research study was presented.

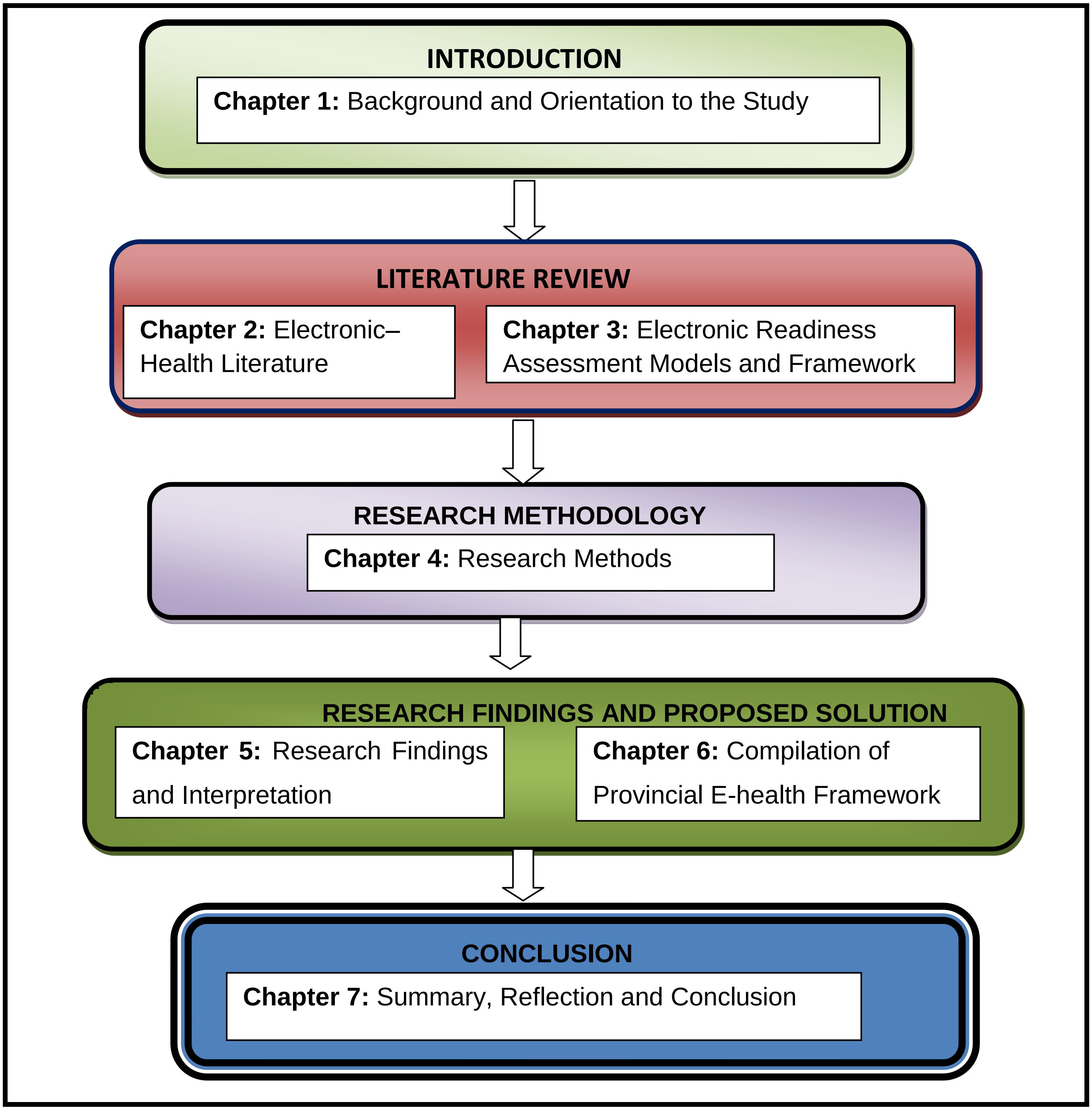
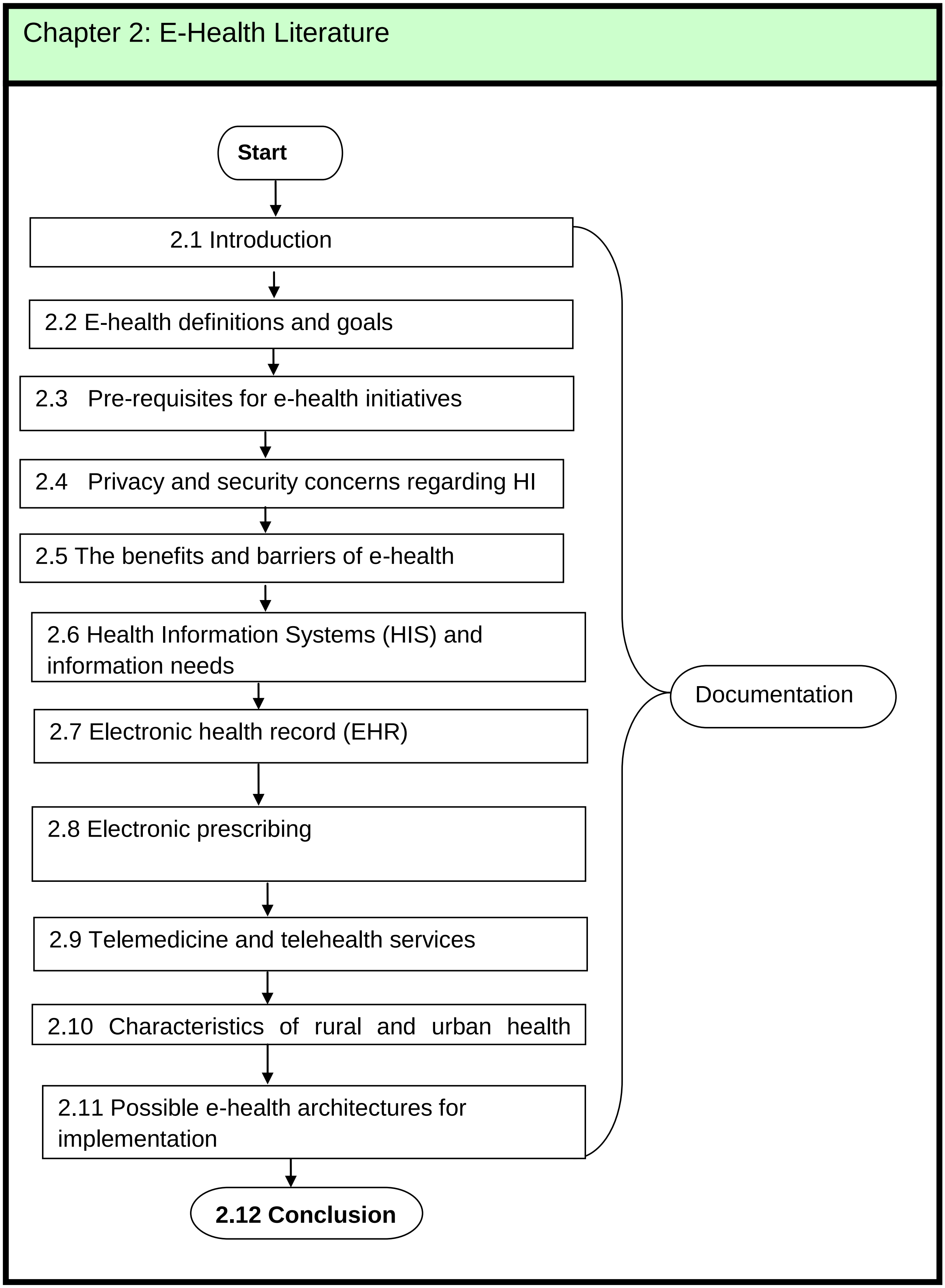


Figure: 1.3: Chapter outlines

This thesis is divided into seven chapters as illustrated in Figure 1.3 above. The first chapter introduces the study by giving the background and the orientation of the research. This is followed by the literature study which is presented in chapters 2 (e-health literature) and 3 (electronic readiness assessment models and framework). Chapter 4 focuses on the research methodology while chapters 5 and 6 present the research findings and the compilation of the PEHF respectively. Chapter 7 concludes the study through a summary and reflection on the study.

1.10 Conclusion

This chapter has provided an overview of the proposed research study by stating the background, the problem statement, the aims and objectives, the research design and the research process, limitations, importance, ethical consideration and chapter outlines. Finally, the chapter has also indicated that the research study will make a valuable contribution to the field of e-health and in the improvement of healthcare service delivery in the North West Province, particularly, in bridging the rural-urban equity divide in healthcare service delivery. The next two chapters (chapters 2 and 3) commence with the literature review, focusing on e-health literature and e-healthcare readiness assessment models and frameworks and their use in measuring readiness to embrace new technologies in healthcare.


Chapter 2: E-Health Literature
Start
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2.2 E-health definitions and goals
2.3 Pre-requisites for e-health initiatives
2.4 Privacy and security concerns regarding HI
2.5 The benefits and barriers of e-health
2.6 Health Information Systems (HIS) and information needs
2.7 Electronic health record (EHR)
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CHAPTER 2

E-HEALTH LITERATURE

2.1 Introduction

Chapter 1 introduced the research study by stating the research question, the aims of the study, and its importance. This chapter and the subsequent one focus on the literature review. Fink (2005:3) defines a research literature review as a systematic, explicit, and reproducible method for identifying, evaluating, and synthesizing the existing body of completed and recorded work produced by researchers, scholars, and practitioners. The literature review in chapters 2 and 3 is guided by these broad guidelines for conducting and writing up a systematic literature review (Fink, 2005; Levy and Ellis, 2006; Webster and Watson, 2002). The broad guidelines include the following steps (Fink, 2005):

1. **Purpose of the literature review**: The first step in conducting any literature review requires the researcher to clearly identify the purpose and intended goals of the review. This is necessary for the review to be explicit to its readers.
2. **Searching for the literature**: The researcher needs to be explicit in describing the details of the literature search, and needs to explain and justify how the comprehensiveness of the search was assured.
3. **Practical screen**: This is referred to as screening for inclusion. This step requires the researcher to be explicit about what studies were considered for review, and which ones were eliminated (a very necessary part of any literature review). For excluded studies, the researcher must state what the practical reasons were for their non-consideration, and justify how the resulting review can still be comprehensive given the practical exclusion criteria.
4. **Quality appraisal**: Also known as screening for exclusion, the researcher needs to explicitly spell out the criteria for judging which articles are of insufficient quality to be included in the review synthesis. All included articles need to be

scored for their quality, depending on the research methodologies employed by the study.

5. **Data extraction**: After all the studies that should be included in the review have been identified, the researcher needs to systematically extract the applicable information from each study.
6. **Synthesis of studies**: Known as analysis, this step involves combining the facts extracted from the studies using appropriate techniques, whether quantitative, qualitative, or both.
7. **Writing the review**: In addition to the standard principles to be followed in writing research report, the process of a systematic literature review needs to be reported in sufficient detail that the results of the review can be independently reproduced.

In this research study, the above steps guided the identification of the following areas/headings in e-health literature:

- E-health definition and goals;
- Pre-requisites for e-health initiatives;
- Privacy and security concerns regarding health information;
- Benefits of e-health and barriers;
- Evolution of Health Information Systems (HIS) and information needs;
- E-health record (EHR);
- E-prescription and its benefits;
- Telemedicine and telehealth care services;
- Characteristics of rural and urban health status; and
- Possible e-health architectures for implementation.

Each of these headings is expounded in the proceeding sections.

2.2 E-health definitions and goals

E-health emerged early in the 21st century and is an all-encompassing term for the combined use of electronic Information and Communication Technology (ICT) in the health sector (Harrison and Lee, 2006). Harrison and Lee (2006) further point out that while some definitions associate e-health strictly with the Internet, the term broadly refers to any electronic exchange of health related data collected or analyzed through electronic connectivity to improve the efficiency and effectiveness of healthcare delivery. Thus, e-health is often used to describe virtually everything related to computers and medicine (Deluca and Enmark, 2000; Kind and Silber, 2004; Kwankam, 2004). The concept e-health is also used to describe the application of ICT across the whole range of functions which affect the health of citizens and patients (European Regional Information Society (ERISA), 2004). E-health has been defined as the use of modern ICT to meet the needs of citizens, patients, healthcare professionals, healthcare providers and policy makers (Open Clinical, 2007). E-health is further defined as an emerging field of medical informatics which refers to the delivery of health services and information by using the Internet and related technologies (Pagliary, Sloan, Gregor, Sullivins, Detmer, Kahan, Oortwijn and Maccillivray, 2005). Eysenbach (2001) offers the following succinct definition which states that, “e-health equals to medicine plus communication plus information plus society”. The Health Telematic Working Group (2003) describes e-health as the use of ICT and the Internet to:

- Connect citizens, health information providers and governments;
- Inform, educate and empower citizens, patients, healthcare professionals, managers and policy makers; and
- Improve the quality and management of health data, care delivery and health system management.

E-health is defined (Wickramasinghe, Fadlalla, Geisler and Schaffer, 2005) as a broad term that encompasses various activities which are related to the use of many e-commerce technologies and infrastructure, most notably the Internet for facilitating healthcare practices. The World Health Organization (WHO, 2004) defines e-health as ‘being the leveraging of ICT to connect providers, patients and governments; to educate and inform healthcare professionals, managers and consumers; to stimulate innovation in healthcare delivery and health system management, and to improve our healthcare system’. In contrast, a technologically orientated definition of e-health is offered by Eysenbach (2001) who refers to e-health as ‘a concerted effort undertaken by leaders in healthcare and hi-tech industries to fully harness the benefits available through convergence of the Internet and healthcare'. The advent of e-health seems fitting to address both opportunities and challenges in the healthcare sector. According to Wickramasinghe *et al.* (2005), the new possibilities for facilitating effective healthcare delivery fall primarily into the following main categories:

- The capability of healthcare institutions to interact with consumers online. This is business to consumers (B2C);
- The possibility to improve healthcare institution-to-institution transmissions of data. This is business to business (B2B);
- The new possibilities for peer-to-peer communication of healthcare consumers. This is consumer to consumer (C2C); and
- The demand by consumers for specific services from the healthcare institution using online facilities (C2B).

Figure 2.1 illustrates the different categories of e-commerce in the healthcare sector.

Source: Wickramasinghe *et al.* (2005)

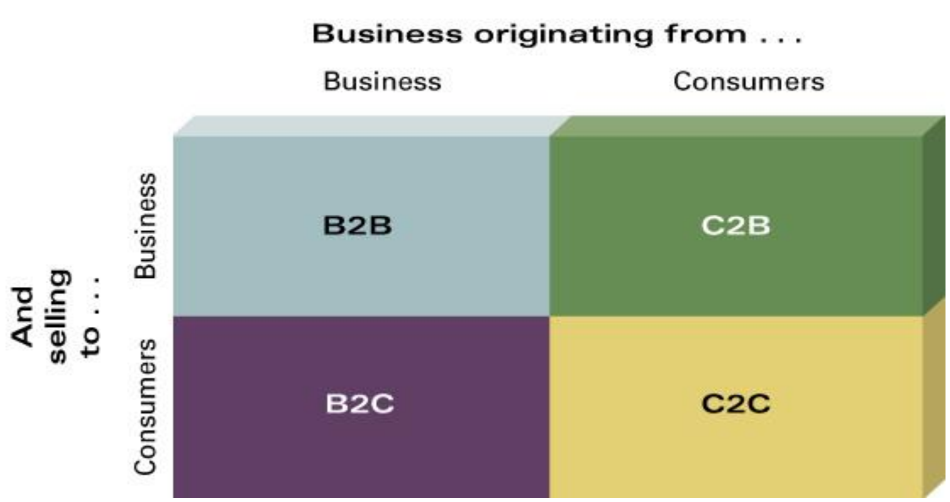


Figure 2.1: E-commerce in health

However, it is essential that a more comprehensive definition of e-health should incorporate healthcare, business and technological perspectives. In this regard, Wickramasinghe *et al*. (2005) emphasize that e-health should incorporate the delivery of health services and health information through the Internet and other related e-commerce technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a paradigm shift, and a commitment to networked global thinking to improve healthcare locally, regionally, and globally by using ICT (Cashen, Dykes and Gerber, 2004). The key application areas of e-health, according to the Open Clinical (2007), include:

- E-medical records, including patient records, clinical administration systems, digital imaging and archiving systems, e-prescribing and e-booking;
- Telemedicine and telecare services and health information networks;
- Decision support tools; and
- Internet-based technologies and services.

E-health also covers virtual reality, robotics, multi-media, digital imaging, computer assisted surgery, wearable and portable monitoring systems and health portals. In this research study, e-health is defined as the use of ICT for effective and efficient delivery of healthcare services. Apart from its definition, it is also important to explore the goals of e-health.

2.2.1 The goals of e-health

The goals of e-health can be summarized to include increased efficiency in healthcare, improved quality of healthcare, increased commitment to evidence-based medicine, empowerment of patients and consumers and the development of new relationships between patients and health professionals (Austin and Boxerman, 2003). These goals are explained below:

- **Efficiency**

One of the promises of e-health is to increase efficiency in healthcare and thereby, decrease costs. One possible way of decreasing costs is to avoid duplication or unnecessary diagnostic or therapeutic interventions. This can be achieved through enhanced communication between the healthcare establishments, and through patient involvement (Healthcare Advisory Board Report, 2002). The Internet will naturally serve as an enabler for achieving this goal in e-health.

- **Quality of healthcare**

Increasing efficiency involves cost reduction and should be considered in conjunction with improving quality, which is one of the ultimate goals of e-health. Wickramasinghe *et al*. (2005) highlight that a more educated consumer, as a result of the informational aspects of e-health, is able to communicate more effectively with his or her primary healthcare provider which will, in turn, lead to better understanding and thus, an improved quality of healthcare.

- **Evidence-based**

E-health interventions should be evidence-based in the sense that their effectiveness and efficiency is not assumed but proven by rigorous scientific evaluation and support from case histories. Web accessible case repositories facilitate the timely accessibility of such evidence and thus, help in achieving the necessary support of a diagnosis or treatment decision (Kunhardt, 2009). The evidence-based medicine goal of e-health is currently one of the most active e-health research domains, yet much work still needs to be done in this area.

- **Empowerment of consumers and patients**

It is pointed out (Wilson, Leitner and Moussalli, 2004) that by making the knowledge bases of medicine and personal e-records accessible to consumers and patients over the Internet by using their personalized authentication identity, e-health opens new avenues for patient-centred medicine, enables patient education, and thus increases the likelihood of informed and more satisfactory patient choices.

- **Education of physicians and consumers**

The education of physicians through online sources (continuing medical education) and consumers (health education such as tailored preventive information for consumers) makes it easier for physicians and consumers to keep up to date with the latest developments in the medical areas of their respective interests (Ball and Lillis, 2001). This, in turn, is likely to have a positive impact on the quality of healthcare with regard to the use of the latest medical treatments and preventive protocols.

- **Relationship between patients and healthcare professionals**

E-health involves new forms of patient-physician interaction and poses new challenges and threats to ethical issues such as online professional practice, informed consent, privacy and security issues (Healthcare Advisory Board Report, 2002). However, Wickramasinghe *et al*. (2005) note that this is not an intrinsic feature of e-health but rather a feature of the Internet technology which is the foundation for all e-business initiatives. Therefore, e-health along with e-government, e-insurance, e-banking, e-finance and e-retailing must all contend with these ethical issues. These issues could be magnified given the nature of healthcare.

2.3 Pre-requisites for e-health initiatives

It is stated (Williams, May, Mair, Mort and Gask, 2003) that most assessment models that are used for e-health implementation are perspective in nature, and that these perspective models that set out the most basic conditions that are needed for the evaluation to follow. Examples of such models are the Bashsur Model (1997) and the Yellowless Model (1997).These models are briefly explained in the following para-graphs.

The Bashsur Model identifies three conditions which must be met before commencing a healthcare or telehealth care evaluation. For instance, the appropriate environment and

specific healthcare needs that can be expected to be met by the system must be identified, the information requirements that are necessary for practising remote medicine must be established, and the technical capabilities of the system must be exploited to the full potential (Bashsur, 1997).
The Yellowless Model sets out six fundamental questions of: who, why, what, where, when, and how. These questions relate to the pre-assessment of the objectives of the service, and the means of evaluating those objectives (Yellowless, 1997).

There are other prescriptive models like Holle and Zahlman's model (1999), which focus on the technical, clinical and cost effectiveness at the final stage of telehealth care or healthcare development. Wickramasinghe *et al*. (2005) on the other hand, emphasize on ICT infrastructure, standardization policies, protocols and procedures, user access and accessibility policies and infrastructure; and governmental regulations and role as critical pre-requisites for e-health initiatives.
The following paragraph elaborates on ICT architecture/infrastructure.

2.3.1 ICT architecture/infrastructure

The generic architecture for most e-health initiatives is illustrated in Figure 2.2 which depicts client-server architecture. To support such client-server architecture, special attention must be paid to the ICT infrastructure. The ICT infrastructure includes phone lines, fiber trunks and submarine cables and other high-speed services, satellites, earth stations and teleports that are used by businesses. A sound technical infrastructure is an essential ingredient to the undertaking of e-health initiatives by any nation. Such infrastructure should also include telecommunications, electricity, access to computers and the Internet. To offer good multimedia content and thus provide a rich e-health experience, a high bandwidth is needed. ICT considerations are undoubtedly one of the most fundamental infrastructure requirements. A client-server computing based architecture is illustrated in Figure 2.2 below.

Source: Wickramasinghe *et al*. (2005)

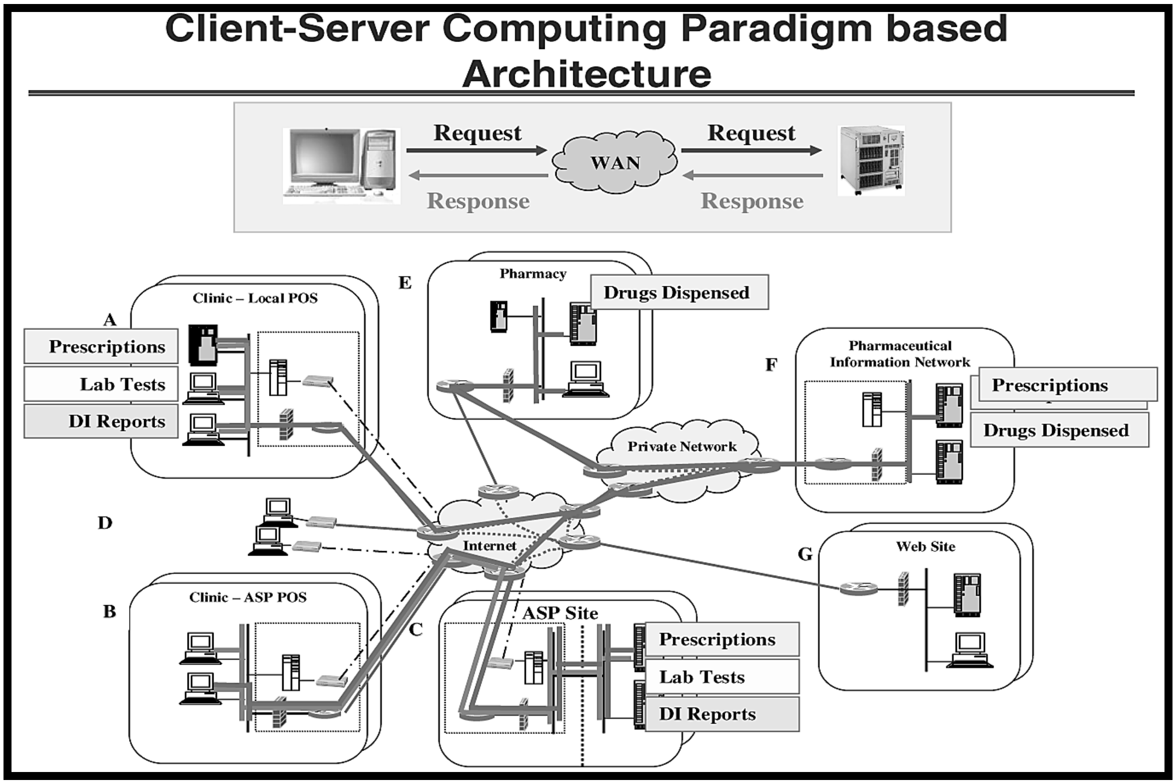


Figure 2.2: Client-server architecture

Networks are now a critical component of the business strategies for organizations to compete globally. Wickramasinghe *et al*. (2005) contend that having a fast microprocessor-based computer at home has no meaning unless there is a high bandwidth based communication infrastructure available to connect the computer with Internet service providers (ISP). With the explosion of the Internet and the advent of e-commerce, global networks need to be accessible, reliable, and fast to participate effectively in the global business environment. Telecommunications constitute a vital infrastructure for Internet access and, hence, for e-commerce. One of the pioneering countries in establishing a complete and robust e-health infrastructure is Singapore, which is in the process of wiring every home, office and factory up to a broadband cable network which will cover 98% of Singaporean homes and offices (ITU, 2009). Its (ITU, 2009) report on measuring information society indicates that Singapore is among the ten top countries in terms of the proportion of households with computers and Internet access. However, while Singapore and other Asian countries show an increase in ICT infrastructure usage, Sub-Saharan Africa remains at a low level of ICT usage with very low Internet usage and broadband penetration (ITU, 2009).

2.3.2 Standardization policies, protocols and procedures

E-health by definition covers many parties and geographical dimensions. To enable such far reaching coverage, significant amounts of document exchange and information flows must be accommodated. The key to this is standardization. Once a country decides to undertake e-health initiatives, standardization policies, protocols and procedures must be developed at the outset to ensure the full realization of the goals of e-health. Fortunately, the main infrastructure of e-health is the Internet which imposes the most widely and universally accepted standard protocols, such as transmission control protocol (TCP), Internet protocol (IP) and hypertext transfer protocol (http). It is the existence of these standard protocols that, according to Wickramasinghe *et al*. (2005), has led to the widespread adoption of the Internet for e-commerce applications. Wickramasinghe *et al*. (2005) further state that the transformation to e-health by any country cannot be attained successfully without the deliberate establishment of standardization policies, protocols and procedures which play a significant role in the adoption of e-health and the reduction of many structural impediments.

2.3.3 User access and accessibility policies and infrastructure

Access to e-commerce is defined as consisting of two critical components (Panagariya, 2000):

a. Access to Internet services; and
b. Access to e-services.

Access to Internet services deals with user infrastructure, while access to e-services pertains to specific commitments to electronically accessible services. The former includes the number of Internet hosts, websites, web users as a percentage of the population, Internet service providers (ISP), availability and costs for consumers and personal computers' (PCs) penetration level. An integral aspect of user infrastructure is the diffusion rate of PCs and Internet usage. The USA and the UK have experienced the greatest penetration of PCs into homes (Samiee, 1998). For developing countries such as India and China including South Africa, there is, however, a very low PCs penetration and tele-density. The ITU (2009) compares the penetration levels of Internet and broadband developments in the developed, developing and the world as a whole. Figure 2.3 shows that the number of Internet users in developing nations were few (12.8% of the population) in the year 2007, as compared to developed nations.

Source: ITU (2009)

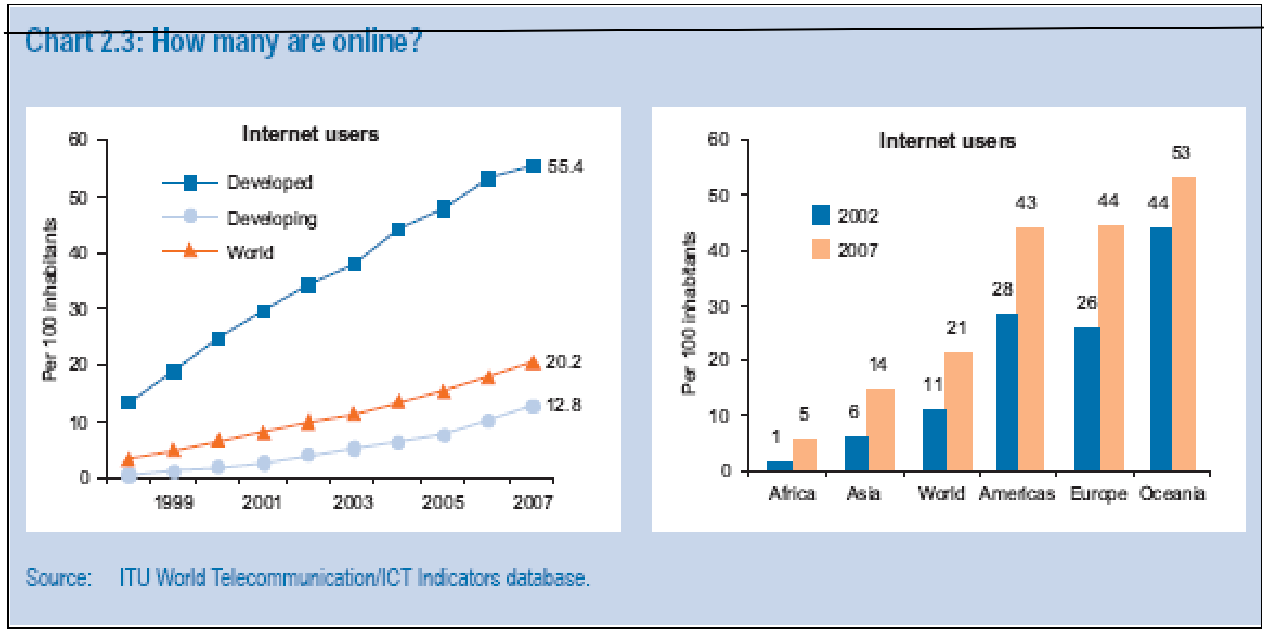


Figure 2.3: Internet users in developed and developing nations

In such a setting where only 12.8% of the population are Internet users, it is a considerable challenge to offer e-health solution, since a large part of the population is excluded from the e-commerce bandwagon. The cost involved in joining the e-commerce bandwagon is unaffordable to the residents of developing countries. Countries have to balance local call charges, rentals and subscription charges, otherwise the majority of citizens will find these costs a disincentive. This is particularly significant for developing and emerging nations where access prices tend to be out of reach for most of the population. Upcoming new technologies hold the promise to increase the connectivity as well as affordability level and developing countries will need to seriously consider these technologies. In addition to access to PCs and the Internet, computer literacy is important and users must be familiar with the use of computers and pertinent software products and the benefits and potential uses of the Internet and the World Wide Web (ITU, 2009).

2.3.4 Governmental regulation and control

Panagariya (2000) indicates that one of the most significant legislative regulations in the United States (US) is the Health Insurance Portability and Accountability Act (HIPAA). The act provides for security needs in the use of e-health services. Extracts from the HIPAA security requirements as provided by Panagariya (2000) include the following:

- Establishment of trust partnership agreements with all business partners;
- Formal mechanisms for accessing e-health records;
- Procedures and policies to control access to information;
- Maintaining records of authorizing access to the system;
- Assuring that system users receive security awareness training and the training procedures are periodically reviewed and updated;
- Maintaining security configuration including complete documentation of security plans and procedures and security incident reporting procedures;
- Communication and network control including maintaining message integrity, authenticity and privacy;
- Encryption of messages advocated for the open network transmission portion of the message; and
- Data authentication to ensure that data is not altered or destroyed in an unauthorized manner.

Given the nature of healthcare and the sensitivity of healthcare data and information, it is incumbent on governments not only to mandate regulations that will facilitate the exchange of healthcare documents between the various healthcare stakeholders, but also to provide protection of privacy and the rights of patients. Some countries, such as China and Singapore, even control access to certain sites for moral, social and political reasons while elsewhere trans-national data flows are hindered by a plethora of regulations aimed at protecting domestic technology and related human resource markets (Goff, 1992; Gupta, 1992; Samiee, 1998). Irrespective of the type of healthcare system; i.e. whether 100% government driven, 100% private or a combination thereof, it is clear that some governmental role is required to facilitate successful e-health initiatives.

2.4 Privacy and security concerns regarding health information

Apart from the government's role to facilitate successful e-health initiatives, the privacy and security of health information is of paramount importance. Tuyikeze and Pottas, (2005) cite the Electronic Privacy Information Center (EPIC) Report (2002) indicating that "privacy" is a term that is inherently difficult to define and that its definition varies widely. Meyer (2001) states that security and privacy are distinct but related. Tuyikeze and Pottas, (2005) indicate that privacy is the right of an individual to control the use of his or her personal information. It should not be divulged or used by others against his or her wishes. Security refers to the ability to control access and protect information from accidental disclosure to unauthorized persons and from alteration, destruction or loss. Furthermore, Tuyikeze and Pottas (2005) report that according to the National Research Council (1997), electronic medical records are potentially vulnerable to misuse from both authorized and unauthorized users who inappropriately access patient information for their personal or economic gain. Authorized users may take advantage of their legitimate authority to access information that they have no valid need to see (often regarding a friend, relative, or celebrity), or they may reveal patient information to others often without the patient's consent. Outside attackers may also break into computerized information to steal, destroy, or to render the system dysfunctional, preventing legitimate users such as doctors and nurses from accessing information critical to healthcare.

Considering the highly personal and potentially destructive nature of the medical data means that it comes with significant concerns about the privacy and security of such information. In order to gain an understanding of these concerns, it is important to look at major threats that could harm the privacy and security of health information. The American Society for Testing and Materials' (ASTM) Provisional Standard (PS 101) "Guidelines for a Technical Security Framework for Transmission and Storage of Healthcare Information" (Amatayakul, 2007) identifies the following security threats relative to healthcare information (CPRI toolkit):

- Masquerading, in which one entity pretends to be another, facilitating any subsequent attacks;
- Modification of information, including message or data content, destruction of messages, data or management information;
- Message sequencing threats, including replay, and delay of messages;
- Unauthorized disclosure, which reveals message content, information derived from observing message flow, and information held in storage on an open system to an unauthorized user;
- Repudiation, in which a user or system denies having performed some action, such as modification of information; and
- Denial of service – this prevents the system from performing its functions.

In order to counteract these threats, countries have adopted various regulatory frame-works that focus on achieving data integrity, confidentiality and availability of health information.

2.4.1 Protecting the privacy and security of health information in South Africa

The South Africa public health sector has adopted an international Information Security Management Standard, the ISO 27799 (in South Africa SANS 27799) which is based on the ISO 27001 and ISO 27002 standards to ensure an appropriate level of information security management. The ISO 27799 is a comprehensive guideline for both security and privacy in healthcare facilities. This standard was published in June 2008 by the ISO technical committee,TC215, which is responsible for health informatics. The ISO 27799:2008 specifies a set of detailed controls for managing health information security and provides health information security best practice guidelines. By implementing these international standards, health organizations and other custodians of health information are able to ensure and maintain the confidentiality, integrity, and availability of personal health information (Fraser, 2006). The context of ISO 27799:2008 is further displayed in figure 2.4 below.

Source: Fraser (2006)

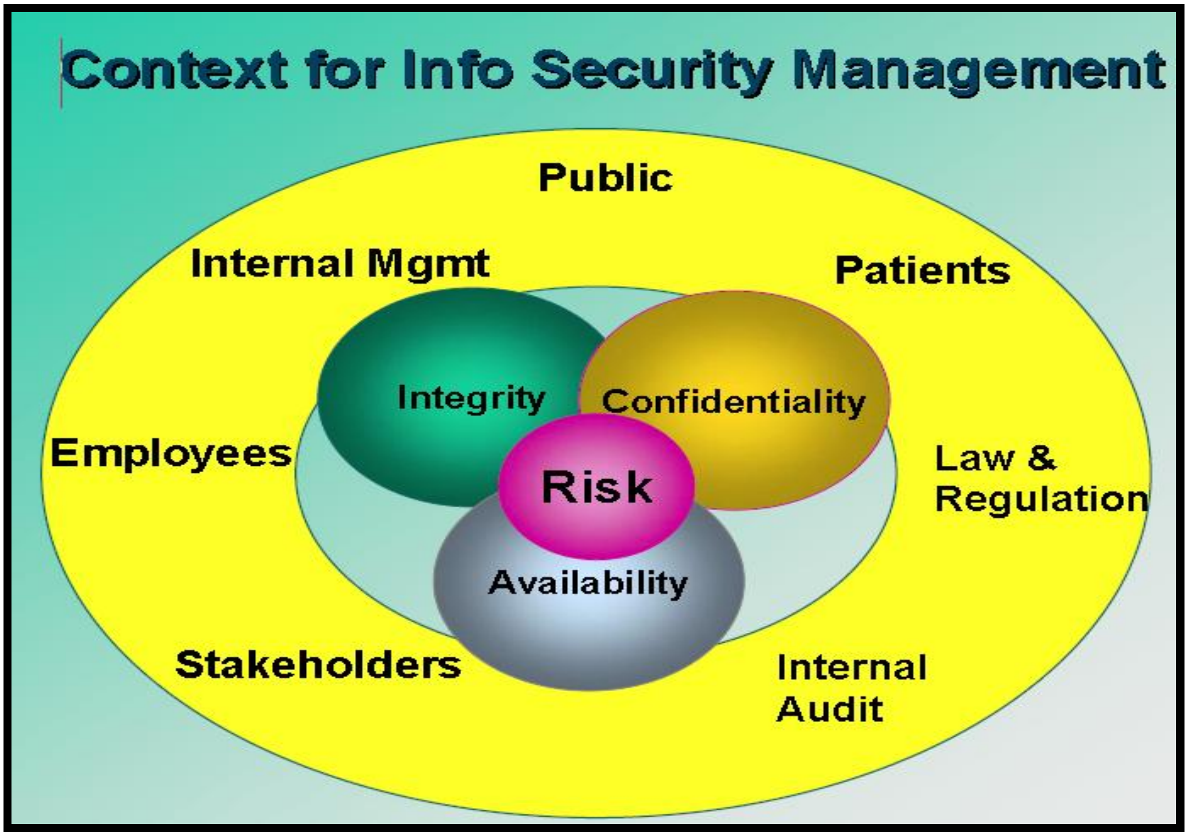


Figure 2.4: Context for information security management

Figure 2.4 indicates that whatever form health information takes, whatever means are used to store it, whatever means are used to transmit it or whoever uses it, the health information must maintain its confidentiality, integrity and availability.

2.5 The benefits of and barriers to e-health

Silber (2003) states that e-health is expected to improve various aspects of healthcare services including quality, cost-efficiency, and access by:

- Supporting the delivery of healthcare that is tailored to individual patients, where ICT enables more informed decision making based on both evidence and patient-specific data;
- Improving transparency and accountability of healthcare processes and facilitating shared healthcare across boundaries;
- Aiding evidence-based practice and error reduction;
- Improving diagnostic accuracy and treatment appropriateness;
- Improving access to effective healthcare by reducing barriers that are created, for example, by physical location or disability;
- Facilitating patient empowerment for self-healthcare and health decision making; and
- Improving cost-efficiency by streamlining processes, reducing waiting times and waste.

Furthermore, Harrison and Lee (2006) emphasize that for patients, who can be viewed as consumers, e-health represents an opportunity to change their relationship with providers and insurance companies. Again, there is the opportunity for improved communication to include provider messaging, access to electronic medical records and the ability to access information about alternative approaches to medical treatment (Harrison and Lee, 2006). Patients generally get only 10 minutes of face to face time with their physician but through e-health, patients can have access to thousands of healthcare Internet sites where they can gain unlimited health information (Deluca and Enmark, 2000). Deluca and Enmark (2000) further indicate that it can take a week to get a return phone call from a physician and almost a month to get a regular office appointment, but with e-health it becomes easier. According to Cashen *et al*. (2004), the potential for e-health technologies to educate patients and promote improved self-management skills is well documented. A typical example of e-health technologies to educate the patient is the European Union portal which is presented in Figure 2.5 below.

Source: Health-EU (2008)

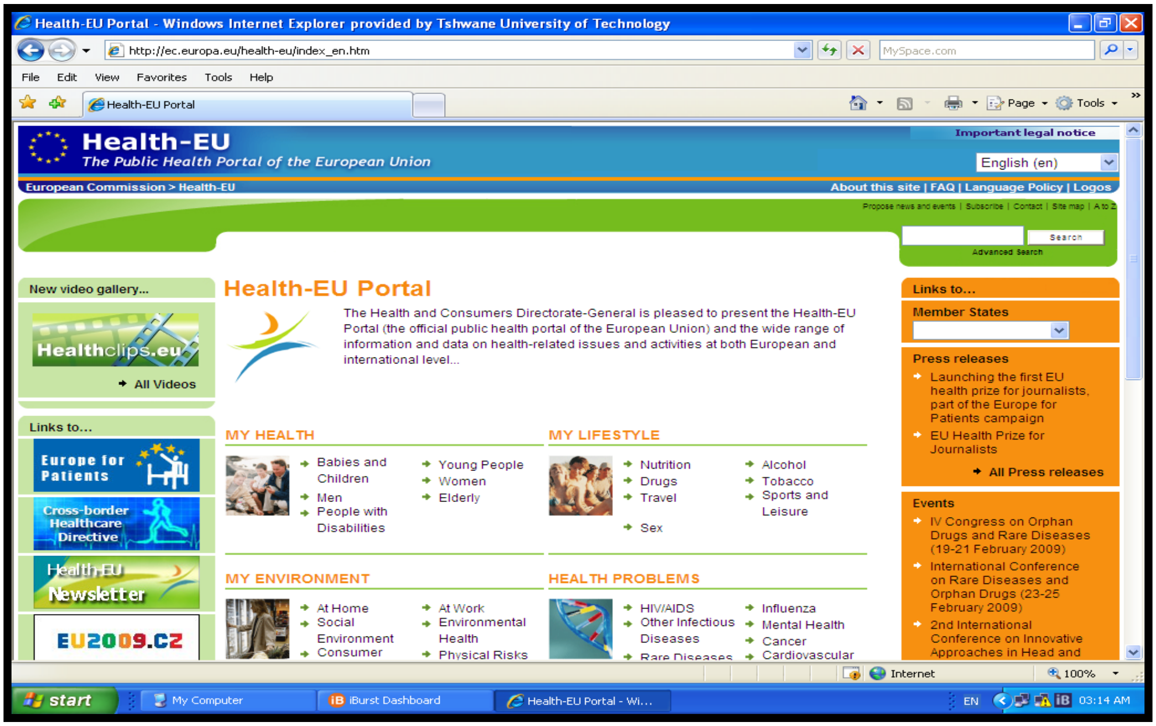


Figure 2.5: EU health portal

Furthermore, health providers view e-health as an opportunity to improve efficiency, reduce administrative cost, facilitate communication and enhance patient healthcare (Kirshenbaum, 2002). For example, according to Chin (2005), U.S medical schools are increasingly using PDAs and clinical information as a mechanism to promote efficiency and safety in healthcare. As public use of the Internet grows, healthcare organizations are using this opportunity to reach a large part of the population cost effectively (Deluca and Enmark, 2000). This includes using the Internet for marketing, patient education, administrative transactions, establishing new relationships with consumers, and increasing operational efficiency in the healthcare sector (Appleby, 2000). Despite the many potential benefits of e-health, Silber (2003) indicates that there are barriers that are associated with e-health which include:

- The lack of rigorous and generalizable evidence of the effectiveness and cost-effectiveness of e-health applications and technologies;
- A research and development need to address human and organizational factors affecting implementation, from the perspectives of both health service staff and

consumers (patients and citizens). Evaluation studies equally require a multidisciplinary approach;

- The legal and ethical implications of using health information technologies and clinical decision support systems which may result in harmful effects in certain cases are not yet clear;
- The effect of e-health tools on patient behavior and the patient-clinician relationship are unclear;
- Potential health inequalities resulting from the ‘digital divide’, particularly affecting the disabled and the elderly, need to be minimized; and
- The potential roles and influences of different e-health media and setting (e.g. kiosks, workplace) need to be explored.

Maloney, Ilic and Green (2005) further state that the greatest barrier to e-health is the difficulty for consumers to find accurate and reliable information. According to Dutta-Bergman (2004), the two critical indicators of *e*-health information quality are source credibility and information completeness. Medical experts suggest that health information provided by a source that is not credible is detrimental to consumer outcomes (Harrison and Lee, 2006). Also, unless health information is complete, it is likely to mislead the consumer into making incorrect decisions. The completeness of health information is considered the single most important criterion in healthcare decision-making (Dutta-Bergman, 2004). Since the Internet as a communications system is relatively uncontrolled, initiatives have been introduced in an attempt to improve the quality of Internet-based health information (Harrison and Lee, 2006). One such control is the Health on the Net (HON) code, which offers a stamp of approval for websites adhering to agreed quality principles. Similarly, Health Internet Ethics (Hi-Ethics) has developed the "e-health code of ethics" in an effort to respond to these concerns regarding reliability of information, privacy, and confidentiality (Kind and Silber, 2004; Maloney *et al.,* 2005).

Finally, from a societal perspective, there are technological, organizational, managerial, and ethical implications associated with e-health proliferation (Deluca and Enmark, 2000). According to Cashen *et al*. (2004), the most vulnerable people in our society may be the least able to benefit from e-health due to cognitive, social, and cultural barriers. These barriers include literacy, cultural differences, language differences, access to technology and educational deficiencies (Cashen *et al*., 2004). Only through conscious efforts to address these barriers can e-health initiatives be expanded to meet a broad range of society's needs.

In the South African context, e-health is coordinated by a single National Department of Health (NDoH) and each of the nine provinces has its own provincial strategy for e-health implementation plan (DoH, 2005). Moreover, each of the Provincial Health Departments is responsible for its own e-health implementation roll-out. However, the NDoH has formulated a single national e-health strategy for the country. The strategy defines e-health in the context of South Africa as; "the combined utilization of electronic communication and information technology to generate, capture, transmit, store and retrieve digital data for clinical, educational and administrative purposes" (DoH, 2005). Therefore, the purpose of e-health in South Africa is to contribute to the improvement of the health status of its citizens through optimal utilization of ICT. In executing e-health initiatives in South Africa, the NDoH receives support and guidance from the Department of Communications under the Minister of Communications, the Presidential National Commission for Information Society and Development, and the Presidential International Advisory Council of Information Society. The concept of an "inclusive" information society is the focal point of a broad policy content of e-health initiative in South Africa (DoH, 2005).

Since the establishment of the national strategy for e-healthcare in South Africa, some of the achievements to date include: Delta 9 Electronic Medical Record in the Eastern Cape Province, Meditech in the Free State Province, Medicom in Gauteng Province and the Patient Administration and Billing (PAAB) System in the North West Province (DoH, 2005). The next section explores three areas of e-health namely, Health Information Systems (HIS), Electronic Health Record (EHR) and Electronic Prescribing (EP).

2.6 Health Information Systems (HIS) and information needs

WHO (2004) defines HIS as a system that integrates data-collection, processing, reporting and the use of the information necessary for improving healthcare service effectiveness and efficiency through better management at all levels of healthcare services. HIS has further been defined as a combination of health statistics from various sources which are used to derive information about health status, healthcare provision and the use of healthcare services (Malley and Storto, 2002). Organizationally, HIS is heterogeneous and it is comprised of a number of sub-systems for collecting and reporting data. Some of those sub-systems are health facility-based and others are based on vertical programmes such as the Expanded Programme on Immunization (EPI), tuberculoses, leprosy and malaria control programmes (Chilundo and Aanestad, 2004). HIS is sometimes referred to as Clinical Information Systems (CIS). CIS is a comprehensive integrated information system designed to manage the administrative, financial and clinical aspect of the hospital. With this broad view of HIS, the question is how did HIS originate and how has it evolved till this contemporary time?

HIS, according to Arzt (2007), began in the 1980s as program-specific, stove-pipe systems that were based on ageing mainframe or early standalone personal computer technology. These early systems were used mainly by epidemiologists and others with public health analytical skills. However, as personal computers and operating systems became more powerful and with the advent of Microsoft Windows, the use of HIS changed. Arzt (2007) elaborates that, as technologies evolved, public health agencies realized that information was a justifiable target for investment which can improve the core performance of health functions. Agencies, therefore, began upgrading, replacing and creating newer systems for their health services (Arzt, 2007).These systems were more robust, specialized and used modern database systems and tools with more reliable platforms.

The final stage of the evolution of HIS ushered in the concept of Integrated Systems. This stage occurred when some agencies realized that deploying systems purely within individual programs caused some serious limitations (Arzt, 2007). The agencies, therefore, took advantage of Internet networks and more HIS applications became networked. This led to the formation of Integrated Systems within HIS. The evolution process is diagrammatically summarized in Figure 2.6 below.

Source: Arzt (2007)

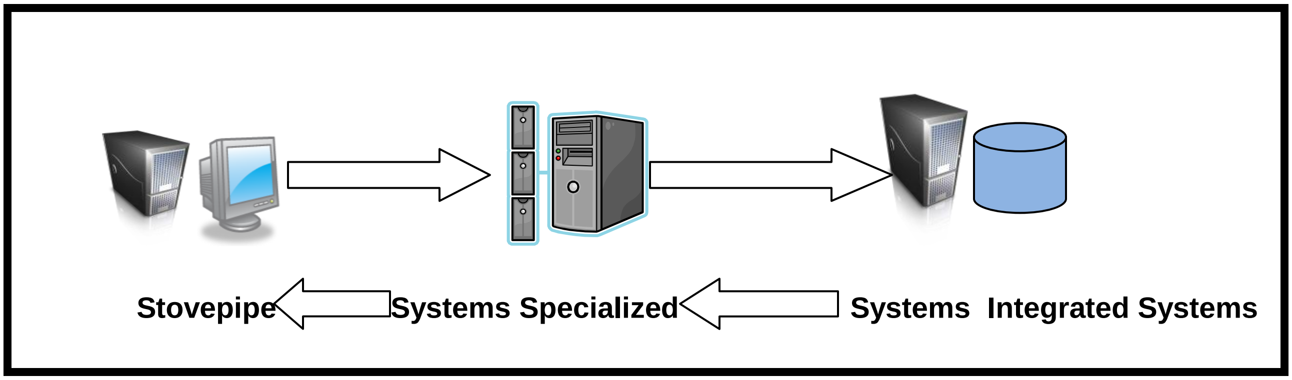


Figure 2.6: The evolution process of HIS

According to Arzt (2007), there are two types of Integration Systems. The first is those systems which provide a link between data integration and application integration. The second type makes data available from different sources through the unified view of a computer application. The two types of Integration Systems are illustrated in Figure 2.7 below.

Source: Arzt (2007)

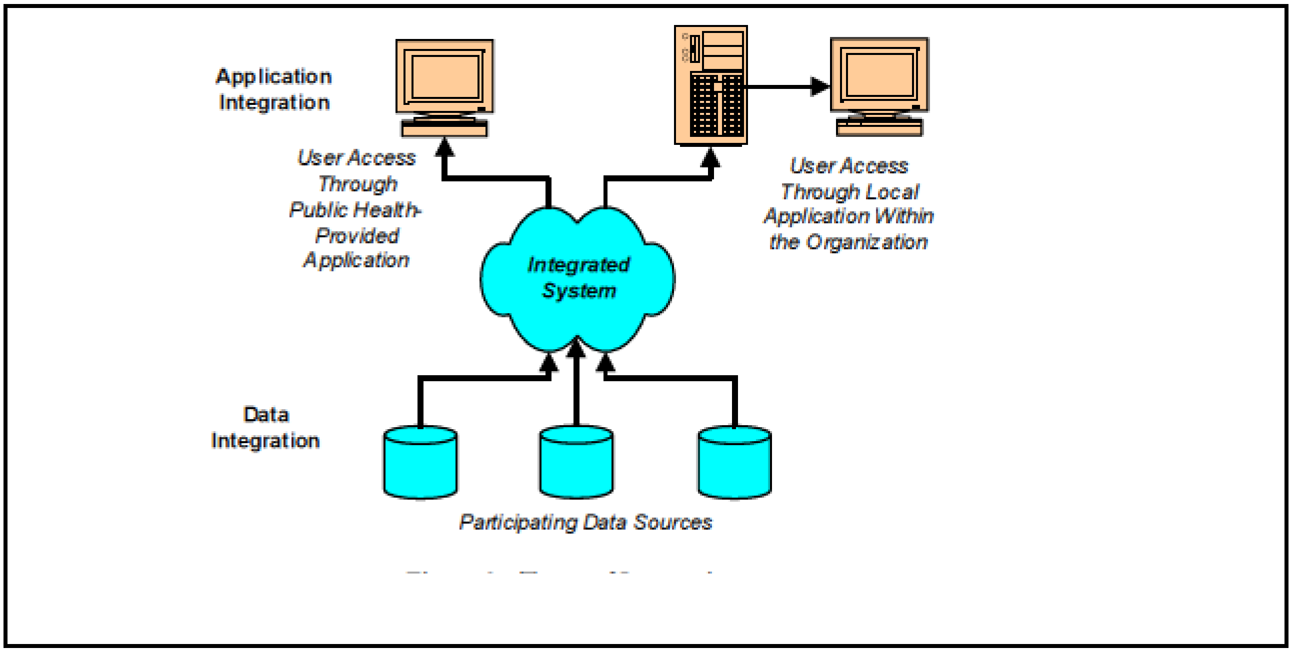


Figure 2.7: Types of integration

In addition, it is stated (Mykkänen, Porrasmaa, Korpela, Häkkinen, Toivanen, Tuomainen, Häyrinen and Rannanheimo, 2004) that in HIS, there are four types of integration models. These are information-oriented integration, process-oriented integration, service-oriented integration and user-oriented integration. These four types of integration are explained below.

Information-orientated integration approaches operate through information exchange and databases and APIs that produce information (Mykkanen *et al*., 2004). An example of this includes the use of DICOM messages and Health Level 7 (HL7). The advantages of this type of integration are (Mykkanen *et al*., 2004):

- Source and target systems need only a few changes;
- State, logic and sequence do not need to be considered; and
- The approach is simple and widely used.

The process-orientated integration approach provides a layer of defined and centrally managed processes on top of existing processes. This type of integration combines relevant processes to support the flow of information and control logic between them (Mykkanen *et al*., 2004).

Service-orientated integration helps share business logic or methods. Shared methods are defined and the infrastructure for such sharing is provided (Mykkanen *et al*., 2004). An example of this type of approach is the Object Management Group (OMG) healthcare specifications.

The user-orientated integration approach provides a user with a consistent view of a multitude of systems (Mykkanen *et al*., 2004). This can be accomplished by using a unifying front-end system or by synchronizing the various applications on the user workstation. An example of this type of approach is the CCOW context management standard from the HL7 (2004). While the use of HIS has various benefits, for example, effective medical decision-making and improved administrative systems, WHO (2004) encourages national states to develop and customize HIS for the needs of their country.

In the South African context, the state has drafted a national health bill, which deals with the establishment of national HIS (Draft National Health Bill, 2007). The draft health bill states that, it is the responsibility of the NDoH to coordinate and maintain a comprehensive national HIS by using information from the provincial and district health authorities, municipalities, and the private health sector. The draft bill further states that district health authorities and municipalities which render health services must establish and maintain HIS within the scope of their functions (Draft National Health Bill, 2007). This has led to the establishment of the District Health Information System (DHIS) which has therefore, become a key element of South African HIS. Data is usually entered into a computer system in the health district or sub-district offices and then transmitted electronically to the Provincial and National Departments of Health. The process of transmitting data from the districts is illustrated in Figure 2.8 below.

Source: Draft National Health Bill (2007)

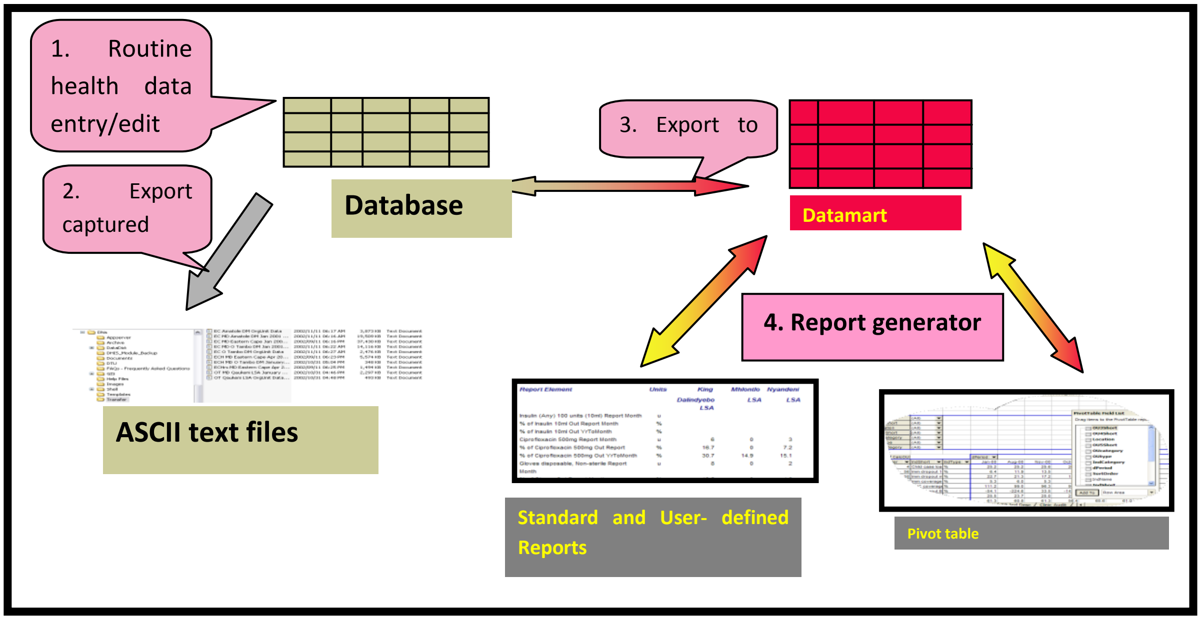


Figure 2.8: The District Health Information System (DHIS)

The DHIS supports routine or quarterly data and also captures and analyzes semi-permanent data (population estimates, equipment, infrastructure, number of personnel, services provided per facility, etc) and audit data. The DHIS uses free and open source (FOSS) applications for collecting and sharing aggregated data collected at health facilities and transmitting this data to higher levels in the public health system. Data from the DHIS are also used in the District Health Barometer (DHB). The DHB is a tool for monitoring and supporting improvement of equitable and efficient provision of primary healthcare in South Africa (DoH, 2005). The DHB produces annual report which uses data from the DHIS, Statistics SA, the National Treasury and the National TB register. The purpose of this report is to highlight inequities in health resource allocation, inputs, outputs and outcomes, as well as the efficiency of health processes between provinces and between all districts in the country, with particular emphasis on rural and urban (metropolitan) districts. Currently, DHB software is being used in all the nine provinces by approximately 200 users at various levels (i.e. sub-district, district, provincial and national). This information is used by administrators at the national level for decision making. There is another system, Patient Administration and Billing (PAAB), in the North West Province which is linked to the DHIS. The PAAB system is developed as a solution to support revenue collection, and patient administration. The PAAB is a non-interactive system which only allows patient information and revenue data to be sent to the provincial Health Department on a monthly basis. Other provinces have similar systems like Delta 9 in the Eastern Cape, PADs in the Free State, and Clinicom in the Western Cape. The next section concentrates on electronic health record systems.

2.7 Electronic health records (EHR)

The effective use of information technology is a key focal point for improving healthcare in terms of patient safety, quality outcomes, and economic efficiency (HL7, 2004). A number of developed countries, such as Sweden, Denmark and Australia have implemented some form of EHR (Taylor and Leitman, 2002; Terry, 2004) although the type and extent of the developed EHR systems may differ (Watson, 2006). In essence, EHR is a repository of information regarding the health status of a subject of care (patient or consumer) in computer processable form (ISO Technical Report, 2007). Again it is defined by the IOM (1999) as the set of components that form the mechanism by which patient records are created, used, stored, and retrieved, usually located within a healthcare provider setting, and including people, data, rules and procedures, processing and storage devices (e.g., paper and pen, hardware and software), and communication and support facilities. This early definition from IOM (1999) has a narrow coverage and does not elaborate on core activities and supportive functionalities, which reflect the modern healthcare practice. A more comprehensive definition given by IOM (2003) defines an EHR system as including:

- A longitudinal collection of e-health information for and about persons, where health information is defined as information pertaining to the health of an individual or healthcare provided to an individual;
- Immediate electronic access to person-and population-level information by authorized, and only authorized, users;
- Provision of knowledge and decision-support that enhance the quality, safety, and efficiency of patient healthcare; and

- Support of efficient processes for healthcare delivery.

The basic EHR concept model depicted in Figure 2.9 represents a general clinical decision process and contains four activities (circles) that are documented in four information entities, i.e., diagnosis, goal, intervention and result (Bernstein, Bruun-Rasmussen, Vingtoft, Andersen and Nohr, 2005). In order to effectively support information flow, EHR systems have the functionality to store longitudinal health information and data, and enable results management, order management, decision support, electronic communication and connectivity, patient support, administrative processes and reporting (Tang, 2003). Accordingly, the EHR should also cover the core activities and the supportive functionalities in the information flow other than patients' data to facilitate an ameliorated healthcare routine.

Source: Bernstein *et al*. (2005)

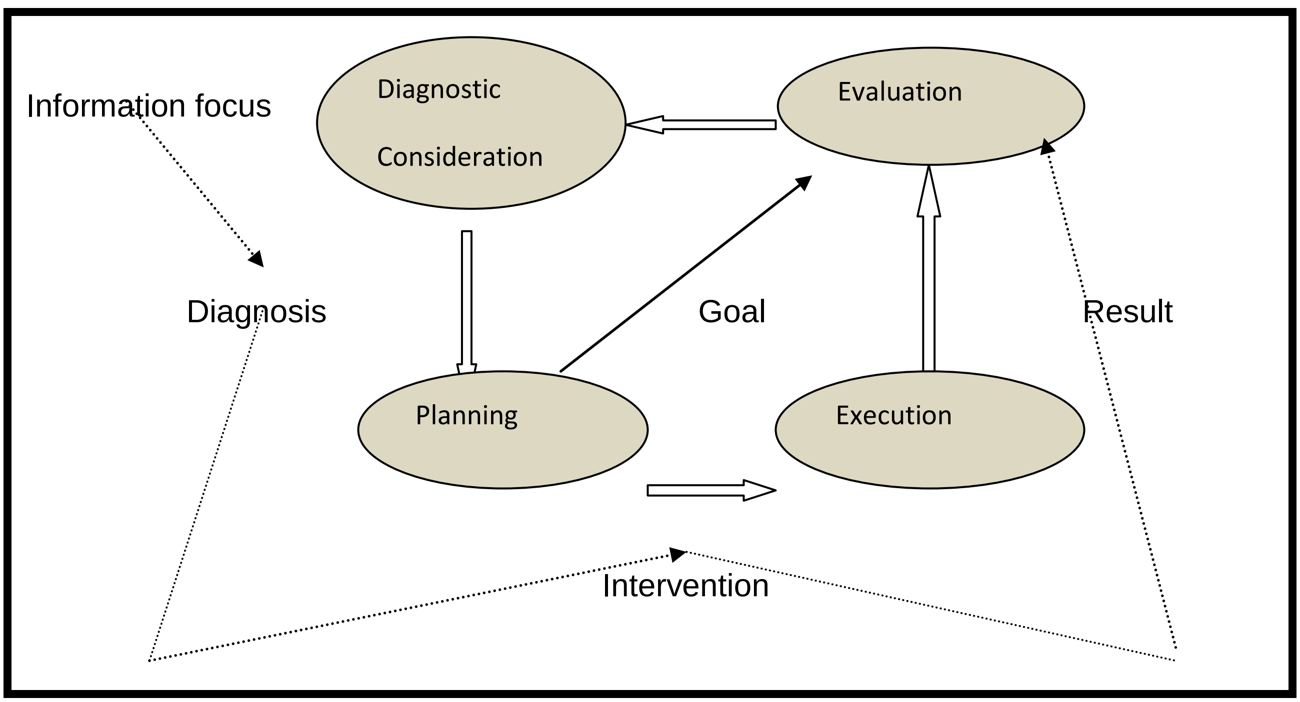


Figure 2.9: The basic EHR model-concept level

An electronic record may be created for each service a patient receives from an ancillary department, such as radiology, laboratory or pharmacy. Again some clinical systems allow the electronic capture of physiological signals (e.g. electrocardiography), nursing notes, physician orders etc. Often these records are not integrated; they are captured and remain in silo systems which have their own user logins and patient identification system. However, with proper planning system interconnection between stakeholders can be achieved. Figure 2.10 presents an EHR concept overview showing interconnection between stakeholders (National Institutes of Health (NIH), 2006).

Source: NIH (2006)

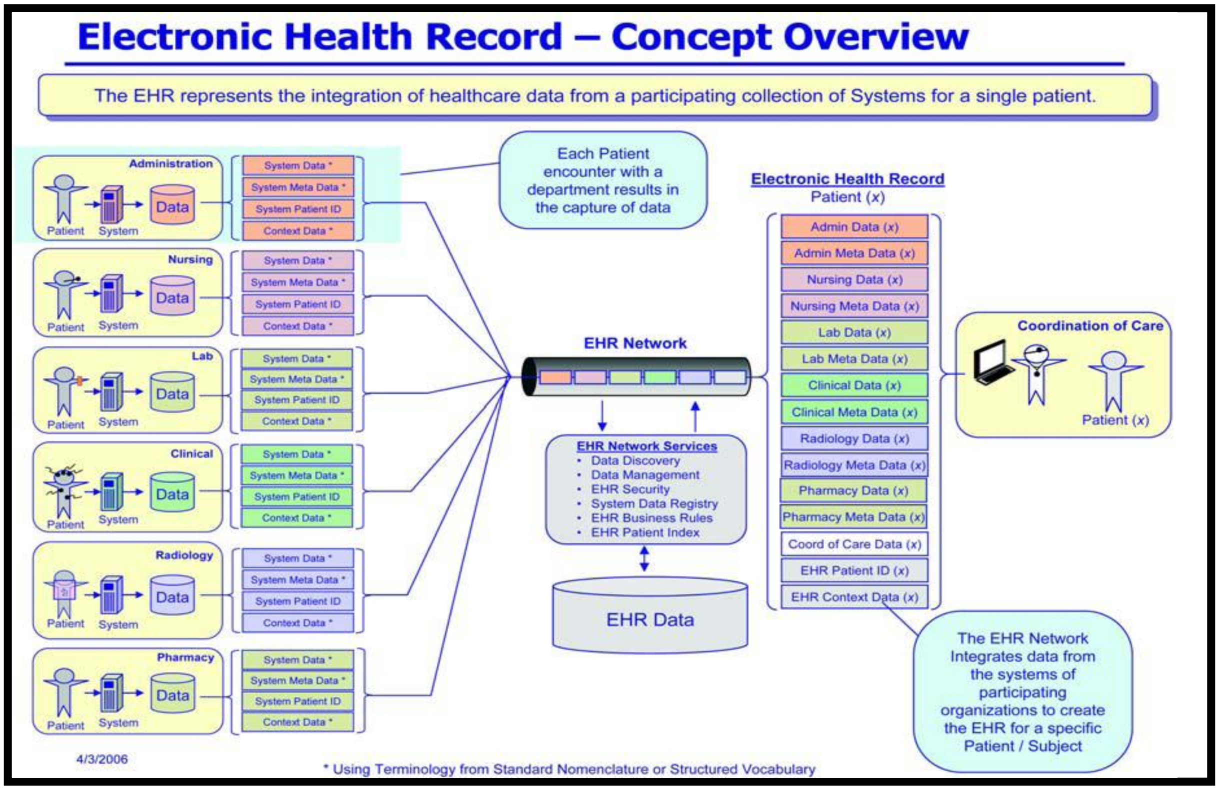


Figure 2.10: EHR concept overview

2.7.1 EHR versus paper health records

Essential differences between paper health records and EHR, regarding location, readability, accessibility, traceability, supported healthcare processes and data self sorting have been identified (Bakker, 2007; Veselý, Zvarova, Peleška, Buchtela and Anger, 2006; Bates, Cullen and Laird, 2003; Kuperman et al., 2001; Warshawsky *et al.*, 1994; Allan and Englebright, 2000).These are summarized in Table 2.1

	Paper Health Records	EHR
Location (Bakker, 2007)	Generally viewed only at one location (where the physical document is present)	Can be viewed from multiple locations
Readability (Bakker, 2007)	Easily and directly read	Software needed to transform the digital data into a readable presentation
Accessibility (Bakker, 2007)	Access to data is all or none	Different levels of authorization are granted to access digital data
Traceability ((Bakker, 2007)	Impossible to record who has seen the data and when	Keep a traill of the use
Supported care process (Veselý *et al*., 2006; Bates *et al*., 2003; Kuperman *et al*., 2001)	No	Physician order entry, appointments, prescription and dose guidelines and so forth
Data self sorting (Warshawsky *et al*., 1994; Allan *et al*., 2000)	No	Yes

Table 2.1: Differences between paper health records and EHR

Due to the differences, the advantages offered by EHR over paper health records can be recognized. Firstly, electronic patient health records are no longer restricted to the data generated within their local healthcare establishment. Data about the health history of patients and their current health status (which may be recorded by multiple healthcare professionals at different locations) can be presented in a coherent and legible way. Secondly, access rules are made explicit and strictly adhered to. Thirdly, the healthcare process can be supported logistically, for example, physician order entry, appointments, as well as the protocols and guidelines that are used to support the behavior and decision-making of healthcare professionals. Moreover, EHR are available with a 24-hour access, data is self sorting, loss avoidance of records (dependant on resilience) and keep audit trail of document use (Suomi, 2006). All of these superiorities of EHR achieve modern healthcare practice by providing multiple functions, such as evidence-based healthcare (Overhage *et al*., 2005) and increasingly efficient medical practice (Ammenwerth, Brender, Nykanen, Prokosch, Rigby and Talmon 2004).

2.7.2 Structure of EHR

The following EHR structure, independent of technology or implementation strategy, was developed by Dickinson, Fischetti and Heard (2004) through extensive reviews by healthcare providers, vendors and other stakeholders (*cf* Figure 2.11). The main components identified are direct healthcare EHR functions, supportive EHR requirements and the EHR information infrastructure.

Source: Dickinson *et al*. (2004)

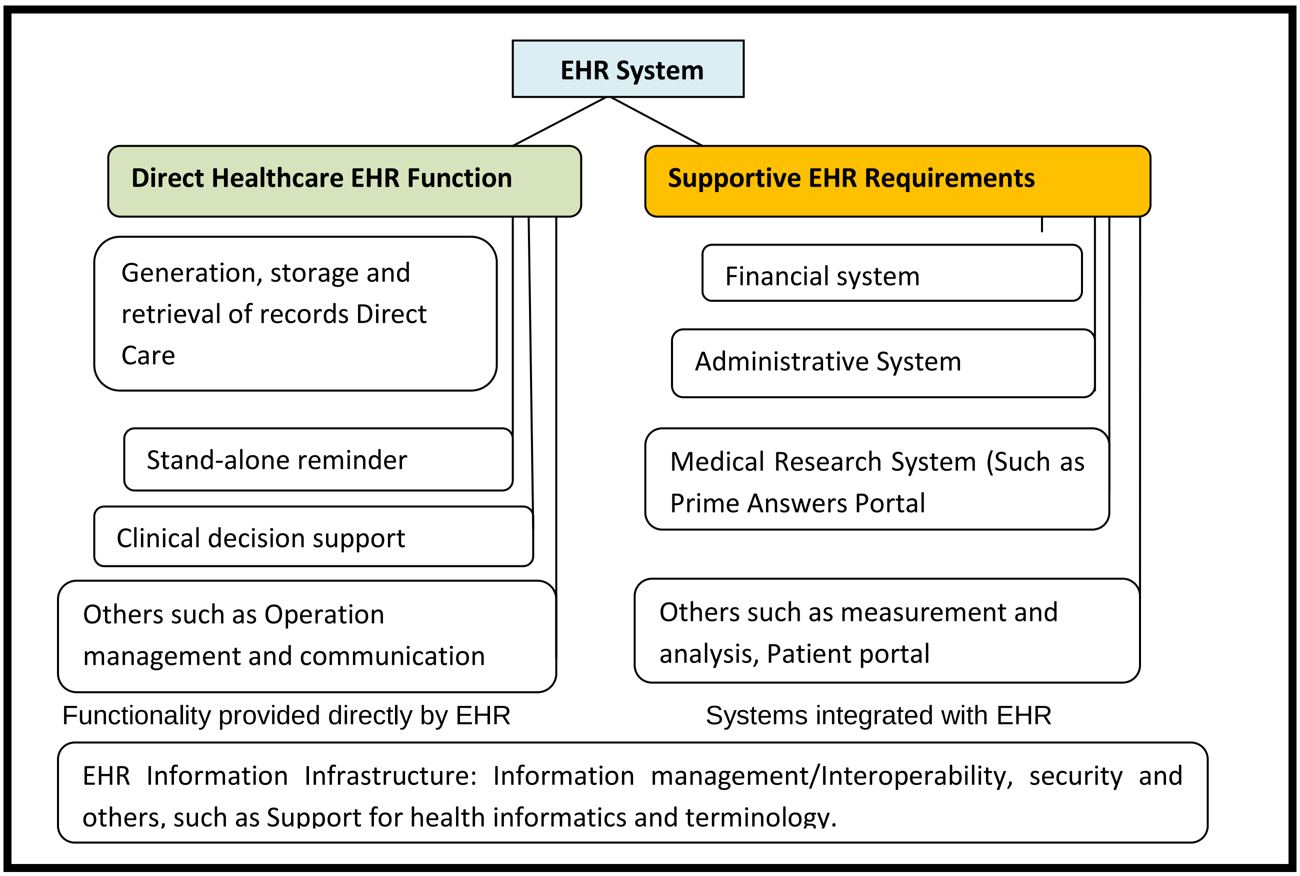


Figure 2.11: Structure of EHR Systems

Direct Healthcare EHR functions enable delivery of healthcare and offer clinical decisions (Dickinson *et al*., 2004). For example, when a patient presents symptoms of a common cold, a Direct Healthcare EHR function enables the physician to record that event. Additionally, stand-alone reminder functions and clinical decision-support functions within the Direct Healthcare EHR section respectively offer illegitimate prescription and contraindication alerts for the medication given to the patient who has the symptoms of a cold (Veselý *et al*., 2006; Bates,2003;Kuperman *et al*., 2001).

Supportive EHR requirements assist with the administrative and financial requirements associated with the delivery of healthcare (Dickinson *et al*., 2004). They also provide inputs to the systems that perform medical research, promote public health, and seek to improve the quality of healthcare delivered (Dickinson *et al*., 2004). For example, supportive EHR requirements electronically query local immunization registries during the encounter to ensure that the child is currently registered, and then determine the child's immunization status. After treatment, supportive EHR requirements will report any immunization to an immunization registry and will provide any encounter data required by financial and administrative systems (Dickinson *et al*., 2004).

The EHR information infrastructure provides a framework for the proper operation of the Direct Healthcare functions and supportive EHR requirements, and offers EHR technical capabilities that are essential, yet transparent, to the user (Dickinson *et al*. 2004). This subset of the EHR structure concerns EHR security (access control and privacy protection), EHR information and records management, the provision of the ability to access, manage and verify accuracy and completeness of EHR information with patient participation, and to audit the use of and access to EHR information; interoperability as the provision of automated health delivery processes and seamless exchange of key clinical and administrative information through standards-based solutions, and so on (Dickinson *et al*., 2004; Coiera and Clarke, 2004; Galpottage and Norris, 2005; Tang, 2003; Tessier and Waegemann, 2003). Although the complete structure of EHR which assumes that a basic technical environment exists (Dickinson *et al*., 2004) has been delineated, to what extent it has been implemented is still an issue. A study demonstrated that few functions of EHR systems were used in practice and physicians used the systems for far fewer tasks than the systems supported (Laerum, Ellingsen and Faxvaag, 2001). The systems were used for only two to seven of the tasks, mainly those associated with reading patient data (Laerum *et al*., 2001). Identification of the issues in paper health records helps to specify EHR requirements and thus, allows EHR systems to more precisely cater for healthcare practitioners' and patients' real needs. The next section focuses on electronic prescribing.

2.8 E-prescribing

Electronic prescribing (e-prescribing) is a computer-based electronic generation, transmission and filling of a prescription, which takes the place of paper and faxed prescriptions (E-health Initiative and Center for Improving Medication Management, 2008). E-prescribing allows a physician, nurse practitioner, or physician assistant to electronically transmit a new prescription or renewal authorization to a community or mail-order pharmacy. A more formal definition of e-prescribing is provided by the E-health Initiative and Center for Improving Medication Management (2008) as the transmission, through electronic media, of the prescription or prescription-related information between a prescriber, dispenser, pharmacy benefit manager, or health plan, either directly or through an intermediary, including an e-prescribing network. It also includes, but is not limited to, two-way transmissions between the point of care and the dispenser. This definition encompasses clinical decision support to aid in safer, more informed prescribing through access to information on drug to drug interaction, drug-allergy interaction, patient medication history, pharmacy eligibility, formulary (which specifies a patient's drug coverage) and benefits information.

There are two types of e-prescribing systems; stand alone systems and EHR systems with an integrated e-prescribing module (E-health Initiative and Center for Improving Medication Management, 2008). The stand alone systems are not linked to EHR systems. This is less costly and less complex to implement, and can be implemented more quickly than an EHR system with an integrated e-prescribing module. On the other hand, an EHR system with an integrated e-prescribing module offers the advantage of having immediate electronic access to all patient data stored in the EHR system, including diagnoses, problem lists, clinical notes, laboratory and radiology results and orders. This adds to the clinicians' ability to make the most informed medication choices for their patients. EHR systems may also offer a broader range of clinical decision support, including notification of needed screening tests, immunizations, etc. Physician practices are increasingly using e-prescribing within an EHR system, due to its more comprehensive functionality, which enables greater gains in quality and safety (E-health Initiative and Center for Improving Medication Management, 2008).

E-prescribing functionality is not specific to any particular hardware or software. The clinical decision support functionality is available through full functioning of EHRs as well as stand-alone e-prescribing systems. In terms of hardware, physicians have implemented e-prescribing using hand-held devices, tablet personal computers, desktop personal computers, and other hardware available from technology vendors for their practices. From the above stated information, it is clear that e-prescribing has many dimensions which can create value for the healthcare industry. This is represented in Table 2.2 below.

Source: NIH (2006)

Process Phase	Key Functions of Innovations	Description
Prescription	1 Patient identification	The prescription is linked to detailed patient demographic information including birth date, gender, and zip code.
	2 Current medication list	The prescriber can access medication history across providers from retail pharmacy transaction data, a health information exchange (HIE) initiative, or a combination of these.
	3 Medication selection	Medication can be selected from a list; options may be driven by diagnosis; accurate dosing; favorites lists.
	4 Safety alerts, clinical decision support	Can alert the prescriber when a medication is selected that is contraindicated or has a significant precaution based on the patient's allergies, current medications, medical conditions, body size, and/or laboratory test results
	5 Formulary alerts	Can alert the prescriber when medication is selected that is contraindicated by the patient's health benefit, e.g., non-preferred, prior authorization, step therapy, higher co-pay

	6 Renewal authorizations	Can alert the prescriber that a refill authorization is required and allows for generation of the renewal.
Transmit	7 Bidirectional electronic data interchange	Can communicate medication information among prescribers, dispensers, and payers, including new scripts, renewal authorizations, change requests, pharmacy benefit information, medication history, counseling results, etc.
Dispense	8 Pharmacist assessment and counseling	Assessment tools can identify patients likely to become none. adherent and encourage pharmacist counseling; makes a personal medication profile available to the patient
Administer	9 Patient education materials	Education materials can be made available about the condition, the therapy, and potential side effects
	10 Administration aids	Can provide graphical/visual medication administration support
	11 Collaborative Medication management	Can connect physicians, other prescribers, pharmacists, health plan care coordinators, and individual care managers to support collaboration for management of medication therapy.
Monitor	12 Linkages to lab testing	Can remind prescribers and patients to obtain lab tests associated with the monitoring of certain medications
	13 Adherence alerts	Can use medication history to alert prescribers, pharmacists, and others that a patient is non-adherent
	14 Patient outreach	Can query patients regarding their experience with therapy, e.g., side effects, via interactive voice, e-mail, or text messaging
	15 Refill reminders	Can remind patients that medications need to be refilled
	16 Remote compliance monitoring	Can alert the patient, caregiver, or care monitor when administration of doses are late or missed

Table 2.2: Domains of e-prescribing

2.8.1 Benefits of e-prescription

The NIH (2006) indicates the following benefits of e-prescription:

- Convenience: With the use of an electronic system, prescriptions should arrive at the pharmacy before the patient does, eliminating the need for the patient to drop off the prescription and wait for it to be filled;
- Streamlined prescription renewal process: E-prescribing streamlines communication between physicians and pharmacies to renew prescriptions. For example, if the prescription has no more refills, the pharmacy will send an electronic renewal request to the doctor's computer system. The doctor's office can respond electronically to approve or deny the request quickly and easily. The patient is much less likely to have to wait for the pharmacist and physician to speak by phone;
- Improved medication safety: By entering prescriptions electronically in a standard format, physicians eliminate many of the opportunities for errors, such as illegible handwriting. Physicians are also more likely to have access to their patients' medication history information, which helps them make safer prescribing decisions and prevents prescribing medications that the patient is allergic to. There is even more benefit when e-prescribing is included in a full EHR that allows greater use of decision tools for the healthcare provider; and
- Better management of medication costs: E-prescribing systems often can access a patient's insurance plan information, so that the physician can prescribe the medications that are covered by insurance. This saves the patient money.

Furthermore, Adler (2009) states that e-prescription is a quicker way of sending prescriptions to the patient's choice of pharmacy. Again, before the prescription is sent, the system automatically check against the patient's current allergy list, medication list and problem list, thus, the system performs drug-allergy, drug-drug and drug-disease checking (Adler, 2009). In addition, the system checks for out-of-range dosing and duplicate drugs - two prescriptions for the same drug or prescription of two drugs in the same class. Potential safety issues are identified by pop-up alerts that describe the problem and its potential seriousness (Adler, 2009). E-prescribing has been shown to reduce prescribing errors when compared to paper prescribing (Arthur and Huntley, 2007).The next section focuses on telemedicine and telehealth services.

2.9 Telemedicine and telehealth services

Telemedicine is electronic communication and information technologies to provide and support clinical healthcare at a distance (Dates, 2008). Again Dates (2008) states that telehealth is the use of electronic ICT to support and promote long-distance clinical healthcare, patient and professional health-related education, public health, and health administration. According to the ATA (2006), telemedicine is the use of electronic communications and information technologies to provide clinical services when participants are at different locations. Closely associated with telemedicine is the term telehealth. Telehealth is often used to encompass a broader application of technologies to distance education, consumer outreach, and other applications wherein electronic communications and information technologies are used to support healthcare services. Video conferencing, transmission of still images, e-health including patient portals, remote monitoring of vital signs, continuing medical education and nursing call centres are all considered part of telemedicine and telehealth (ATA, 2006).

Within existing healthcare facilities, a few key clinical staff members have often led the development of telemedicine applications. As a result, the initial telemedical services that are offered reflect the clinical specialties of those leaders. Leading examples in the past have included radiology, dermatology, cardiology and pathology. However, telemedicine does not represent a separate medical specialty but rather is a tool that can be used by health providers to extend the traditional practice of medicine outside the walls of the typical medical practice. In addition, telemedicine offers a means to help transform healthcare itself by encouraging greater consumer involvement in decision making and providing new approaches to maintaining a healthy lifestyle. The delivery of remote health services through telemedicine and telehealth is used for a variety of purposes (Effertz, 2004):

- Specialist referral services: typically involve a specialist assisting a general practitioner in rendering a diagnosis. This may involve a patient “seeing” a specialist over a live, remote consult or the transmission of diagnostic images and/or video along with patient data to a specialist for viewing later;

- Direct patient healthcare: such as sharing audio, video and medical data between a patient and a health professional for use in rendering a diagnosis, treatment plan, prescription or advice. This might involve patients who are located at a remote clinic, a physician's office or home;
- Remote patient monitoring: uses devices to remotely collect and send data to a monitoring station for interpretation. Such "home tele-health" applications might include using telemetry devices to capture a specific vital sign, such as blood pressure, glucose, ECG or weight. Such services can be used to supplement the use of visiting nurses;
- Medical education and mentoring: which range from the provision of continuing medical education credits for health professionals and special medical education seminars for targeted groups to interactive expert advice provided to another professional performing a medical procedure; and
- Consumer medical and health information: This includes the use of the Internet for consumers to obtain specialized health information and on-line discussion groups to provide peer-to-peer support.

Furthermore, remote healthcare relies on several means for the delivery of data which include the following (ATA, 2006):

- Networked programs: link tertiary healthcare hospitals and clinics with outlying clinics and community health centres in rural or suburban areas through either hub-and-spoke or integrated networked systems. The links may use dedicated high-speed lines or the Internet for telecommunication links between four sites;
- Point-to-point connections using private networks: are used by hospitals and clinics that deliver services directly or contract out (outsource) specialty services to independent medical service providers at ambulatory care sites;
- Health provider to home connections: involve connecting primary healthcare providers, specialists and home healthcare nurses with patients over single line phone-video systems for interactive clinical consultations. Such services can also be extended to a residential healthcare centre such as a nursing home or assisted living facility;

- Direct patient to monitoring centre links: are used for pacemaker, cardiac, pulmonary or fetal monitoring and related services and provide patients the ability to maintain independent lifestyles; and
- Web-based e-health patient service sites: provide direct consumer outreach and services.

Figure 2.12 illustrates architecture of telemedicine which was adopted by e-health activities in Turkey (Nihat-Yurt, 2008).

Source: Nihat-Yurt (2008)

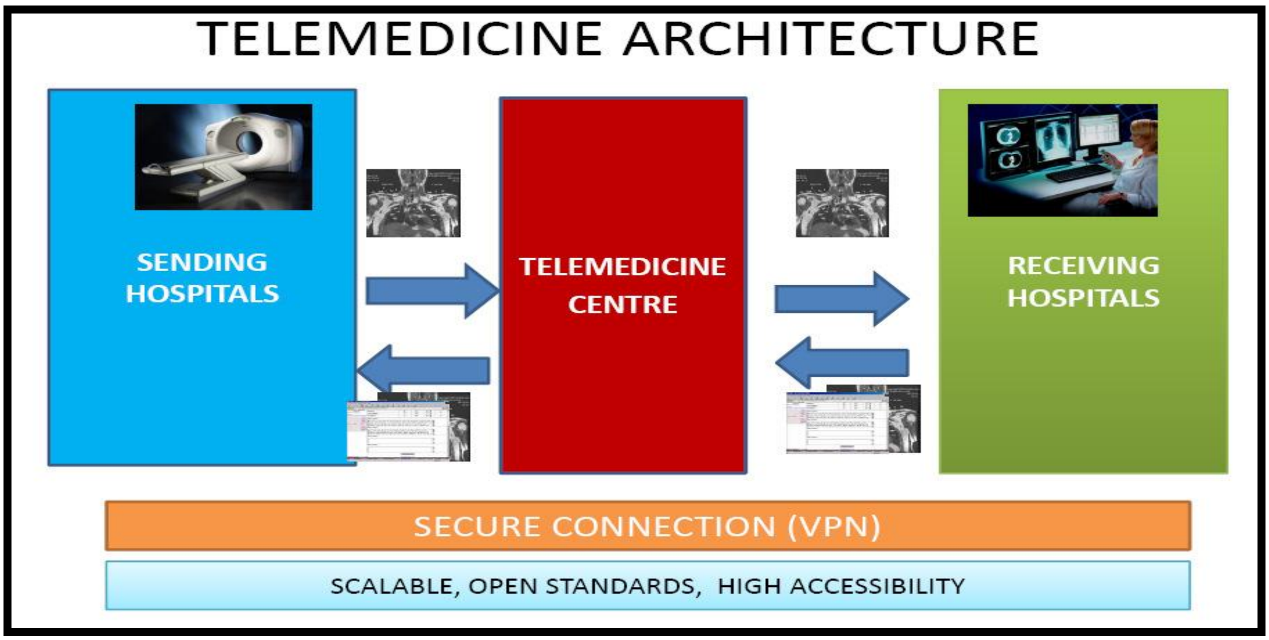


Figure: 2.12: Telemedicine architecture

The next section presents two areas of telemedicine which are e-consultation and e-referrals.

2.9.1 E-Consultation

Telemedicine includes many applications including doctor-to-patient and doctor-to-doctor tele-clinic (Biemans, Swaak, Hettinga and Schuurman, 2005). Furthermore, telemedicine is described as medical education, patient tele-monitoring and homecare as well as doctor-to-doctor remote consultation (Bardram, Bossen and Thomsen, 2005;

Luk, Ho and Aoki, 2007). Doctor-to-doctor remote consultation, referred to as e-consultation, has become the typical approach applied in developing regions and other locations where transportation infrastructure may be limited and network infrastructure capable of sustaining real-time media connection is not cost effective (Vassallo, Swinfen, Swinfen and Wootton, 2001; Hersh, Hickam, Severance, Dana, Krages and Helfand, 2006). According to Luk *et al*. (2007), remote specialist consultation, which is doctor-to-doctor consultation is effective when asynchronous computer-mediated communication. Asynchronous remote consultation systems can be divided into message-centric systems and storage/discussion-centric systems (Luk *et al*., 2007). Message-centric systems provide functionality resembling e-mail facilities which enables doctors to send questions to specialist consultant groups and receive replies (Vassallo *et al.,* 2001). storage-centric systems, which function like the Web, allow basic search and storage capabilities, while discussion-centric systems exhibit the functionality of a typical Web-based bulletin board system. In this research study, e-consultation refers to doctor-to-doctor remote consultation, doctor-to-specialist remote consultation nurse-to-doctor remote consultation and other healthcare professionals-to-doctor remote consultation. The next section focuses on e-referrals.

2.9.2 E-referrals

To refer is “to direct somebody to somebody or somebody else for information, help, treatment or judgment (DHS, 2006). Again the Australian Standard (AS, 2006) defines referral as the communication, with the intention of initiating healthcare transfer, from the provider making the referral to the receiver. The essential components of referral is, therefore, the intent and facilitation of transferring patient healthcare in whole or in part from one healthcare provider or organization to another provider or organization. According to the DHS (2006), e-referrals means the transmission of an electronic document, such as a text document or PDF which can be received and viewed by the referee on their computer. The e-referral message is generated from the referrer’s computer, ideally by the referral being auto-populated with information directly from the referrer's records about the patient. The message is then securely transmitted to the referee. Figure 2.13 below shows the processes that are involved in e-referral.

Source: DHS (2006)

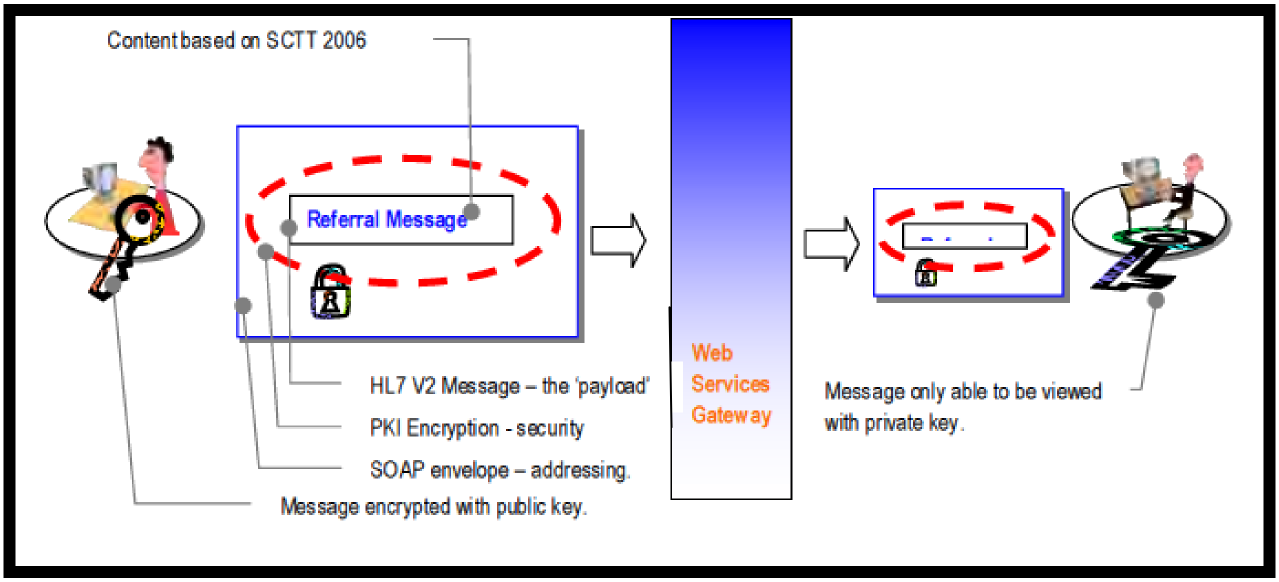


Figure 2.13: E-referral process

In this research study, e-referral means transmitting electronic documents from doctor-to-doctor, doctor-to-other health professionals and doctor-to-other departments within and outside the hospitals/clinics with the intention of transferring healthcare to the relevant recipient. The next section of this study discusses e-training.

2.9.3 E-training

E-training is the process of acquiring the knowledge and skills that are related to work requirements by using computers or guided means but excluding general supervision, job specific innovations and learning by experience (Sloman, 2002). Sloman (2002) further states that training lies within the domain of the organization and it is an intervention designed to produce behavior from individuals that have positive organizational results. In this study, e-training means a set of applications and processes which use available electronic media to deliver e-health application training to healthcare professionals.

The e-training system proposed is based on constructivist ideas. Redmond and Lock (2006) define constructivism as the engagement and active construction of knowledge by learners. Brown (2004:36) states that learners construct their learning through their environment and at their individual learning rates. Swan (2005) advocates that while the learners are constructing knowledge, they should have support from more knowledgeable people such as educators, peers, mentors or experts in the particular field of knowledge. These knowledgeable people can provide additional expertise, different perspectives and scaffolding of the co-construction of knowledge to enhance the learning process (Redmond and Lock, 2006). For e-training to occur, ICT systems are involved and ICT needs to be seamlessly integrated and grounded in the context of the learner (Good, Connor and Luce, 2004). The ICT system revolves around network-delivered interactive multimedia courses and network-based tutoring which constitute the main learning features (Practikakis, Karahaliou, Vassiou, Virvilis, Kosmopoulos and Perantonis, 2007). Pratikakis *et al*. (2007) presented an e-training framework architecture which is illustrated in Figure 2.14 below.

Source: Pratikakis *et al.* (2007)

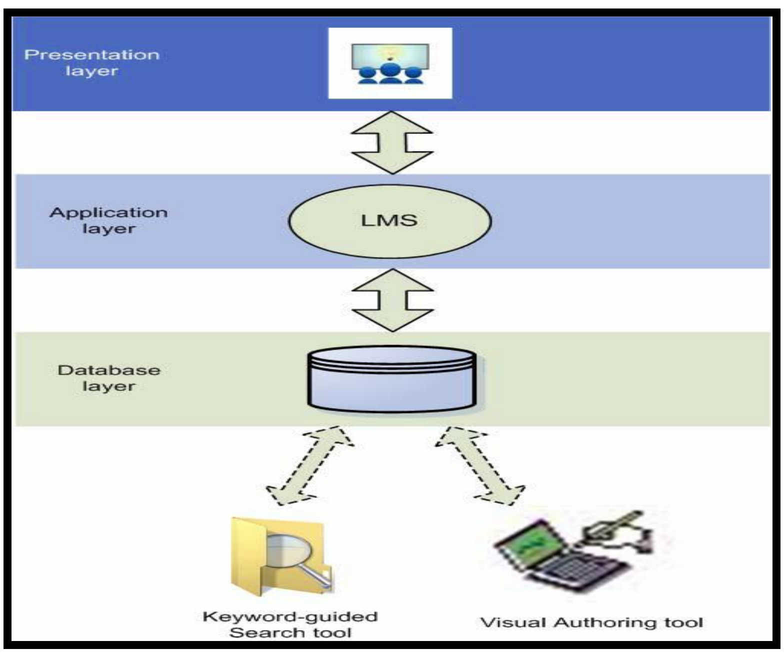


Figure 2.14: E-training framework

The e-training framework consists of the following components: learning management system (LMS), visual authoring tool, trainee interactive e-learning environment and key-guided search tool. These components are elaborated in the following paragraphs (Pratikakis *et al*., 2007):

- **Learning Management System (LMS)**: This is a complex administrative system which is used to deliver electronic content in the form of lessons and to organize the people who participate in the training activities. When it is incorporated with a learning content management system, it is able to create, store, reuse, manage, and deliver digital learning content from a central object repository;
- **Visual Authoring Tool**: This is custom-developed software which facilitates the efficient creation of lessons. Experienced authors construct simple lessons with this tool;
- **Trainee Interactive e-learning environment**: This is the presentation tier where user interaction is focused. Its focus is on efficient user interface (UI) design and accessibility. The user interface can reside on the user's desktop or an Intranet or the Internet; and
- **Keyword Search Tool**: The database holds all the available content along with their corresponding descriptions. The keyword search tool allows searching through keywords with the aim to allow users to find content.

The next section deals with the characteristics of rural and urban health status.

2.10 Characteristics of rural and urban health status

Rural areas have been defined in many ways, sometimes based on population density, geographic location or utilization of resources (Pong and Pitblado, 2001:105). There are numerous definitions of the term "rural", which results in users often disagreeing about which definition to use (Pong and Pitblado, 2001:105). Despite these differences, individual nations need to come up with their own definitions for the equitable distribution of health resources in their countries. According to Pitblado (2005), most definitions for "rural" are based on geographical concepts. These include measures such as population size, population density and distance from urban centre settlement patterns, labor market influences and postal codes. The impact of "place", where people live, work and play makes a large difference in terms of access and utilization of health services (Bollman and Biggs, 1992). Again there are interacting factors in every specific geographic location which shape the utilization of health services.

Rural populations are viewed as vulnerable when accessing healthcare facilities.
This is based on their composition of being older, more likely to be uninsured, have a lower health status, and exhibit higher rates of chronic diseases as compared to urban populations (Ricketts, Johnson-Webb and Randolph, 1999). Again Ricketts *et al*., (1999) indicate that structural aspects of rural environments show low population density, fewer economic resources, a different occupational mix, higher unemployment, and higher and more persistent rates of poverty when compared to urban areas. Additionally, the barriers that rural populations must overcome in order to access healthcare services may be of greater magnitude, and may also differ from those faced by urban populations. For instance, rural residents must travel farther to access healthcare services due to low population density and the lower availability of providers and facilities (Rosenblatt and Hart, 1999). Culture can also act as a barrier to accessing healthcare services, as fewer resources combined with an emphasis on self-reliance may predispose some rural residents to be less likely to recognize or acknowledge healthcare needs (Mayer, Slifkin, Cockrell and Skinner, 2005).

Research supporting this idea shows that rural residents in the USA receive fewer preventive services than urban residents and utilize fewer healthcare services irrespective of physician availability (Casey, Thiede and Klingner, 2001; Larson and Fleishman, 2003). The reasons for such poor rural services and utilization may be due to factors such as education and literacy level of rural people, income and social status of the people, employment and working conditions, personal health practices and coping skills, physical environment and finally, the availability of healthcare services to the rural people (DesMeules, Pong, Lagacé, Heng, Manuel, Pitblado and Bollman, 2006).These factors are further explained in the following paragraphs.

- **Education and literacy level of rural people**

DesMeules *et al*. (2006) report that people living in rural locations have lower rates of secondary school graduation. In Australia, similar results were reported with only about 30% of adults in rural areas having completed secondary school in comparison to about 48% in major cities (Australian Institute of Health and Welfare, 2005). Unsurprisingly, young people from rural locations were also less likely to pursue post-secondary education (Australian Institute of Health and Welfare, 2005).

- **Income and social status of rural people**

Rural people report higher percentages of low income status, similar to the result of their lower education (DesMeules *et al*., 2006). Singh (2004) confirms income gaps ranging from $4,821 to $3,725 between 1980 and 2000, all in favor of the urban regions of Canada. In the United States, the rural-urban income gap has been calculated at 23% ($27,776 vs. $36,079) (Economic Research Service, 1998). China's focus on growth along its coasts has led to a large urban-rural income gap. There is also a wide gap in provision of social and health services between the regions. In 1993, only 10% of the rural population in China had medical insurance when compared with 50% of the urban residents (Brant, Garris, Okeke and Rosenfeld, 2006).

- **Employment and working conditions**

The people living in rural areas experience higher rates of unemployment. Bollman and Biggs' data (1992) pertaining to Canada demonstrates unemployment rates to be consistently higher in rural and small towns from 1976 through 1989, fluctuating between 7% and 12%. The 'service' industry is currently the dominant occupation in rural and small towns, although the forestry, farming, fishing, manufacturing and mining labour forces are still prevalent (Bollman and Biggs, 1992). These occupations are often accompanied with greater health and safety hazards due to the use of complex machinery, exposure to chemicals, working hours, noise pollution, harsher climates, and task related physicality. Such health and safety hazards can explain the higher rates of life threatening injuries that are reported from the rural workforce (Gerberich, Gibson, French, Lee, Carr, Kochevar and Renier, 1998; Pickett, Hartling, Brison, Guernsey and Program, 1999).

- **Personal health practices and coping skills**

There appears to be strong urban-rural differences in several health behaviors. According to the DesMeules *et al*. (2006) report, people from rural areas report higher rates of smoking, higher exposure to second-hand smoking, higher overweight/obesity rates and lower rates of fruits and vegetable consumption. Suicide rates, injury and poisoning are also important contributors to the higher mortality rates found in rural areas. In addition, the Australian Institute of Health and Welfare (2005) also reports higher rates of interpersonal violence, like homicide, in rural areas when compared to urban areas. It should be noted, however, that lower levels of stress and a higher sense of communal belonging were found as levels of rurality increased (DesMeules *et al*., 2006).

- **Physical environment**

The Australian Institute of Health and Welfare (2005) identified additional evidence of environmental variations in determinants of health. This particular project reported lower water quality and the crowding of households as factors affecting disease control in rural and remote locations. Also insufficient wastewater treatment, lack of paved roads and exposure to agricultural chemicals have been identified as additional environmental concerns for those living in rural locations (Aday, Quill and Reyes-Gibby, 2001).

- **Healthcare services to rural people**

People in rural communities have poorer health status and greater needs for primary healthcare, yet they are under-served and have more difficulty accessing healthcare services than people in urban centres (Romanow, 2002: 197). During the 1990's, only 20% of the public health spending of the government was spent in the rural health system that served 70% of the Chinese population (Brant *et al*., 2006). A recurring theme in relation to rural and remote demography signifies that population density is low and dispersed. In relation to the current discussion, are the impacts of these characteristics on healthcare services, especially the inability of rural and remote locations to sustain healthcare services at accessible locations (Humphreys, Hegney, Lipscombe, Gregory and Chater, 2002). For example, between 1990 and 2000, 228 rural hospitals closed in the United States (7.8%), which led to a reduction of 8, 228 hospital beds (U.S Department of Health and Human Services, 2003). Canadian rural and small town dwellers have half as many physicians (1 per 1000) as their urban counterparts, and on average, have to travel five times the distance to access these services (10 km) (Liu, Hader, Brossar, White and Lewis, 2001).

While an increase in local hospital closures within rural and remote locations have resulted in a reduction of primary healthcare and an increase in travel, these have not been the sole rural healthcare issues. Liu *et al*. (2001) confirm that good rural healthcare does not depend on the presence of a small hospital that cannot, in the current environment, provide genuinely acute healthcare. Additional healthcare concerns have included the quality of healthcare, specialization of services, ambulatory care and emergency treatment. All these factors have inadvertently impacted on the health of rural people. Haselth and Ryser (2006) found reductions in specialized healthcare services such as dentists, dental surgeons and social workers, between 1998 and 2005 in selected rural areas in Canada. In addition, ambulatory services were only available in 40% of the selected sites, blood and urine testing services in one third of the sites, and only one of the 19 sites had neo-natal services. It is of particular concern for the aging rural population, that nursing services had reduced from 26.3% in 1998 to 21.1% in 2005.

It is apparent that rural and remote locations are plagued with problematic healthcare services. In large part, distance, isolation, and dispersed populations have been the leading causes of these problems. These common characteristics of rural areas have led to the difficulties in recruiting and retaining qualified and skilled professionals in the healthcare field. The urban and more prosperous areas are disproportionately home to the skilled healthcare work force in most if not all countries in Sub-Saharan Africa. For example, urban Zambia has 20 times more doctors and over five times more nurses and midwives than its rural areas. In Malawi, despite 87 percent of its population living in areas considered rural, 96.6 percent of doctors are found in urban health facilities. In Burkina Faso, there is one midwife for approximately 8,000 inhabitants in the richer zones, against one for nearly 430,000 inhabitants in the poorest zone. Many remote regions and districts do not have a single doctor, nurse or midwife to provide assistance to those that need it most (World Bank, 2008).

These issues have resulted in innovative ways of delivering healthcare to rural dwellers, including over the phone medical consultations, travel grants, as well as mobile preventative and treatment programs including e-health. Furthermore, there have been increased efforts to attract health professionals to these isolated locations. For example, increasing the number of medical students from rural areas and improving financial incentives for rural practice (Rourke, 2008).

In South Africa, the rural health problems are not different from those experienced in other parts of the world. In South Africa most rural communities live in poverty. According to Koch (1993:28), rural areas in South Africa have always remained poor, impoverished underdeveloped and less inhabited. Oxford (2004:13) indicates that rural communities and especially healthcare in these areas is of great concern. Therefore, the use of ICT to improve the delivery of quality healthcare will be a major benefit to rural areas and the country as a whole. The next section examines possible e-health architectural styles.

2.11 Possible e-health architectures for implementation

In order to compile a framework, it is necessary to define it. According to Shields and Tajalli, (2006), a framework is a real or a conceptual structure which is intended to serve as a support or guide for the building of something that expands the structure into something useful. Mifflin (2003) defines a framework as a set of assumptions, concepts, values, and practices that constitute a way of viewing reality. In this research study, the envisaged e-health framework that is to be compiled is meant to improve the quality of healthcare services rendered to the people in the North West Province through the use of ICT. However, it is important to recognize that ICT is an enabling infrastructure, but not the end goal. The use of ICT in the health environment is to provide high performing healthcare system, where all those engaged in the care of the patient are linked together in a secure and interoperable environment and where the decentralization of flow of healthcare information directly enables the most comprehensive, patient centered, safe, efficient, effective, timely and equitable delivery of healthcare at where and when it is needed most, that is, at the point of healthcare (IOM, 2001).

Many e-health models and frameworks that have been discussed in this chapter include e-health record system, e-consultation system, e-prescription system, e-referral system, and health information system. Each of these models or frameworks targets a specific e-health domain but does not give a comprehensive e-health framework for which a total e-health solution for a healthcare institution can be accommodated. Furthermore, most of these models and frameworks have been developed in developed countries like Canada, USA and the EU. These models and frameworks have emerged in the context of wealth where there are well developed national and local ICT infrastructures in place (Drury, 2005). Drury (2005) further states that in developing countries like South Africa, the context in which e-health models and frameworks are developed is not wealth but poverty. Therefore, for the envisaged e-health framework that this study intends to compile to be useful, it should be contextualized to serve the rural and urban hospitals/clinics in the North West Province of South Africa.

There are different architecture styles which can inform the development of different e-health frameworks and models. Garlan and Shaw (1994) define an architecture style as a set of principles, a coarse grained pattern that provides an abstract framework for a family of systems. These include among others, client /server architecture, component-based architecture, domain-driven architecture, layered architecture, message-bus architecture, object-oriented architecture and service-oriented architecture (SOA).These architecture styles serve as guidelines for developing ICT frameworks for enterprises including healthcare institutions. These architecture styles are briefly described in Table 2.3 below.

Source: Garlan and Shaw (1994)

Architecture style	Description
Client-Server	Segregates the system into two applications, where the client makes a service request to the server.
Component-Based Architecture	Decomposes application design into reusable functional or logical components that are location-transparent and expose well-defined communication interfaces.
Domain Driven Design	An object-oriented architecture style is focused on modeling a business domain and defining business objects based on entities within the business domain.
Layered Architecture	Partitions the concerns of the application into stacked groups (layers).
Message-Bus	A software system that can receive and send messages that are based on a set of known formats, so that systems can communicate with one another without needing to know the actual recipient.
Object-Oriented	An architectural style based on division of tasks for an application or system into individual reusable and self-sufficient objects, each containing the data and the behavior relevant to the object.
Service-Oriented Architecture (SOA)	Refers to applications that expose and consume functionality as a service using contracts and messages.

Table 2.3: Architectural styles and descriptions

Furthermore, these architectural styles can be categorized by their key focus areas. Table 2.4 lists the major areas of focus and the corresponding architectural style.

Category	Architecture styles
Communication	Service-Oriented Architecture (SOA), Message Bus,
Deployment	Client/server,
Domain	Domain Driven
Structure	Component-Based, Object-Oriented, Layered Architecture

Table 2.4: Architectural style category

The following paragraphs focus on SOA.

2.11.1 Service-Oriented Architecture (SOA)

Many researchers indicate that the SOA approach is the key to solving many challenges emanating from the integration of organizations and their data (Denaro, Pezz, Tosi and Schilling, 2006; Neubauer, 2007; Kelly, Coddington and Wenelborn, 2006; Davidson, Smith, Amoussou and Steinberg, 2009; Papazoglou and Heuvel, 2007). Erl (2005) further indicates that the SOA approach can offer a real potential benefit that can improve organizations including healthcare organizations. The SOA approach is based on the concept of service (Lammer and Germany, 2008). Ilia (2006) defines service as a vehicle by which a consumer's need or want is satisfied according to a negotiated contract which includes service agreement of the functions offered. Burbeck (2000) further states that a service represents a well-defined function which is generated in reaction to an electronic request. SOA is defined as an approach to designing a system that allows for loose coupling, interoperability and standards-based computing (Papazoglou and Heuvel, 2007). Ilia (2006) defines SOA as the principles and guidance to transform an organization's array of heterogeneous, distributed, complex, and inflexible systems into integrated, simplified, and highly flexible resources that can be changed and composed to support business goals. When SOA is applied it will allow the hospitals/clinics the autonomy and flexibility they need to take control over their own IT environment while at the same time it enables inter-organizational business integration (Lammer and Germany, 2008). The British Columbia E-health Steering Committee (2000) indicates that SOA approach is an ideal method for the development of e-health solution for developing countries.

From the above discussion, it can be inferred that SOA enables application functionality to be provided and consumed as a set of services. Services use a standards-based form of interface that can be invoked, published, and discovered. SOA services are focused on providing a schema and message-based interaction with an application. SOA services provide application-scoped interfaces and not component or object-based interfaces. In other words, an SOA service should not be treated as a component-based architecture. The main benefits of the SOA architectural style are:

Domain alignment: Reuse of common services with standard interfaces that increases business and technology opportunities and reduces cost;
Abstraction: Services are autonomous and accessed through a formal contract, which provides loose coupling and abstraction; and
Discoverability: Services can expose descriptions that allow other applications and services to locate them and automatically determine the interface.

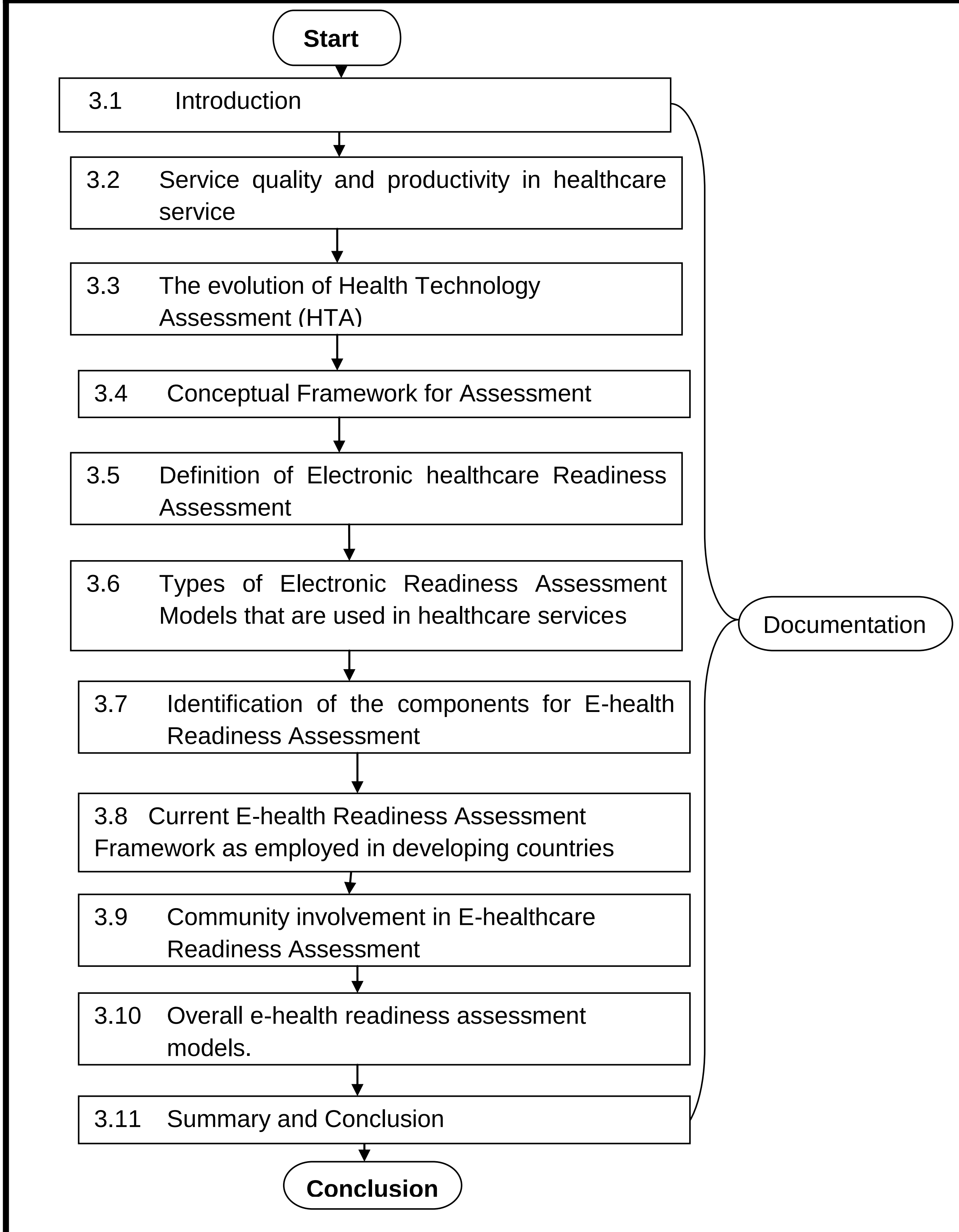
This research study, therefore, proposes SOA architectural style as the pattern for the compilation of the provincial e-health framework for the North West Province. However, the choice of SOA depends upon the outcomes from the e-health readiness assessment to be conducted in the selected hospitals/clinics in the North West Province

2.12 Conclusion

This chapter highlights some important aspects of the research project namely, e-health definition and goals, pre-requisites for e-health initiatives, privacy and security concerns regarding health information, the benefits of e-health and barriers, evolution of HIS and information needs, EHR, e-prescription and its benefits, and telemedicine and telehealth care services. These subsections of the literature review highlight the various components of e-health frameworks and their benefits, which the researcher applied to the compilation of the provincial e-health framework.

Finally, the chapter explains the characteristics of rural and urban healthcare needs and highlights that rural populations are vulnerable in terms of access to healthcare services because of their composition and the structural aspect of rural environments. The chapter ends with possible e-health architectures for implementation of which SOA was proposed as a guide to the compilation of the final provincial e-health framework due to the outcome of the e-health readiness assessment which was conducted in the selected hospitals/clinics in the North West Province. The next chapter presents the electronic healthcare readiness assessment models and frameworks.

Chapter 3: ELECTRONIC HEALTHCARE READINESS ASSESSMENT MODELS AND FRAMEWORKS



CHAPTER 3

ELECTRONIC HEALTHCARE READINESS ASSESSMENT MODELS AND FRAMEWORKS

3.1 Introduction

This chapter focuses on the theories which researchers have applied in Electronic Healthcare Readiness Assessment (E-healthcare Readiness Assessment), (Campbell, Harris and Hodge, 2001; Demiris, Oliver, Porock and Courtney, 2004; Jennett, Gagnon and Brandstadt, 2005; Overhage, Evans and Marchibroda, 2005). This is in accordance with Babbie (2006: 57), who contends that using theories to understand how society works is a key to offering practical solutions to its problems.

Considering the research objectives of this thesis, firstly, this chapter looks at service quality and productivity in healthcare. Secondly, it focuses on the evolution and definitions of HTA. Thirdly, it examines a conceptual framework for assessment models, definitions of e-healthcare readiness assessment and types of e-healthcare assessment models that are used in healthcare services. Finally, the chapter ends with the identification of the components for e-health readiness assessment, current e-healthcare readiness assessment models that are employed in developing countries and community involvement in e-readiness assessment. These are discussed in detail as follows:

- Service quality and productivity in healthcare;
- Evolution of HTA;
- Conceptual framework for assessment models;
- Definitions of e-healthcare readiness assessment;
- Types of e-healthcare readiness assessment models that are used in healthcare services;
- Identification of the components for e-health readiness assessment;

- Current e-healthcare readiness assessment models employed in developing countries; and
- Community involvement in e-readiness assessment.

In the next section, quality and productivity in healthcare are discussed as they form crucial aspects of the research objective that is, using electronic systems as a means of improving quality healthcare services to the rural community of the North West Province.

3.2 Service quality and productivity in healthcare

Hospital quality has been widely debated in public policy debates. One of the challenges when debating hospital quality is the fact that it means different things to different stakeholders. Turner and Pol (1995) summarize the different views as follows:

- To a surveyor, quality means conformity to a text of accreditation goals and standards;
- To a hospital CEO, quality can mean an absence of adverse publicity, a larger market share, and an established quality program;
- To a health plan purchaser or insurer, quality may be equated with cost efficiency and resource utilization as measured by some standard, such as Health Plan Employer Data and Information set;
- To physicians and professional organizations such as the American Medical Association, quality is best measured by peer review organizations;
- To clinicians, quality is tied to medical outcomes; and
- For many marketers, quality is best measured by patient satisfaction.

Taking into account the marketers' view on quality, Parasuraman, Zeithaml and Berry (1988) define service quality as a "global judgment or attitude, relating to the superiority of the service". This definition covers two types of hospital output qualities: clinical quality and process quality (Donabedian, 1982; Gronroos, 1990). There are a number of ways to enhance the perceived service quality of public medical services. For example, upgrading and redesigning physical facilities (Berry, Parker, Coile, Hamilton, O'Neil and Sadler, 2004) and providing the patients with more information and improving the organizational culture (Keller, 2003). Parasuraman (2002) points out that higher level of service quality can be obtained through more consistent quality over time, and by reducing customer inputs (time, effort, and emotional energy) and increasing company input (labor, technology, equipment, etc.). This implies that both the customer and the company are co-producers of quality healthcare services. Since healthcare services are co-produced services, quality from the perspective of both the company and the customer ought to influence the output of the organization. Parasuraman (2002) defines customer output as service performance and satisfaction, and company output as sales, profits and market share. However, as stated by Buckly (2003), profit motivation is of less relevance in the public sector and thus, cannot be used as the major determining factor for company output. In this regard, Lanseng and Andereassen (2007) define company output as the liberation of scarce resources and the number of patients treated at a satisfactory goal.

Finally, Oliver (1980) states that customer satisfaction increases with increased perceived service quality while it decreases with poor or decreased perceived service quality. Lanseng and Andereassen (2007) note that a sick person has a reduced health condition and, therefore, spends more physical and mental energy relative to a healthy person when in need of medical care. This increases the input from the side of the sick person who is seeking medical care. However, Parasuraman (2002) indicates that reducing the input of a sick person through the use of, for instance, an Internet-based healthcare system (e.g. perform it at their convenience and tempo, no travel to or wait time at healthcare provider) may improve patient perceived service quality, patient satisfaction and reduce providers' costs at the same time. From welfare perspective, injecting e-health into healthcare may prove to have a substantial potential benefit for users (e.g. increased satisfaction) and providers' (e.g. reduced costs or improved capacity). Therefore, in this research study service quality is defined as a "global judgment or attitude, relating to the superiority of the service" (Parasuraman, et al.

1988). This definition which is adopted as service quality in healthcare provision forms an integral part of this research study.
The next section focuses on the origins of HTA and how it has developed until the current time.

3.3 The evolution of HTA

The term ‘Technology Assessment’ (TA) was first introduced in 1965 during a committee meeting on Science and Astronautics in the United States of America’s (USA) House of Representative Congress for the purpose of helping policymakers take appropriate decisions (Goodman, 2004). However, as explained by Goodman (2004), the detailed technical information that was needed by policymakers was not available nor in the right form. Consequently, policymakers could not judge the merit or the consequences of any technology program within a technical context. This implies that policymakers used to consider social, economic and legal implications for any course of action they had to take with little or no consideration of the technical details. Goodman (2004) states that Congress, therefore, commissioned an independent study through the National Academy of Science (NAS), the National Academy of Engineering (NAE), and the Legislative Reference Services (LRS) to investigate and influence the development and application of TA which could be a useful instrument to policymakers. These studies and further congressional hearing led to the establishment of a Congressional Office of Technology Assessment (OTA) which became fully operational in 1974 (Health Technology Assessment Information, 2003).

After the establishment of the OTA, TA aided the US congress to become more effective in their decision making and was able to serve the broad public and private interests of the population. Apart from the benefits which TA offered to decision makers in the US congress, private institutions had different aims regarding its use (Goodman, 2004). Some private industries used TA to help their organizations compete in the marketplace and to improve their future business environment and their internal organizational decision making.

Mclver and ODennel (2005) indicate that in the private sector where TA was needed to provide information for technological design or policy making processes, TA was performed retrospectively, that is, it was used to analyze existing systems, but where the assessment was carried out prospectively, TA was used to project the existing potential impacts of either the existing technologies in the context of a design process or emerging technologies. Armstrong and Harman (1980) state that retrospective technology assessment includes processes that are designed to gain understanding of existing or potential impact of technologies, while prospective technology assessment includes processes that encourage the development of emerging technologies. Mclver and ODonnel (2005) refer to the former type of process (retrospective technology assessment) as analytical technology assessment and the latter (prospective technology assessment) as constructive technology assessment. Analytical technology assessment evolved as linear processes that were divided into steps or activities. Each set of activities includes:

- Defining the nature and scope of the assessment;
- Data collection;
- Analysis of technology impact according to a specific set of dimensions; and
- Production of conclusions and recommendations.

Mclver and ODonnel (2005) again explain that new methods which emerged after the introduction of analytical technology assessments include the iteration of the steps that are mentioned above and allow for alternative steps. The introduction of iteration means that individual steps or activities may be repeated to correct earlier outputs and to gain new insights based on the cumulative perspective. In contrast to analytical technology assessment is the constructive type which is primarily concerned with the production of technology and policy making decisions that are associated with the technology (Mclver and ODennel, 2005). Schot and Rip (1997) present a survey of constructive technology assessment and cite three types as follows:

- Technology forcing;
- Strategic niche management; and
- Technology stimulation.

Technology forcing is a form of policy making where some authority, usually the state, dictates a goal for the assessment. For example, in the area of environmental regulation where goals are closely linked to technological development. Strategic niche management, on the other hand, involves an activity whereby an authority manages the design processes. This is usually practised within standard bodies or coalitions within industrial sectors that foster the development of a new technology. Finally, technology stimulation which involves an activity where some authority creates the environment and the linkage that is necessary to encourage the development of technology. However, McIver and ODonnel (2005) emphasize that technology assessment methodologies have to be adapted to a specific domain like health and Health Technology Assessment (HTA). The introduction of HTA coincided with the development of technology assessment which prompted widespread public interest in the 1960s (Goodman, 2004). This prompted researchers to define HTA. Some of the definitions are discussed in the proceeding paragraphs.

Health Technology Assessment has been defined as a structured analysis of health technology, a set of related technologies, or technology–related issues that are performed for the purposes of providing input to policy decision (U.S. Congress, Office of Technology Assessment, 1994). HTA is further defined by Health Technology Assessment Information (2003) as “research-based, practical-oriented assessments of relevant available knowledge on the direct and intended consequences of technology, as well as the indirect and unintended consequences. Goodman (2004:15) defines HTA as the systematic evaluation of properties, effects or impacts of health technology. Bozic *et al*. (2004:1305) explain that HTA is a growing field that is concerned with the multidisciplinary evaluation of clinical data on the basis of safety and efficacy and the economic aspects of technology acquisition. Bozic *et al. (2004:1305*) further state that healthcare technology includes all the drugs, devices and all medical and surgical procedures that are used in medical care and the organizational and supportive system within which such care is given. Draborg, Gyrd-Hansen, Poulsen and Horder (2005:89) define HTA as “a policy research approach that examines the short and the long-term social consequences of the application or use of technology”. The purpose of their definition was to aid decision making. Draborg *et al*. (2005:90) explain that technology assessment in healthcare is a "multidisciplinary field of policy analysis which studies the medical, social, ethical and economic implications of development, as well as the diffusion of the use of health technology". This definition is viewed as comprehensive with focus on the four main aspects, namely, technology-clinical evidence, economy, patient, and organization, with each aspect having several underlying dimensions (Draborg *et al*., 2005:90). In spite of these broad definitions of HTA, some HTA institutions across the world have acquired their own interpretation to accommodate their own local decision making context (Draborg *et al*., 2005:90). A typical localized definition is the Danish definition of HTA which states that HTA is a comprehensive systematic evaluation of the assumptions for, and the consequences of the application of health technology (Jorgensen, Hvenegaard and Kristensen, 2000:348).

In this research study HTA means a systematic evaluation of supportive systems, that is, healthcare information technology systems, in healthcare institutions. This definition of HTA adopted for this research study differs from the Danish definition of HTA (Draborg *et al*., 2005:90) because the Danish definition covers broader domain (medical devices and its economic implication) which falls outside the scope of this research. Having stated the evolution and definitions of HTA, the next section briefly reviews the intentions for carrying out an assessment in the healthcare services. This conceptual framework upon which assessment is done, guided the intentions of this research.

3.4 Conceptual framework for assessment models

Evaluation has been defined by Ammenwerth, Brender, Nykanen, Prokosch, Rigby and Talmon (2004) as an act of measuring or exploring properties of a system, in the planning, development, implementation or operation phases, to inform decision making that concerns the particular system in a specific context. Wanke, Juzwishin, Thornley and Chan (2006:3) have identified four useful generic frameworks upon which the evaluation of systems and programs, including HTA programs, can be done. This framework is based on Stufflebeam's (2001:8) classification of 22 evaluation approaches. Stufflebeam (2001:9) defines program evaluation as a study which is designed and conducted to assist some audience to assess an object's merit or worth. The four categories identified by Wanke *et al.* (2006:3) are:

- **Pseudo-evaluation**: this represents evaluation with incomplete or invalid findings, which is often undertaken for public relations or political objectives;
- **Question and methods oriented**: it generally addresses specific questions or employs specific methods which include accountability, experimental, case study benefit-cost and program theory based evaluation;
- **Improvement–oriented**: it stresses the comprehensiveness of the merit and worth of a program. This approach seems to examine pertinent technical and economic criteria for judging program plans and operations. It further looks at all relevant outcomes; and
- **Social agenda or advocacy approach**: this is an evaluation that is focused on making a difference to society. The underlying objective of this evaluation is to ensure that segments of society have equal access to education and social opportunities and services, such as healthcare services. Stakeholders are usually heavily involved in the design, collection and interpretation of findings. Unlike the previous category, this evaluation approach eschews the possibility of finding right or best answers and reflects the philosophy of postmodernism, with its attendant stress on cultural pluralism, moral relativity and multiple realities.

Wanke *et al*. (2006:3) further state that there is always an underlying drive or often unstated purpose for which the evaluation is done. They (Wanke *et al.* 2006) outline six possible underlying rational or driving forces for conducting an evaluation which are illustrated in Table 3.1 below.

Source: Wanke *et al.* (2006)

Intent/Agenda	Main Objective	Characteristics or Examples
Accountability	Account for "investment" in health institutions Determine if pre-determined objectives or requirements are	• Stress the need to assess a program's merit or worth, sometimes related to a decision for continuation or discontinuation • Employs external, independent perspective • A primary concern may be whether a funded agency is meeting its contractual obligations,

	met	and the assessment may be related to a decision regarding continuation • Involves mostly a retrospective orientation • Many may include pass/fail standards (or minimum standards of performance), payment for good results or sanctions for unacceptable performance
Political agenda/public relations	Convince constituents about the value or merit of the program/agency	• Lack of full disclosure of findings • Biased instruments, processes or interpretations • Manipulative use of data
Problem-solving/Issue resolution	Address specific questions	• Issues driven-public or sponsor concerns may have stimulated the need for a closer look at the health institution • Narrowly defined questions
Quality improvement	Strengthen health institutions	• Retrospective with view to future (e.g., needs assessment or strategic planning approaches) • May be more likely than accountability approaches to employ internal evaluation resources
Research/curiosity	Generate knowledge	• General purpose is to add to the body of knowledge without drawing specific conclusions or recommendations about the value or merit of the health institution
Social agenda/advocacy	Improve or make a difference in society	• Concerned with societal issues, such as inequity • Bent towards reform or affirmative action • Involvement of stakeholders in design, collection and interpretation of data • Includes consumer-driven, constructivist and deliberative democratic evaluation approaches • Will sacrifice objectivity in favour of a democratic process, recognizing the many realities of a pluralistic society and multiple realities

Table 3.1: Possible evaluation intents

This means that there are different intentions for carrying out any evaluation in a healthcare environment. As indicated earlier (*cf* 3.3), technology assessment can be performed retrospectively or prospectively. The principle of performing technology assessment in early 1965 gave birth to contemporary healthcare technology assessment approaches. In the modern healthcare context, the assessment can be done either at post-implementation phase of technology innovation or pre-implementation phase of technology innovation. These two terms are vital in electronic healthcare readiness assessment and are, therefore, explained further. In the modern healthcare context, post-implementation phase of technology innovation means an assessment after an e-health system has been delivered (Ammenwerth, Eichstadter, Haux, Pohl, Rebel and Ziegler, 2001). Pre-implementation phase, on the other hand, refers to assessment before an e-health system is delivered. While Alexander (2007) points out that post-implementation evaluation is crucial for assessing the merit, success and value of systems, pre-implementation evaluations in healthcare, according to Brender (2006), aim to give direction for decision making with regard to subsequent development or implementation of tasks. During the pre-implementation phase and the planning stage, the evaluation of e-health systems should cover the following (Brender, 2006):

- **Relevance**: assessing whether the solution is entirely able to solve the current problems and meet the demands and requirements of the organization;
- **Problem areas**: identify the weakness and the elements of risk in the solution;
- **Feasibility**: assessing the organization's resources that are needed to implement the chosen solution;
- **Completeness and consistency**: assessing whether the solution is a coherent entity that is neither over nor undersized; and
- **Elements of risk**: assessing whether there are any external conditions outside the organization's control that may involve substantial risk to the project.

In accordance with the above, numerous methods can be used for the evaluation.
For example, balanced scorecard (Gordon and Geiger, 1999; Protti, 2002), field study (Brender, 1999), focus group interview, organizational readiness (Khoja, Scott, Ishaq and Mohsin, 2007) and others. Electronic healthcare readiness assessment for health institutions, which is a way of identifying the potential causes of failure in order to bring innovation into heath institutions, is categorized under organizational readiness (Khoja *et al*., 2007). Considering the objectives of this research as indicated in chapter 1 and the table of intent (*cf*. Table 3.1), it is evident that the intentions underpinning this

research are quality improvement, research curiosity and social agenda. The next section explores electronic healthcare readiness assessment definitions as applied to healthcare services.

3.5 Definitions of electronic healthcare readiness assessment

The concept of technology readiness assessment refers to the evaluation of the propensity of people to embrace and use new technology for accomplishing goals in life and at work (Parasuraman, 2002:308). Ojo *et al*. (2006) define e-healthcare readiness as the degree to which a community is ready to participate and succeed in e-healthcare adoption. Mannan, Murphy and Jones (2006), explain that the concept of "readiness" to implement technology is used as a shorthand term to cover a range of organizational dimensions. The related terms to readiness are "innovation and adoption" of new technologies (Manna, *et al.* 2006). Aas (2001) emphasizes that the introduction of e-health or telehealth into a healthcare organization is regarded as a novel information technology innovation and adoption. Aas (2001) further states that any innovation into a community or system requires the community to adapt to the changes when such innovation is introduced.

The adoption of an innovation is essentially an adoption to change, and therefore, must be examined in the light of extensive change management and innovation adoption (CANARIE, 2002). Again CANARIE, (2002) indicates that change and the adoption of innovation which have been perceived as a precursor to readiness in health institutions have been described as an idea, practice or objective, perceived as new by an individual, group or organization. Lewin (1951) puts forward that change has been commonly portrayed as moving through three phases. These phases are unfreezing, moving and freezing. The unfreezing phase reduces the status quo forces, while the moving phase develops new attitudes, values and behavior, and the freezing phase reinforces a new culture (Lewin, 1951). Beckhard and Harris (1977) refer to the three phases as the current state, the transition state and the future state. Figure 3.1 illustrates the three phases.

Source: CANARIE (2002)

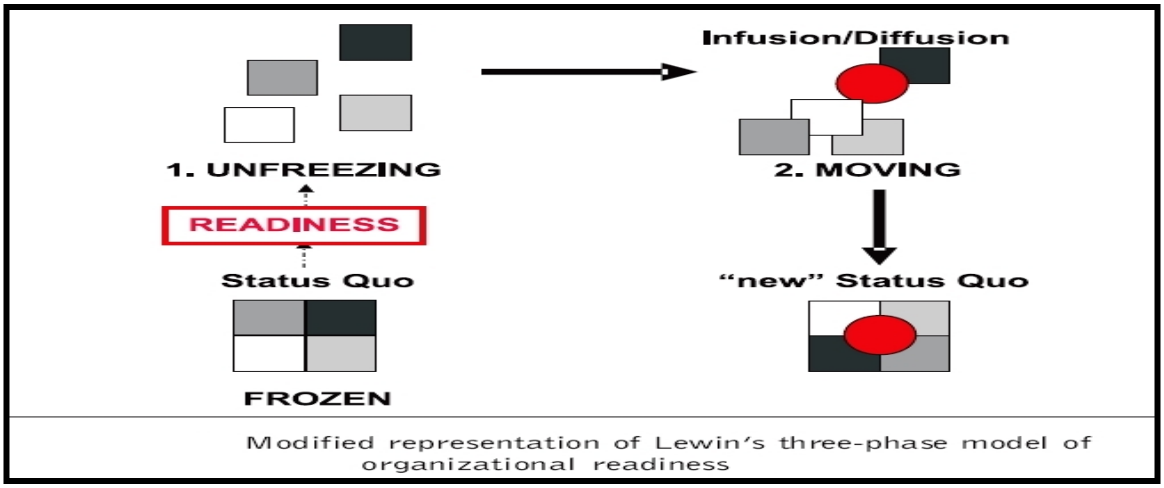


Figure 3.1: Three phase model of organizational readiness

In addition, Prochaska and DiClemente (1982) indicate that change requires an iterative spiral approach and therefore, added a new dimension to the early theories of change. Prochaska and DiClemente (1982) have added two phases prior to the actual change, namely, a pre-contemplation and contemplation phases. The pre-contemplation phase is the state where the community has no thought of change, where there is unawareness that change is possible or where there is simply a lack of intent to change, while the contemplation phase refers to the stage where there is thought about change (CANNARIE, 2002). This leads to the preparation stage where plans to make a change begin. After this comes the concept of readiness which is explained in the following paragraphs (Lewin, 1951; Prochaska and DiClemente, 1982; Rogers, 1983; Armenakis, Harris, and Mossholder, 1993).

Lewin (1951) refers to readiness as a concept that involves the early aspect of change, the period between the frozen status quo and unfreezing, that is, the movement of a community or individuals from the pre-contemplation to the contemplation and to the preparation phase (Prochaska and DiClemente, 1982), and the development of a social environment conducive to the diffusion and infusion of innovations (Rogers, 1983). Furthermore, Rogers (2003) research on diffusion of innovation indicates that the adoption of technology by members of a social group is strongly influenced by the technologies' usefulness and value to them and the demand of the social environment and the expectations of their clients. This means that readiness is an integral and preliminary step in the successful adoption of an innovation. Armenakis *et al.* (1993) define readiness as the cognitive precursor to the behaviour of either resistance to or support for a change effort. Readiness for a change considers the capacity for making change and the extent to which individuals perceive the change as needed. Social information processing models suggest that an individual's readiness to accept innovation may also be shaped by the readiness of others (Armenakis *et al*., 1993; Romano, 1995). This may be one of the reasons for the importance of champions and change agents (Jennett, Jackson, Ho, Healy, Kazanjian, and Woollard, 2005). Jennett *et a*l. (2005) further indicate that creating readiness involves proactive attempts by a change agent to influence the beliefs, attitude, intentions and behaviors of change participants.

Despite the fact that champions and change agents contribute positively to the shaping of other people's readiness, the concept of readiness has received limited attention in the general organizational change literature (Snyder-Halpern, 2001). However, with accumulating evidence about the failure rates of new IT systems in healthcare settings, it is essential to have some indication as to whether organizations are ready to make effective use of technology or not. The US healthcare organization's failure rate of new IT implementation is estimated at around 50% (Kaplan, 1997). Snyder-Halpern (2001) argues that the primary reason for this high rate is the lack of assessment of broader organizational risks that are associated with clinical IT innovation. Her research suggests that an important way to identify hazards that are associated with clinical systems' innovation is to assess the readiness of healthcare institutions for these innovations (Snyder-Halpern, 2001).

The preceding paragraphs have briefly illustrated how critical it is to conduct a readiness assessment of healthcare institutions prior to the provisioning of any e-healthcare services. The next section focuses on the types of electronic readiness assessment models that are used in healthcare assessment. This will assist the researcher to construct a specific e-healthcare readiness assessment as indicated in the objectives of this research in chapter 1.

3.6 Types of Electronic Readiness Assessment Models that are used in healthcare services

There are many e-readiness assessment models that are used in the healthcare sector and many of them assess a specific dimension in the healthcare environment. Each assessment model has a different goal and definition of e-readiness. Most of the major models are used in assessing and ranking the e-readiness of countries and each model has its specific area of assessment (Ojo *et al.,* 2006).It is reported (Bridges.org, 2005) that based on the underlying goals, existing assessment models can generally be divided into three main categories, namely, E-Economy Readiness Models, E-Society Readiness Models and E-System Readiness Models. These models are discussed in the following paragraphs

- **E-Economy Readiness Models**

These models focus on basic infrastructure or the readiness of a nation for ICT and enabled economic activities towards economic growth. For example, the WITSA e-Commerce Survey Model, Mosaic's Global Diffusion of Internet Framework and EIU's e-Business Readiness Rankings Model (Bridges.org, 2005).

- **E-Society Readiness Models**

Bridges.org (2005) explains that models relating to this aspect focus on the ability of the overall society to benefit from ICT at work and in their personal lives. Examples are CSPP's e-Readiness Assessment Guide, the ASEAN Readiness Assessment Model and the World Bank's Knowledge Assessment Methodology (KAM).

- **E-System Readiness Models**

These models, according to Bridges.org (2005), examine the underlying technology infrastructure which is a prerequisite for both e-economy and e-society. An example of this is the ITU's (2009) World Telecommunication Indicators. There are other models which have been developed through case studies, digital divide reports and position papers which assess specific areas in e-readiness, especially in healthcare. Within the healthcare sector, there are currently six of these assessment models that are commonly used for assessment (Campbell *et al.,* 2001; Demiris, Oliver, Porock and Courtney*,* 2004; Jennett *et al.,* 2005; Overhage *et al.,* 2005; Wickramasinghe, Fadlalla, Geisler and Schaffer, 2005; Khoja. 2007). The most commonly used models are discussed and analyzed to develop a comprehensive model for this research study. These models include those proposed by Campbell *et al.,* (2001); Demiris *et al., (2004);* Jennett *et al., (*2005); Overhage *et al.,* (2005); Wickramasinghe *et al*., (2005) and Khoja, (2007).

3.6.1 A framework for telehealth readiness (Campbell *et al*., 2001)

Campbell *et al.* (2001) developed a framework to assess the readiness of rural health providers in adopting telehealth. The study is not explicitly based on a theory of readiness but it involves the development of a framework for telehealth readiness. It investigates multiple providers' views (e.g. physicians, nurses and administrative personnel) for readiness evaluation of e-health applications. This readiness framework is administered through semi-structured interviews (regarding both video and computer components of telehealth care) and is followed by thematic analysis. These results reveal six themes (Campbell *et al.,* 2001):

- Turf: a threat to healthcare providers' livelihood or professional autonomy or both;
- Efficacy: the desire to know that e-health applications will fill a functional need in healthcare providers' practice before they invest time and money in making such a big change;
- Practice context: barriers to adopting e-health applications;

- Apprehension: as a human aversion to change;
- Time to learn: hesitancy among the providers to take the time to learn a new technology and to persuade patients of its worth; and
- Ownership: participants who professionally and emotionally invested in the technology and who acknowledge its benefits, adapt it to their needs, and try to help others.

These six themes consist of the framework that helps in understanding the three categorized organizational settings which Campbell *et al.* (2001) refer to as "fertile soil, somewhat fertile soil, and barren soil". These different categories provide an outline for determining and dealing with three different levels of readiness for implementing e-health applications. However, the problem with this framework is that the categories do not involve organizational, public or patient readiness for e-health; it only reflects the views of the healthcare providers.

3.6.2 Readiness evaluation instrument (Demiris *et al*., 2004)

Demiris *et al.* (2004) designed a readiness evaluation instrument, which is based on existing readiness scales known as Organizational Information Technology System Innovation Readiness Scale (OITIRS) and the Organizational and Functioning Readiness for Change (ORC) scale. Demiris *et al.* (2004) mention that experts in healthcare and hospice care reviewed the survey and the instrument was developed to ensure readability, yet neither of the readiness scales specified the qualification, nor described the review process (Jennett *et al*., 2005). Although certain findings were stratified either by organizations (e.g. hospice1 and 20), community location (e.g. urban vs. rural)), or professional category (e.g. nurses and physicians), the main results were combined and differences found among stratified groupings were not interpreted (Jennett *et al.,* 2005).

3.6.3 Readiness framework (Jennett *et al*., 2005)

By contrast, the readiness framework by Jennett *et al.* (2005) is relatively comprehensive in terms of its evaluation scope. Sixteen expert key informant interviews, two-community awareness sessions, five community focus groups and two community in-depth interviews were conducted. Furthermore, a separate readiness model was developed for each of the following groups: public, patient, practitioner, and organization. The strengths of the research, according to Jennett *et al*. (2005), include the repeated application and modification of the model in rural communities, the development of the readiness model through the process of participatory action research, the triangulation of results and the completion of the qualitative data analysis by an independent qualitative research expert. Six themes are felt to be of relevance to readiness. These are core readiness, structural readiness, projection of benefits, assessment of risk, awareness and education, and intra-group and inter-group dynamics. Four different types of readiness are also outlined: core readiness, engagement readiness, structural readiness and non-readiness. These four types of readiness are explained below (Jennett *et al.,* 2005):

- Core readiness: refers to the realization of needs and expressed dissatisfaction with the present situation and conditions;
- Engagement readiness: involves the active participation of people in the idea of e-health, risk assessment and the question of e-health as a solution;
- Structural readiness: focuses on the establishment of efficient structures as foundation for successful e-health projects within an organization e.g. human, technical, training, policy and funding; and
- Non-readiness: is expressed as a perceived lack of need or failure to recognize a need for change and implementation of e-health technology

In addition to the four types of readiness that were identified, six common themes were also identified within each type of readiness (Jennett *et a*l., 2005). These are explained as follows:

- Core readiness: refers to a recognized need for the service by evaluators, along with an expressed dissatisfaction with existing services or circumstances;

- Structural readiness: is concerned with whether an organization includes adequate human resources, training, policies, funding and appropriate equipment that functions properly or is easily repaired;
- Projection of benefits: means the benefits that e-health can bring, such as reducing the need to travel and improving access to service;
- Assessment of risk: involves health practitioners' demand on working time and professional liability to decide whether to trust the information available to them through web-based applications for practitioners. Additionally, privacy, obtaining reliable information for patients, a fear that e-health services will replace the existing health system as reflected in the public perspective, and a financial risk, especially in the short term, are of relevance;
- Practitioners' awareness and education: refers to the understanding of the various applications, their potential benefits and limitations; and
- Intra-group and inter-group dynamics: means communication and cooperation within or across the communities of interest.

The framework proposed by Jennett *et al*. (2005) is comprehensive and attempts to address the overall readiness categorization. The model stresses the importance of end-user ownership of innovation adoption and assesses organizations, health providers, public and patients' readiness for e-health.

3.6.4 E-healthcare readiness assessment (Overhage *et al*. 2005)

The study of Overhage *et al*. (2005) involves system readiness evaluation rather than practitioner or organizational readiness. Overhage *et al*. (2005) analyzed secondary data that were submitted for the funding of better healthcare programmes. Readiness at system level was assessed by using descriptive statistics and subjective evaluation to explore seven dimensions that an expert review panel had judged to be important determinants of a community's success in creating health information exchange. These include clinical components, a demonstration of community commitment and leadership, matching funds, overall technical readiness, plans for a sustainable business model, use of data standards, and the use of replicable and scalable tools. The problem with the model, according to Jennett *et al*. (2005), is that the objectives of the study (Overhage *et al*., 2004) are not explicitly stated and the purpose is vaguely described. Moreover, Jennett *et al*. (2005) further indicate that the model does not differentiate between urban and rural settings.

3.6.5 E-healthcare readiness assessment (Wickramasinghe *et al*. 2005)

Another framework proposed by Wickramasinghe *et al*. (2005) is concerned with three domains that are relevant to e-health readiness, namely, practitioner, organization, and the public. Wickramasinghe *et al*. (2005) state that the framework provides a tool that allows analysis beyond the quantifiable data into a systematic synthesis of four major impacts and four pre-requisites. The implication of these pre-requisites and impacts to the goals of e-health, such as efficiency, evidence-based and preventive medicine are embedded in the framework. Figure 3.2 illustrates the framework of Wickramasinghe *et al*. (2005).

Source: Wickramasinghe *et al.* (2005)

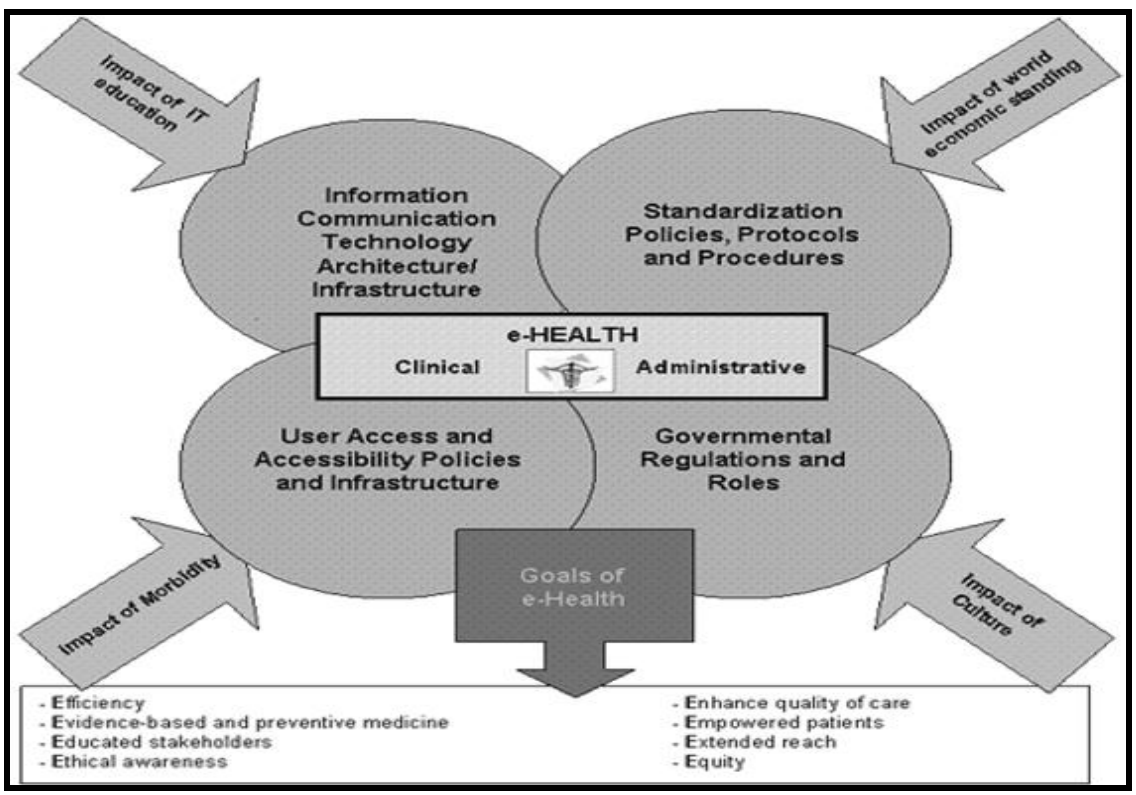


Figure 3.2: E-health Readiness Framework

The framework of Wickramasinghe *et al.* (2005) contains four main prerequisites which are listed below:

- Information Communication Technology (ICT) architecture/infrastructure: a sound technical infrastructure such as phone lines, fibre trunks and submarine cables, telecommunications, electricity, access to computers etc. are needed;
- Standardization policies, protocols and procedures: e-health by definition spans many parties and geographical dimensions. To enable such far reaching coverage a significant amount of document exchange and information flow must be accommodated. Standardization is the key to this, using widely and universally accepted protocols such as TCP/IP and http;
- User access and accessibility policies and infrastructure: access to e-commerce is defined as consisting of two critical components, access to Internet services and access to e-service (Panagariya, 2000). The former deals with the user infrastructure whereas the latter pertains to specific commitments to electronically accessible services; and
- Government regulation and control: the challenges to e-health include cost effectiveness which means less cost for the government than traditional healthcare delivery. Functionality and ease of use is expected to enable many users like physicians and other health workers to combine various types and forms of data without difficulty.

In addition to the four main prerequisites discussed, there are also four impacts of e-health that are embedded in the framework of Wickramasinghe *et al*. (2005):

a. Impact of IT education: an educated population boosts e-health initiatives;
b. Impact of world economic standing: awareness of the importance of and the critical role that the Internet plays in an economy;
c. Impact of morbidity rate: education/awareness and the overall health standing of a nation; and

Impact of culture/social dimensions: the influence of culture and traditions.

The framework of Wickramasinghe *et al.* (2005) is based on multiple perspectives which include organizational ICT infrastructure, practitioners' user access, public user access and governmental regulations. The framework can also be used for the assessment of the potential of a country and its readiness/preparedness for e-health and its ability to maximize the goals of e-health.

Wickramasinghe *et al*. (2005) developed a grid for assessing e-health preparedness in which various institutions can be plotted with respect to key parameters like ICT infrastructure, standardization policies, protocols and procedures, user access and accessibility policies and infrastructure and governmental regulations and roles. The grid consists of four quadrants that represent the possible states of preparedness with respect to the key parameters for e-health success. These parameters are the prerequisites that are needed for e-health implementation and these include user access and accessibility, government regulations and roles, ICT architecture and infrastructure and standardization policies, protocols and procedures.

The low preparedness quadrant identifies situations that are low with respect to all four pre-requisites for e-health potential as indicated in Figure 3.3. The medium preparedness quadrant identifies two symmetrical situations; namely, a combination of high and low positioning with respect to the four pre-requisites for e-health potential. Finally, the high preparedness quadrant identifies situations that are high with respect to all the four pre-requisites for e-health potential.

Source: Wickramasinghe *et a*l. (2005)

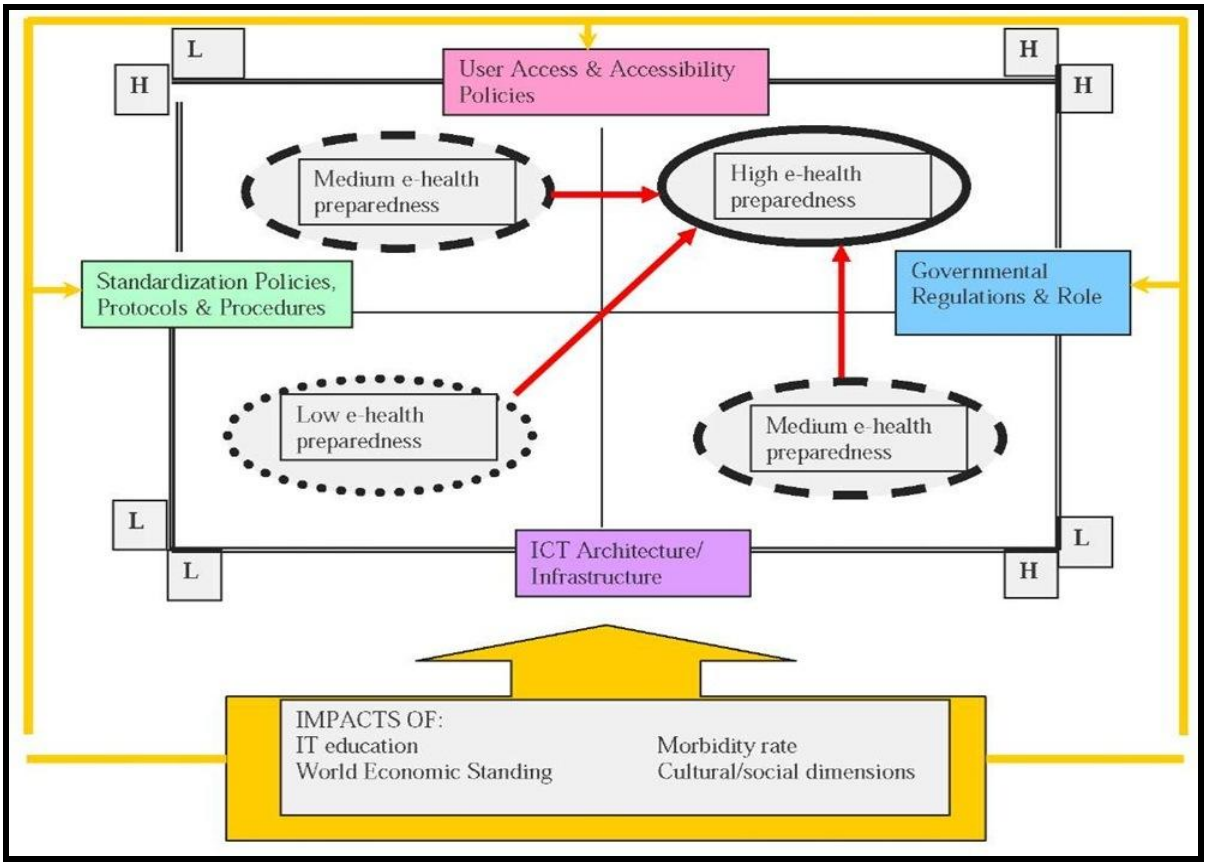


Figure 3.3: Readiness preparedness grid

This grid shows the possible positioning of a given institution with respect to its e-health preparedness (i.e. low, medium or high) and the path it must take, and more specifically, the pre-requisite factors it must focus on to migrate to the ideal state of preparedness, which is, being high within all the four pre-requisites. The grid also underscores the moderating role of the four prerequisites irrespective of the relative positioning of the state of preparedness of a given institution. It is therefore, important for health institutions to fall within the high e-health preparedness quadrant for effective implementation of e-health solutions. The next section discusses e-health readiness assessment as proposed by Khoja *et al*. (2007).

3.6.6 E-healthcare readiness assessment (Khoja *et al.,* 2007)

The final framework which is examined is the framework proposed by Khoja *et al*. (2007). This recent study aims at testing the reliability of e-health readiness evolution tools for both managers and health providers within five categories of measurement in developing countries. Khoja *et al.* (2007) used Cronbach's alpha score scale to measure each of the five categories which are presented in Table 3.2 below. The scores for core-readiness, learning readiness, technology readiness, societal readiness and policy readiness for both managers and health providers were observed to be higher than 0.08 which shows high reliability. Table 3.2 represents this reliability.

Source: Cronbach (1951)

CATEGORY		Cronbach's Alpha score For Managers	Cronbach's Alpha score For healthcare Providers
Overall		0.94	0.91
Core readiness	i) needs-assessment and dissatisfaction with status quo; ii) awareness about e-health in the organization; iii) comfort with the use of technology; iv) trust in technology; v) planning of e-health projects; vi) overall willingness and satisfaction; and vii) integration of technology.	0.92	0.86
Learning readiness	i) use of ICT in enhancing education for healthcare providers; and ii) involvement of healthcare providers in e-health projects.	–	0.88
Technological readiness	i) speed and quality of ICT; ii) availability of service and support; iii) availability and affordability of hardware and software; and iv) training in ICT.	0.86	–
Societal readiness	i) communication with other organizations and communities; ii) sharing of locally relevant content; iii) provision of care in	0.91	0.81

	collaboration with other institutions; iv) consideration of socio-cultural factors among staff; and v) consideration of sociocultural factors among clients.		
Policy readiness	i) ICT related regulations; ii) policies regarding licensure, liability and reimbursement; iii) awareness and support for ICT among politicians; and iv) awareness and support for ICT among institutional policymakers.	0.89	0.92

Table 3.2: Cronbach's Alpha Score

Khoja *et al.* (2007) note that each of the items within the respective five categories for managers and healthcare providers showed Pearson's correlation coefficient to be greater than 0.35 ($p<0.05$), which means that all the items in these categories relate appropriately with other items in the same category. Although the framework of Khoja *et al.* (2007) can guide users to take appropriate measures and improve e-health readiness assessment, the idea of e-health is relatively new to healthcare centres in developing countries and therefore, the framework needs to be customized to the specific needs of the individual countries. Gagnon and Scott (2005) state that evaluators and decision makers must accept that e-health evaluation may serve a different purpose for different stakeholders, hence, no single evaluation framework or methodology is considered as totally objective.

The reviewed frameworks are derived from different perspectives to evaluate e-health readiness. By comparing their components it can be concluded that each framework differs. For example, the framework of Jennett *et al.* (2005) emphasizes core readiness while the framework of Wickramasinghe et al. (2005) neglects it. This is why, according to Gagnon and Scott (2005), e-health evaluation is often criticised for the poor quality of research design, the lack of common outcome indicators and the absence of an agreed theory. Moreover, Wickramasinghe *et al*. (2005) state that how authors of the reviewed framework measure or quantify readiness levels is not clear, because different authors emphasize different perspectives. Table 3.3 summarises the different perspectives of e-health readiness frameworks by the different authors.

Source: CANARIE (2002)

Author and date	Patient	Provider	System	Organizational	Public
Campbell,et.al.,2001		√			
Demiris, et.al, 2004		√			
Jennett,et,al,2003,2004,2005	√	√		√	√
Overhage, et.al, 2005		√	√	√	
Wickramasinghe,et.la 2005		√		√	√
Khoja,et.al,2007		√		√	

Table 3.3: Different perspectives of e-health readiness assessment frameworks

The identification of the components of e-health readiness assessment is discussed in the following section.

3.7 Identification of the components of e-health readiness assessment

CANARIE (2002) refers to readiness as the degree to which a community is ready to participate and succeed with an e-health implementation. Overall e-health readiness can be assessed using four components. These are core, engagement, technological and societal. The components are illustrated in Figure 3.4. Each of the components is briefly explained.

Source: CANARIE (2002)

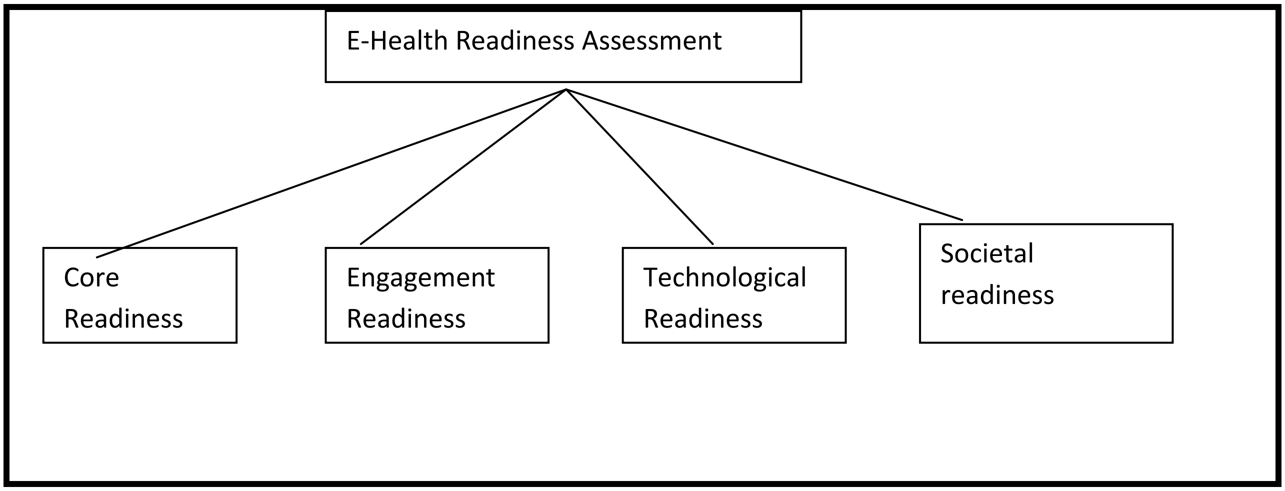


Figure 3.4: General e-health readiness assessment constructs

Core readiness: refers to the identification of a need (usually based on conditions caused by isolation), and a felt or expressed dissatisfaction with current conditions which is so strong that members of the community in question are willing to adopt new practices (like e-health) to create a change (CANARIE, 2002). This is presented in Figure 3.5.

Source: CANARIE (2002)

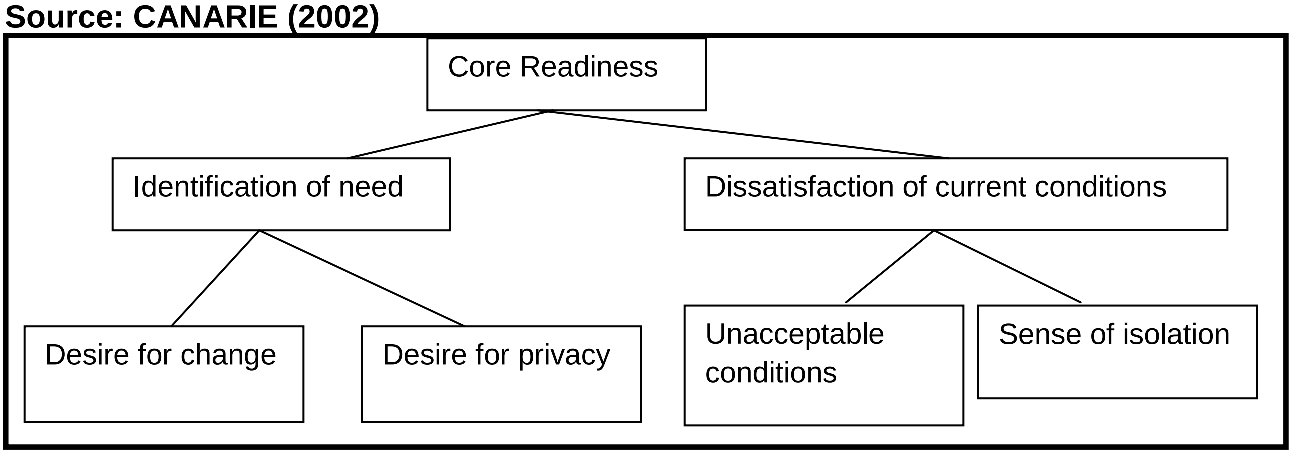


Figure 3.5: Core readiness construct

Engagement readiness: is the situation where people are aware of their needs as members of rural or remote communities but are unaware of the potential of the e-health applications and, therefore, do not immediately and unquestionably accept e-health solutions (CANARIE, 2002). They ask questions about what e-health can do and express their hopes, fears and concerns about adopting such a system. Figure 3.6 illustrates this.

Source: CANARIE (2002)

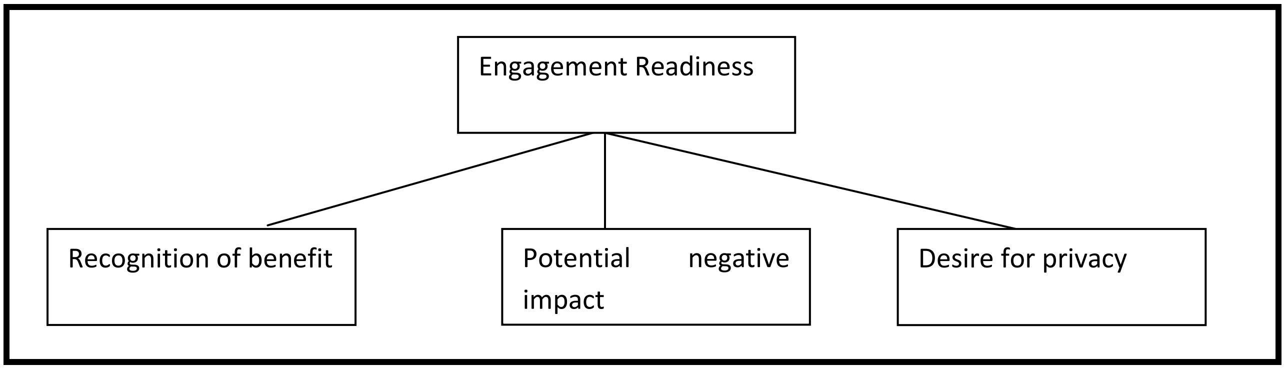


Figure 3.6: Engagement readiness construct

Technological readiness: which CANARIE (2002) refers to as structural readiness means building efficient structures to support successful implementation of e-health. This implies that a certain level of structural readiness is needed to participate and succeed in e-health implementation as indicated in Figure 3.7.

Source: CANARIE (2002)

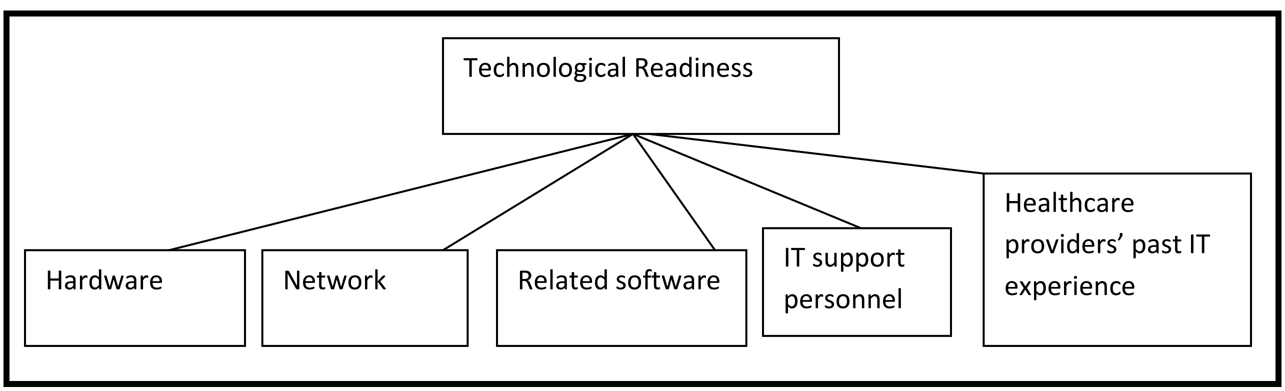


Figure 3.7: Technological readiness construct

Technological readiness can be further decomposed into key technological categories that are needed to support successful implementation of e-health. These key technological categories are illustrated in Figure 3.8 below.

Source: Haag and Cummings (2008)

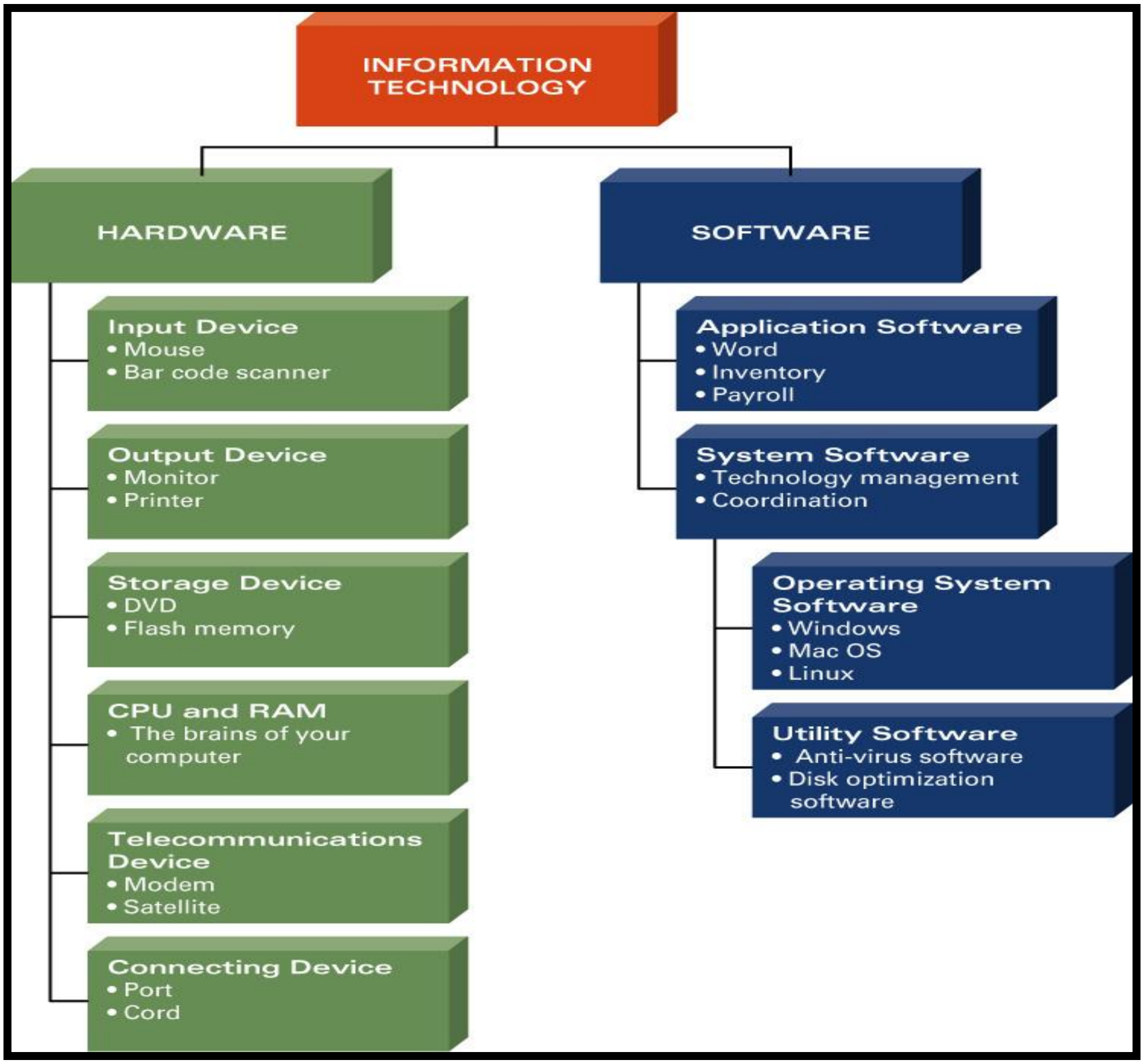


Figure 3.8: Key technological categories

In addition, technological readiness can further be tabulated in detail as indicated in Table 3.4 below.

Source: LI *et al*. (2008)

INDICATORS	ITEMS
Hardware	1. Laptop computers 2. Desktop computers 3. Monitors 4. Printers 5. Document scanners 6. Photocopiers 7. Phones 8. TV based conferencing 9. PC based conferencing 10. Web cam connected 11.Digitalized x-ray equipment 12. High resolution digital cam monitored on a microscope
Network	1. Internet access
EHR related software	1. Maintenance of EHR 2. Electronic healthcare training 3. To send emails 4. Standard software
IT support personnel	1. Provision of technical support 2. Technical support personnel
Healthcare providers' past IT experience	1. Frequency of using PC 2. Frequency of using e-media 3. Computer users for e-health 4. Training or direct experience in using EHR

Table 3.4: Indicators for technological readiness

The next paragraph deals with societal readiness assessment.

Societal readiness: a societal readiness assessment result is determined by organizational communication links to hospitals, administrative centres and provision of healthcare in collaboration with various healthcare organizations. A consideration of socio-cultural factors among staff and among clients is also considered as societal readiness (Khoja *et al.,* 2007). Figure 3.9 below shows the construct of societal readiness.

Source: Khoja *et al*. (2007)

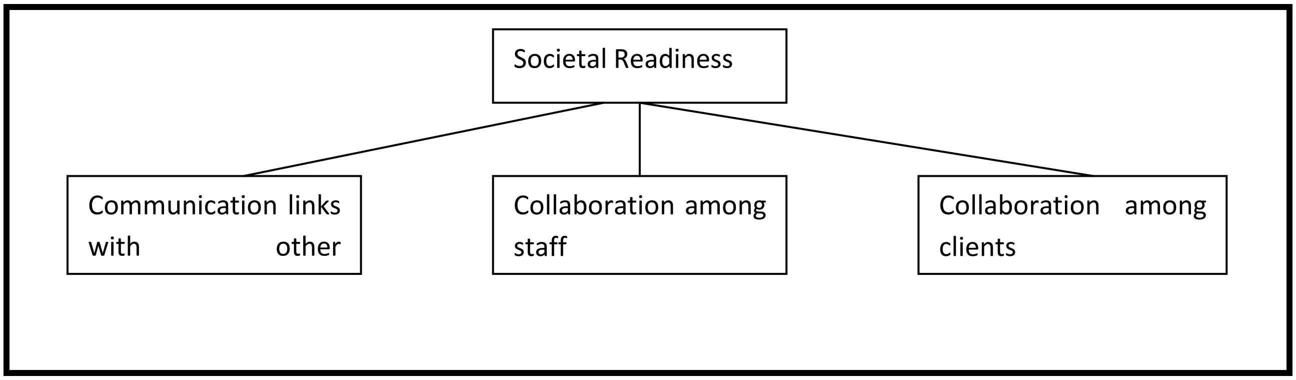


Figure 3.9: Societal readiness construct

In the framework developed by CANARIE (2002), non-readiness is emphasized rather than societal readiness. CANARIE (2002) explains that non-readiness may be characterized by being unaware of the benefits that technology can offer to healthcare delivery, and by avoiding even addressing the topic with any real consideration. This is an indication of lack of need or failure to recognize need.

In the final report presented by CANARIE (2002) on rural and remote readiness for telehealthcare, readiness is explored across all the domains of the community (i.e., public, practitioner, patient and organization) to examine the domain specific factors of telehealth readiness. Table 3.5 shows each community in terms of core readiness, engagement readiness and structural readiness.

Source: CANARIE (2002)

Public	**Patient**	**Practitioner**	**Organization**
Core Readiness • Dissatisfaction with the current state of health care • Dissatisfaction with typical doctor-patient interaction; desire for a more comfortable setting for obtaining health information • Desire for change •Isolation/poor access	**Core Readiness** • Sense of isolation/lack of access • Recognition of unmet need • Desire for change; willingness to actively help themselves/their condition	**Core Readiness** • Extreme dissatisfaction with the status quo • First-hand understanding/experience of negative effects of isolation • Driving need to address a public or patient problem (as opposed to practitioner specific one)	**Core Readiness** • Recognition of unaddressed needs • Dissatisfaction with the organizational status quo
Engagement • Wanting to know what	**Engagement** • Knowledge about what exactly telehealth is • Knowledge about the	**Engagement** • Innovators; champions • Sense of curiosity • Peer influence	**Engagement** • Champions • Availability of risk-takers, pioneers

telehealth is; having a clear definition of telehealth • Recognizing (or estimating) the benefits of telehealth • Having a sensitive health condition; desire for privacy regarding health practice	benefits (or anticipated benefits) • Fear of damaging equipment • Gender • Privacy concerns • Availability/reliability of content that fits rural/remote culture • Address concerns about telehealth as a replacement for already available services • Sense of ownership	• Evidence of utility • Inter-group cooperation (between practitioners and the other domains) • Intra-group cooperation (between working practitioners) • Communication • Openness; respect for others • Willingness to make initial extra investment in time	• Education/Awareness process for innovators • Reduction of naysayers/ resisters • Ability/Willingness of senior administration to consider benefits outside standard business case/cost effectiveness schemes • Willingness to consider long timelines for implementation • Movement from short-term funding; short-term accountability deadlines • Cost-benefit analysis • Established mechanisms of knowledge transfer between staff
Structural Readiness • Education • Availability of formal and informal information networks • Availability of testimonials from people • Awareness campaigns • Champions, especially local ones • Community consultation sessions; sense of ownership • Healthy interorganizational dynamics in promotion activity	**Structural Readiness** • Education about telehealth • Awareness about telehealth; over-coming sense of vulnerability in videoconference • Ability/training to use equipment • Practitioner mediated liaison for telehealth programs	**Structural Readiness** • Addressing scheduling concerns; overextended workloads • 24 hour access to equipment • Established reimbursement plans • Reliability in equipment functioning; good technical support; backup plans • Confirmation of reliable and available clinical consultants • Reliable content-clinical and CME • Liability	**Structural Readiness** • Identification of equipment difficulties; "bugs" • Well-conducted needs assessment • Community consultation process; ownership • Allowance for creative use of equipment by practitioners and patients • Accessible, comprehensive technical support: locally available and on-call • Effective scheduling; integration into the routine • Proper facilities: lighting, size, heating, adequate equipment • Accessible, sustained staff training (including training at medical school to encourage routine perception) • Provision of a telehealth coordinator • Written policy on Reimbursement, Liability, cross jurisdiction use, privacy • Sufficient ongoing funding: local, provincial, federal buy-in

Table 3.5: Community readiness

Furthermore, it is noted by CANARIE (2002) that some of the characteristics are shared between domains but not necessarily at the same level. The current e-readiness assessment framework as employed in developing countries is discussed next.

3.8 Current e-health readiness assessment framework as employed in developing countries

There are various e-healthcare readiness assessment models that have been discussed in the previous sections. However, Ojo *et al.* (2006) argue that the existing e-healthcare readiness models have their origin in the developed world context and therefore, are biased towards it. Ojo *et al*. (2006) continue to point out that due to the contextual differences between the developed and the developing worlds, the possibility of model mismatch in e-readiness models may occur if the adoption is carried out without proper adaptation. Drury (2005) emphasizes this when he indicates that most of the models have been developed in the UK, Canada and the EU and have emerged from the context of wealth where there are well-developed national and local ICT infrastructure through which health and other public and private services are supported. Drury (2005) further states that in low-income developing countries where, for example, one out of every seven children born may not survive up to age five and where there are twelve million AIDS orphans in Africa alone, with an average life expectancy dropping to 48 years in sub-Saharan Africa, the context is not wealth but poverty. This implies that in developing countries the appropriate model for e-health and its assessment may differ from those seen in developed economies.

However, there are recent e-healthcare readiness assessment models which focus on rural communities in developing countries. One such current e-healthcare readiness models which is adapted for rural communities is the Rural e-Healthcare Readiness Assessment (ReHRA) Model which is developed by Ojo *et al*. (2006). This model incorporates the Technology Acceptance and Use (TAU) Model (Davis, 1989), which according to Venkatesh, Morris, Davis and Davis (2003) has been subjected to rigorous theoretical and empirical validation. Davis (1989) stresses that any information technology acceptance model should consist of two prominent models, namely, a Technology Acceptance Model (TAM) and a Motivational Model. This is illustrated in Figure 3.10.

Source: Wilson and Lankton (2004)

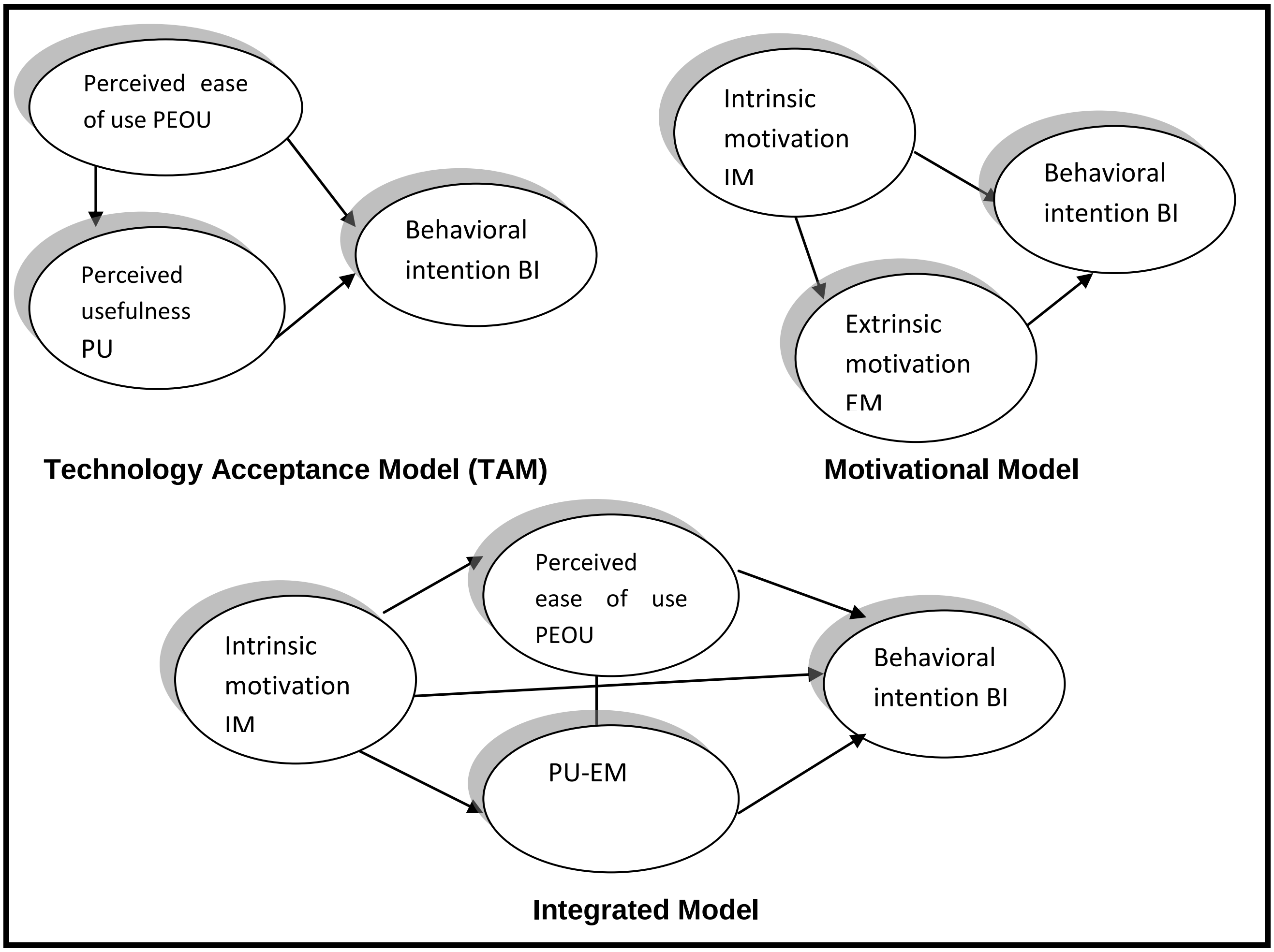


Figure 3.10: Three models of technology acceptance

According to Lanseng and Andreassen (2007), the TAM Model suggests that when users are presented with a new technology, two notable factors influence their attitude towards using the application. These are its perceived usefulness and perceived ease of use. Davis (1989) explains that perceived usefulness refers to the degree to which a person believes that using a particular system can enhance his job performance, while perceived ease of use refers to the degree to which a person believes that using a particular system may free him or her from effort. These two, according to Davis (1989), are key contributors to behavioural intention (BI) to the use of that technology.

Furthermore, the motivational model from Davis (1989) proposes that intrinsic motivation (IM) and extrinsic motivation (EM) are also key factors in determining BI. Wilson and Lankton (2004) indicate that in technology acceptance research BI is typically used as the dependant variable in place of actual usage. Lanseng and Andreassen (2007) further state that TAM should always be measured in addition to Technology Readiness Index (TRI). According to Lanseng and Andreassen (2007), TRI measures the propensity of the population to embrace and make use of new technology, and therefore, a higher score suggests that the general public will reach a certain level of comfort with the usage of that technology. Due to the high degree of people's involvement in the use of health technology, Ojo *et al*. (2006) have included the component of TAM in their ReHRA Model for use in developing countries, especially in the rural areas.

The principal components which the ReHRA Model assesses, according to Ojo *et al.* (2006) are: Need-Change Readiness (NCR), Engagement Readiness (ER), Structural Readiness (SR) and Acceptance and Use Readiness (AUR). The components NCR, ER and SR are adaptations from the concepts of Core Readiness, Engagement Readiness and Structural Readiness respectively and were developed by The Alliance for Building Capacity (2003). Figure 3.11 depicts the principal components (construct) of the ReHRA Model with their definitions and characteristics.

Source: Ojo *et al*. (2006)

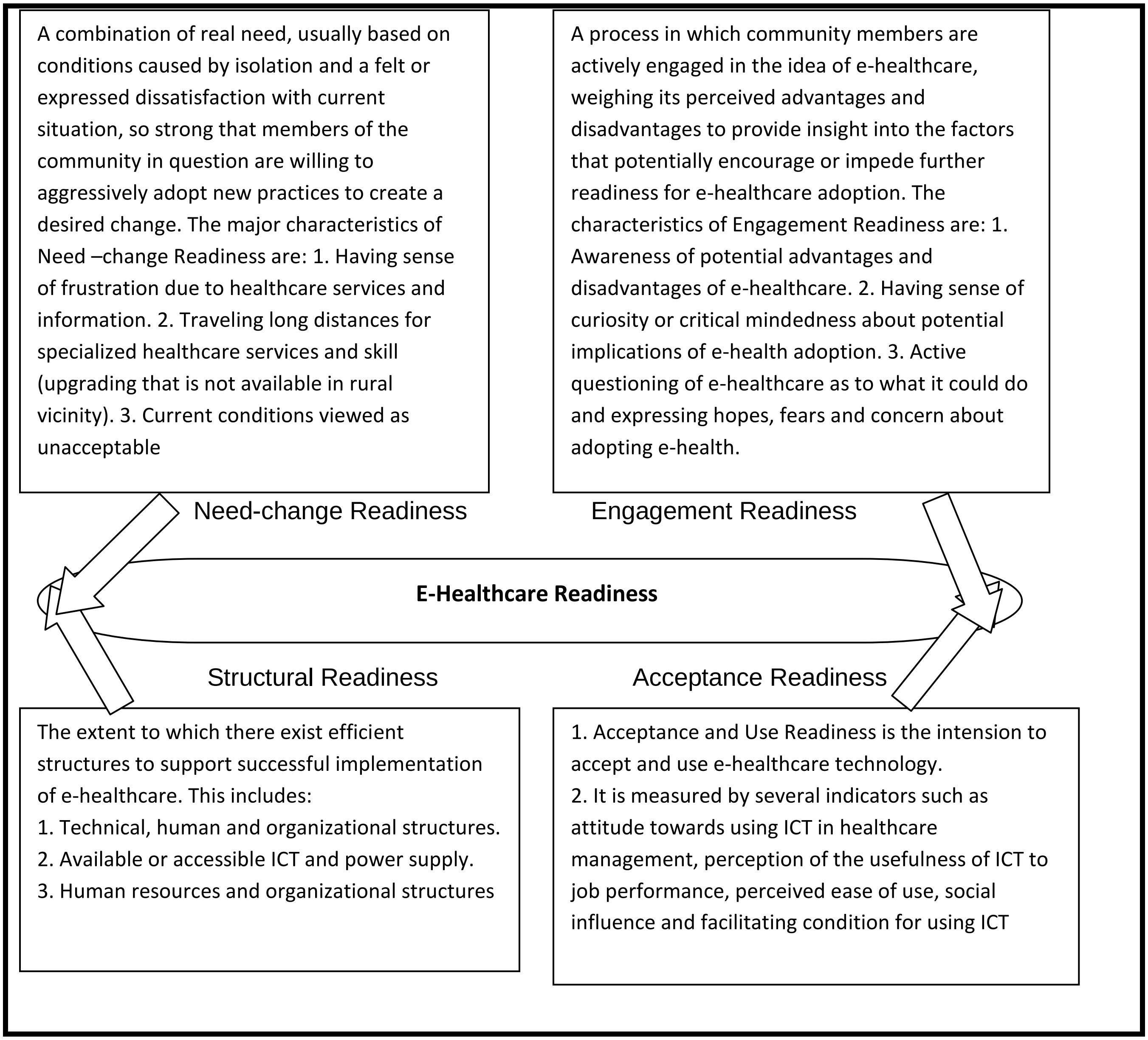


Figure 3.11: ReHRA model construct and characteristics

The ReHRA model construct and characteristics in Figure 3.11 are presented in a hierarchical index form referred to as Hierarchical e-Healthcare Readiness Index System (He-HRIS) as illustrated in Figure 3.12. The He-HRIS model is utilized in collaboration with the ReHRA model for assessment in this proposed research study.

Source: Ojo et al. (2006)

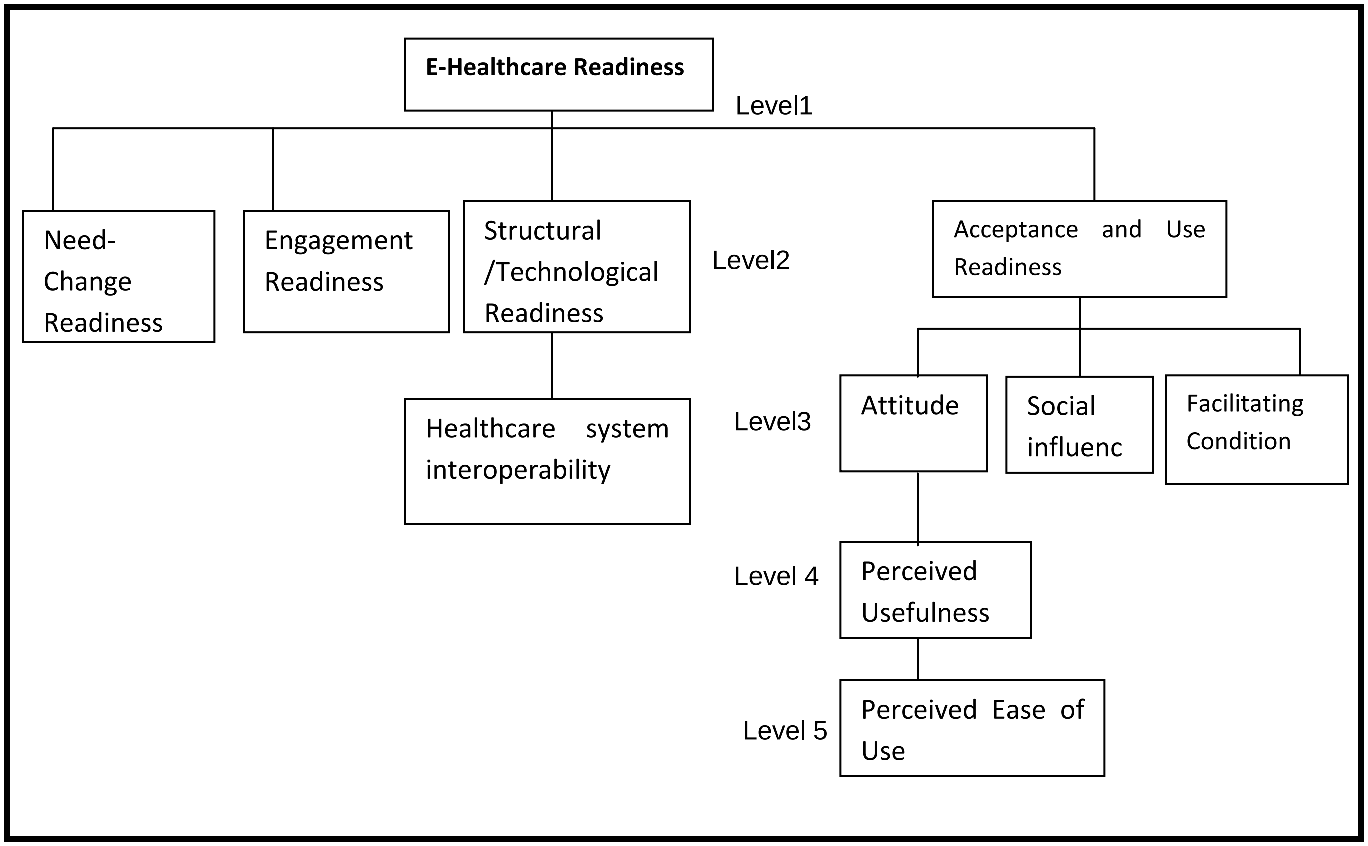


Figure 3.12: Hierarchical e-Healthcare Readiness Index System (He-HRIS) model

It can be observed from Figure 3.12 that the domains, Need-change Readiness, Engagement Readiness and Structural Readiness correspond with Core Readiness, Engagement Readiness, and Structural/Technological Readiness as expressed by some researchers (Jennett *et al*., 2003; Overhage *et al.,* 2004; CANARIE, 2002). In this research study the ReHRA Model for developing countries was used for assessment in consultation with all the stakeholders in the North West Health Department and the communities where the assessment was carried out. The technological readiness assessment carried out under the ReHRA Model further assessed the healthcare systems' interoperability within and between the hospitals/clinics.

The next section gives a brief definition and types of healthcare systems interoperability.

3.8.1 Healthcare systems interoperability

The HL7 EHR (2008) defines interoperability as the prospect of systems communicating with one another and proposes a three part definition for health systems interoperability, which is explained as follows:

- Technical interoperability: This focuses on the physical transmission and receipt of health data and its transport between participating systems;
- Semantic interoperability: This focuses on ensuring shared meaning between sending and receiving partners .This is to ensure that the meaning of what was sent is consistent with the understanding of what was received; and
- Process interoperability: This also focuses on higher-order workflow concepts that make data sharing a richer and more valuable experience. It tries to ensure that shared health data support the specific activities and workflow of the organization.

Arzt (2007) indicates that there are different models of interoperability which an organization can adopt. For example, the Centralized Model, the Co-operative Model and the Distributed Model. The Centralized Model and the Co-operative Model are illustrated diagrammatically in Figures 3.13 and 3.14 respectively.

Source: Arzt (2007)

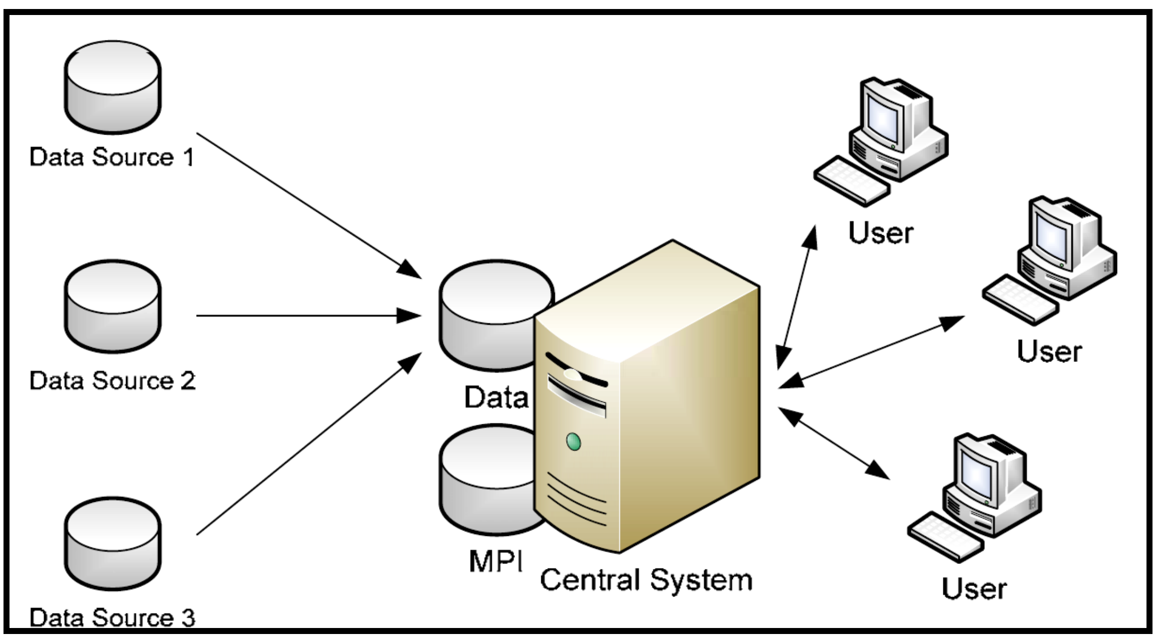


Figure 3.13: Centralized Model

This model utilizes a centralized server where the records of all the patients are registered, matched, and de-duplicated. Data may be collected from various sources behind the scenes, but users may only access a single consolidated application or suite of applications. Due to the fact that the data and the applications are more centralized, data security tends to be more straightforward. Figure 3.14 illustrates the Co-operative Model.

Source: Arzt (2007)

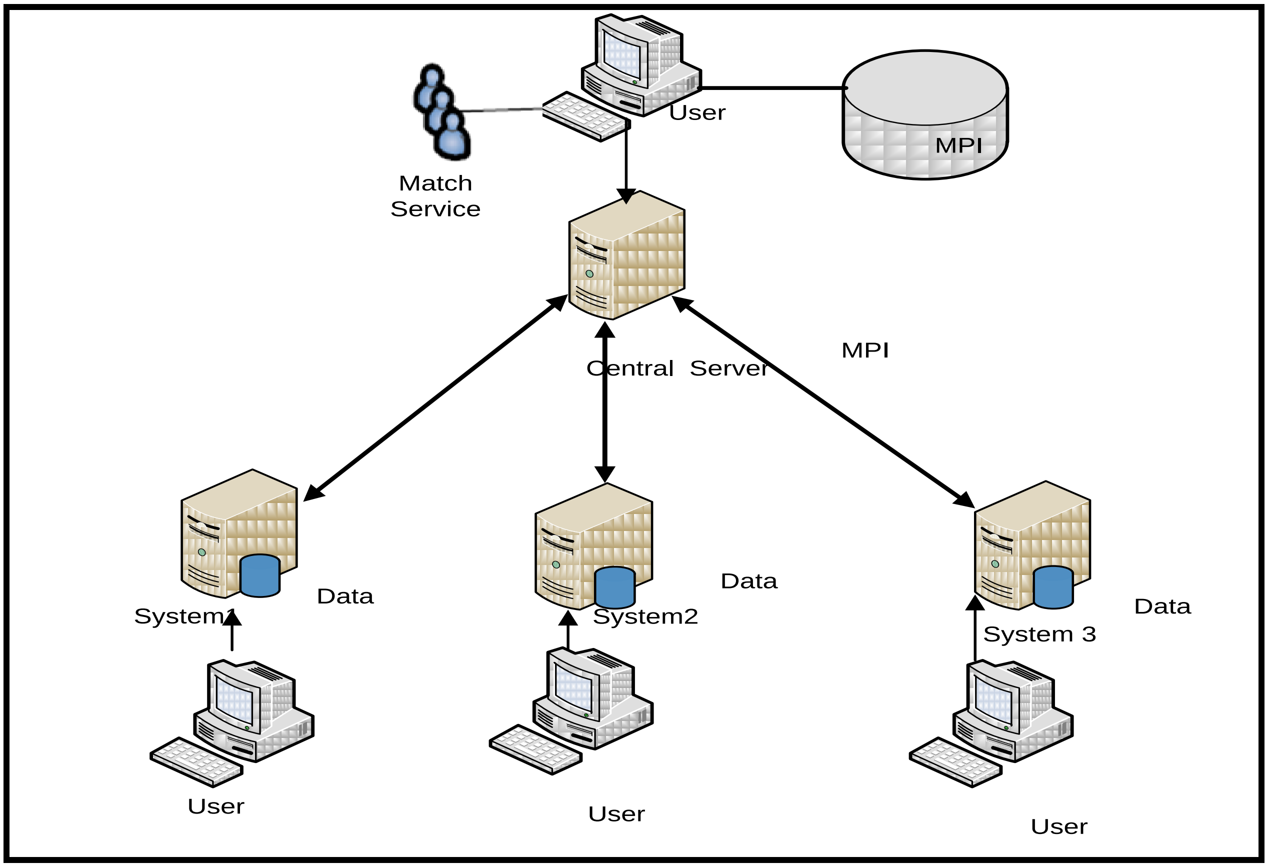


Figure 3.14: Co-operative Model

The Co-operative Model is a combination of the Centralized and the Distributed Models. It has both a central storage and a mechanism for obtaining data from participating servers on demand. The advantage of the Co-operative Model is that, data is stored centrally and what remains distributed can be anywhere between 0 and 100 percent. This can be adjusted over time as requirements, usage patterns and technology constraints change. The cooperative model allows a flexibility approach where certain categories of frequently needed data can be stored centrally for quick and reliable access from the single store while large data blocks can remain in the originating server for quick release when needed. Depending on where data is stored, the quality of service guarantees can vary, and this often drives the decision of what to store centrally and what to keep distributed. In contrast, in the Centralized Model, data that is not in the central storage can never be available to subsidiary servers. Similarly, in the Distributed Model, no data can be obtained without a real-time request or response from the respective servers. There are various other healthcare systems interoperability models which organizations can use in addition to these. The next section presents an E-Health Maturity Model in e-health readiness assessment.

3.8.2 The E-Health Maturity Model in e-healthcare readiness assessment

Barry and Winn (2000) describe the E-health Maturity Model as an e-health transformation which stretches from a basic presence to transformation phase of e-health services. Ilia (2006) explains that the E-Health Maturity Model has four phases namely, the Presence, Interaction, Transaction and Transformation phases. Each of these phases is summarized as follows:

- **Presence phase**: The Presence phase is where non-interactive websites are provided with the main purpose of disseminating information.

- **Interaction phase**: The Interaction phase offers services that are more advanced than the Presence phase. Larger volumes of information enable healthcare professionals to search for relevant content, communicate with other healthcare professionals, participate in online case and clinical discussions, and submit opinions and requirements. In addition to the potential cost savings through reduced traffic over traditional communication channels such as telephone calls, interaction services can also extend the range and intensity of communications among healthcare professionals, and thus, increase the rate of participation in discussions and decision-making. Implementing interactive services is more complex and more costly and may require access to data and some level of integration with departmental and back-office systems to work effectively.

- **Transaction phase**: The Transaction phase focuses on building channels for online access to services to enable the completion of whole tasks electronically. Some examples of such services are appointment making, referrals, clinical data retrieval, test requests, and patient record updating and maintenance. Furthermore, the uses of online facilities to establish the availability of specialist healthcare professionals and facilities and to order and deliver medication can be done. Transactional services can also increase the convenience and efficiency of interactions among hospitals/clinics and other healthcare institutions and thus, reduce costs. The integration with other systems can streamline processes and eliminate errors that are introduced by manual data entry. The implementation of transactional services requires higher levels of security and reliability. Online submissions are also subject to stringent legal requirements in terms of non-repudiation, archiving, privacy, and so on.

- **Transformation phase**: In the Transformation phase, existing business processes and workflows (such as those replicated and enabled through online channels in the previous stages) are redefined and rationalized to take advantage of the new delivery capabilities. Traditional methods, like point-to-point or face-to-face interactions of users within and across the various hospitals/clinics (even if through online channels), are replaced by more user-centric aggregated services, which isolate the consumer from the multitude of services and systems and present a unified view appropriate for the user. The greatest advantage in this phase derives from the new types of joined-up, streamlined, and efficient services that are better tailored to suit the needs and preferences of the end users, rather than asking them to adjust to the way the different healthcare institutions and their systems operate. The implementation of the transformation phase utilizes the foundations built for the transaction phase, with incremental development of the new joined-up services and applications.

There is a Trigger Point which shows how the stages of maturity move towards providing better value to the communities that use the online services as time goes by and as complexity increases. The costs involved in providing the online services increase at each phase, but they can often be offset by the savings over traditional healthcare services. The Trigger Point is the stage where real changes appear. There is a leap in the value to the user communities and as e-health applications become able to provide wider and deeper interaction with the core services of healthcare, it balances the increases in cost and complexity. Moreover, as more services integrate into the system, the savings in traditional processing and transaction efficiency increase significantly. The E-Health Maturity Curve which illustrates and explains these important levels is illustrated in Figure 3.15.

Source: Ilia (2006)

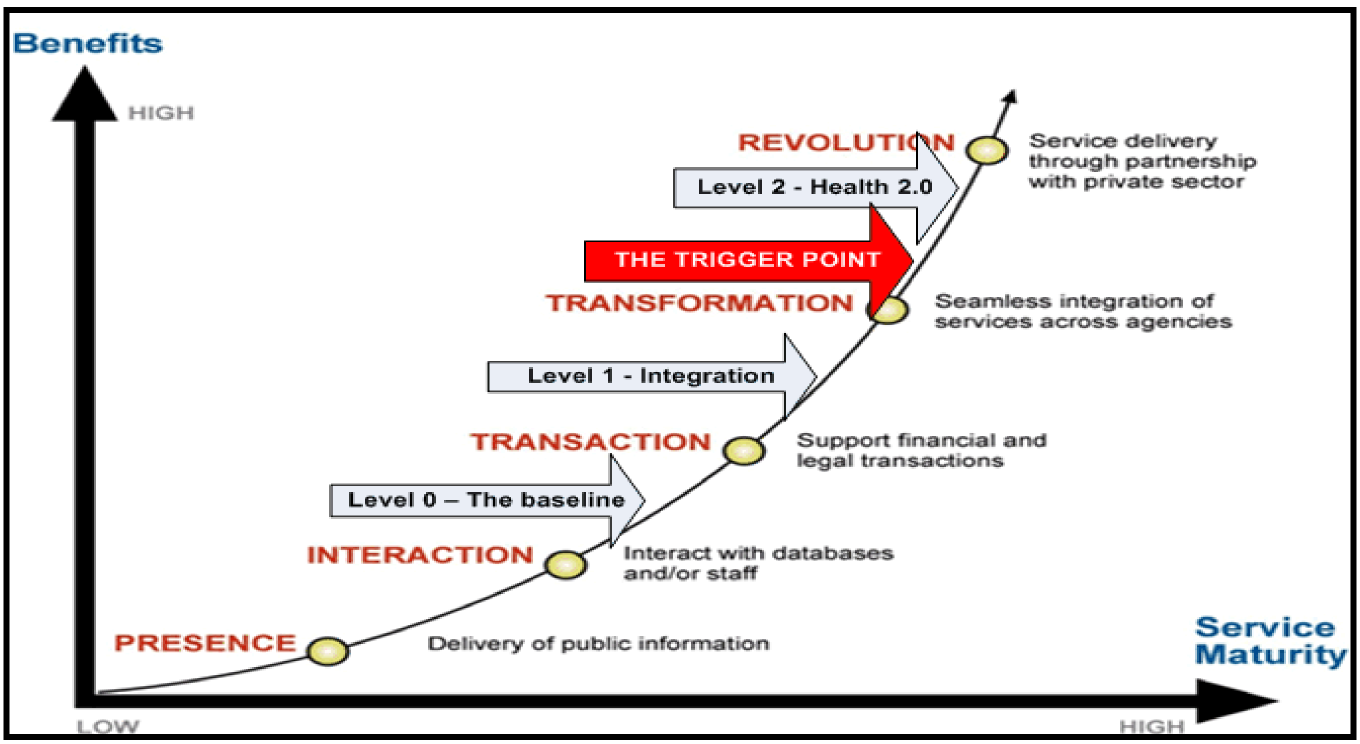


Figure 3.15: E-Health Maturity Curve

The next section focuses on community involvement in e-health readiness assessment.

3.9 Community involvement in e-healthcare readiness assessment

Lanseng and Andreassen (2007) who point out that healthcare service is quite different from ordinary consumer services, also indicate that the demand for many types of healthcare services is negative. This is in accordance with Kotler (1973) who explains that although people need these health services, they are unlikely to look forward to vaccinations, vasectomies or gall bladder surgery. As pointed out (Berry *et al.,* 2004), patients and their families typically demand for healthcare services when under considerable stress. Secondly, as these services are targeted at the receiver's mind or body, patients become co-producers of medical services (Berry and Bendapudi, 2003). In this respect, healthcare service is a prime example of customers working together with providers in co-creating value (Darby and Karni, 1973). With this backdrop, it is important that communities become involved in the design and assessment of any healthcare technology innovation. Hence community oriented technology is vital for successful implementation.

Mclver and ODonnell (2005) refer to Community Oriented Technology Assessment as a process where community members become partners in the assessment. Communities present a unique context from organizational settings and must, therefore, be part of any assessment process. Communities are a common and at the same time a complex concept which, according to CANNARIE (2002), may be characterized according to spatial and social boundaries. For the purposes of this study the researcher examines aspects of the community from both perspectives, that is, communities of interest, as well as place-based community (Taggart, 1997). Taggart (1997) further states that the definition of community is broad because it includes rural geographical communities, communities of health providers (such as physicians, nurses and rehabilitation therapists), communities of patients who share a common problem (e.g. cardiac and cancer), and the communities of multidisciplinary health team providers who care together for either patient or public health promotion (e.g. eating disorder support and women's health support). Figure 3.16 depicts the various domains of communities.

Source: CANARIE (2002)

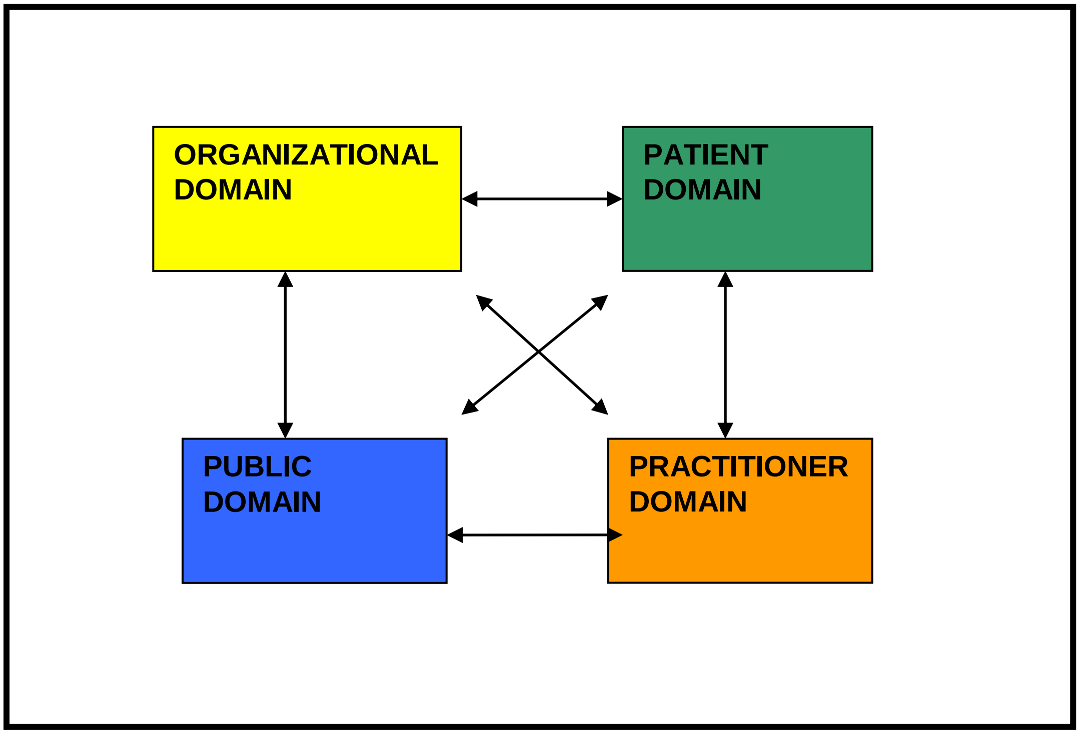


Figure 3.16: Community domains

Communities are often geographically situated, which can raise significant design and usage problems. Again communities often face tighter financial constraints than business or governmental organizations, and therefore, technology assessment and development processes must devote greater attention to these communities' needs such as training and technical support, and respond to change in system requirements (Mclver and ODonnell, 2005). Furthermore, it is recognized by Landauer (1995) and Norman (1998) that to adequately address the unique characteristics of communities, the design and the development processes of any system must be user-centered throughout. Mclver and ODennel (2005) argue that this is necessary for technology assessment as communities may provide input into the design process. This implies that a technology assessment process needs to establish and maintain a community partnership from the period of inception to completion in order to facilitate a user-centered approach.

Some researchers (Landauer, 1995; Norman, 1989) point out that a major reason for poor design is the failure to adequately involve the target user community in the design process. It is, therefore, imperative that any formal health technology assessment process for communities, which includes an e-healthcare readiness assessment, must be community-centered (Landauer, 1995). However, without proper training or partnership, communities will fail to embrace user-centered processes.

Mclver and ODennel (2005) further state that beyond technology assessment, community informatics in general must be opened to the use of alternative design and implementation approaches. These include the use of free and open source software, the creative appropriation and adaption of existing technologies and infrastructure and the use of traditional ICTs. The use of open technologies, as opposed to custom commercial or commercial off the shelf (COTS) solutions, requires people in the community with sufficient expertise to develop, operate and maintain the system (Mclver and ODennel, 2005). This is an added challenge for developing communities where such expertise may be difficult to find and afford. Therefore, a community-oriented technology assessment process must establish partnership that empowers communities to build capacity and knowledge to participate in the requirement analysis, technology projection and impact analysis. Mclver and ODennel (2005) emphasize that communities that are properly involved in such a process must develop an educational process to assist their members to participate, and this must be a partnership. It is, therefore, important that this research study incorporates community participation in its e-health readiness assessment and the development of an e-health framework

The next section deals with the overall e-health readiness assessment construct that was applied in this study to measure the e-health readiness assessment of the selected hospitals/clinics in the North West Province that were investigated.

3.10 Overall E-health Readiness Assessment Construct (Theoretical Framework) to be applied in this study

Having examined the different e-readiness assessment models and frameworks (Campbell *et al.,* 2001; Demiris *et al*., 2004; Jennett *et al.,* 2005; Overhage *et al.,* 2005; Wickramasinghe *et al*., 2005; Khoja *et al*., 2007; Ojo *et al*., 2006 and CANARIE, 2002) in section 3.6.6; section 3.7 and section 3.8, an overall E-health Readiness Assessment Construct, which consists of five domains was developed. This formed the theoretical framework upon which the e-health readiness assessment construct was complied. This was used in the development and the design of the research instruments (questionnaire and interview questions) which were used for the e-health readiness assessment of the selected hospitals/clinics. This is illustrated in Figure 3.17.

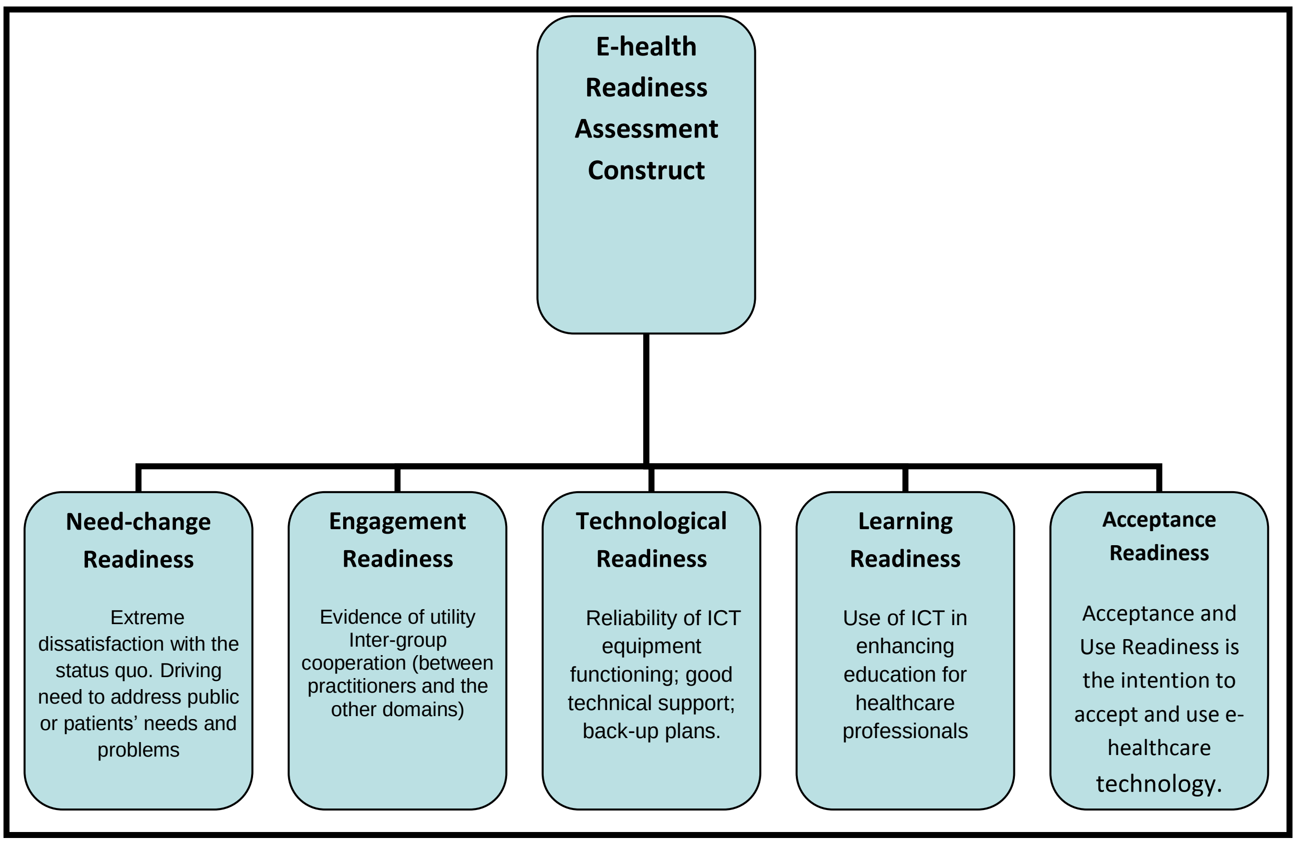


Figure 3.17: Overall e-health readiness assessment construct to be applied in this study

The e-health readiness assessment domains that are indicated in Figure 3.17 (Need-change Readiness, Engagement Readiness, Technological Readiness, Learning

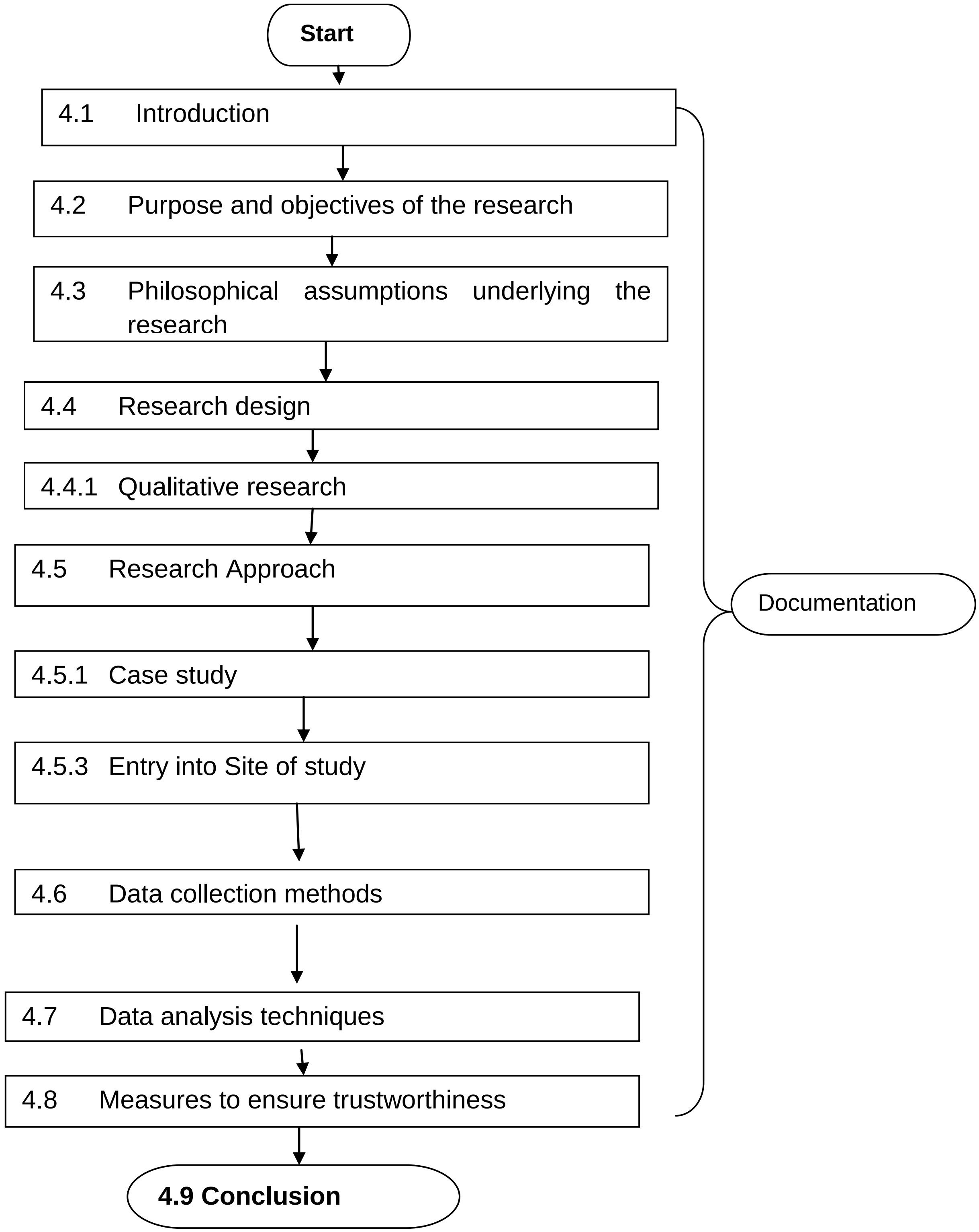
Readiness, and Acceptance Readiness) serve as the construct upon which the assessment instruments, the questionnaire and interview questions, were designed (*cf* Sections 4.6 and 5.2). The next section summarizes and concludes this chapter.

3.11 Summary and conclusion

This chapter deals with different aspects of e-healthcare readiness assessment by examining what constitutes service quality and productivity in healthcare services. The definition of quality covers two types of hospital output qualities, clinical quality and process quality. It is further noted that quality healthcare services are co-produced by both the patient and the provider. Therefore, the patient's satisfaction increases with increased perceived service quality. Furthermore, the literature highlights the evolution of technology assessment and indicates that technology assessment started in the US in 1965 and this has given birth to our modern health technology assessment.

In addition, it is noted that the introduction of e-healthcare into a health organization is through IT innovation and adoption. An adoption of an innovation is essentially an adoption to change. Therefore, such adoption needs to be examined in the light of change management. The literature also discussed some of the different models upon which e-health readiness assessment is conducted. These models include papers by Campbell *et al*. (2001); Demiris et al. (2004); Jennett *et al*. (2005); Overhage *et al.* (2004); Wicramasinghe *et al*. (2005); Ojo *et al*. (2006) and Khoja *et al.* (2007). The comparison, analysis and the examination of these models led to the construction of the overall E-health Readiness Assessment Construct (*cf* Figure 3.17). Finally, the literature emphasizes the importance of community involvement in e-health readiness assessment. Community is defined in terms of spatial and social boundaries in this research study. Again it is stated that the success of any healthcare technology design and assessment for any community requires the total involvement of that community. The next section, which is Chapter 4, focuses on the research methodology used in this research study.

Chapter 4- Research Methodology



CHAPTER 4

RESEARCH METHODOLOGY

4.1 Introduction

A brief background and orientation of this study and the objectives of the study, were provided in chapter 1. In this chapter, a detailed description of the philosophical assumptions underlying the research is explored. The chapter also examines the research design, the research methods, population sampling, data collection methods, data analysis and the measures to ensure trustworthiness and authenticity of the study. Additionally, the chapter places the purpose and the objectives of the study into context.

4.2 Purpose of the research and research objectives

The main aim of this research is to compile an e-health framework with regard to effective and efficient use of ICT in:

- Patient health record system;
- Training of users of ICT in e-health;
- ICT equipment distribution; and
- Processes and procedures in e-consultation, e-referrals and e-prescription.

The e-health framework is based on the feedback from case studies of the investigated hospitals/clinics in the North West Province. The specific objective of this research was to:

- Obtain information on current Electronic Readiness Assessment Models globally, and existing information on e-healthcare by means of literature study;
- Use a specific Electronic Readiness Assessment tool in the North West hospitals/clinics with the guidance and support of experts in the North West Health Department;
- Conduct a comparative Electronic Readiness Assessment between rural and urban hospitals/clinics in the North West Province; and

- Apply the assessment results to compile an e-health framework.

A research design model from Saunders, Lewis and Thornhill (2000:85) is applied to achieve these objectives. This model is represented as a research onion with many layers illustrating the different perspectives of the research methodologies. The research onion is illustrated in Figure 4.1.

Source: Saunders, Lewis and Thornhill (2000:85)

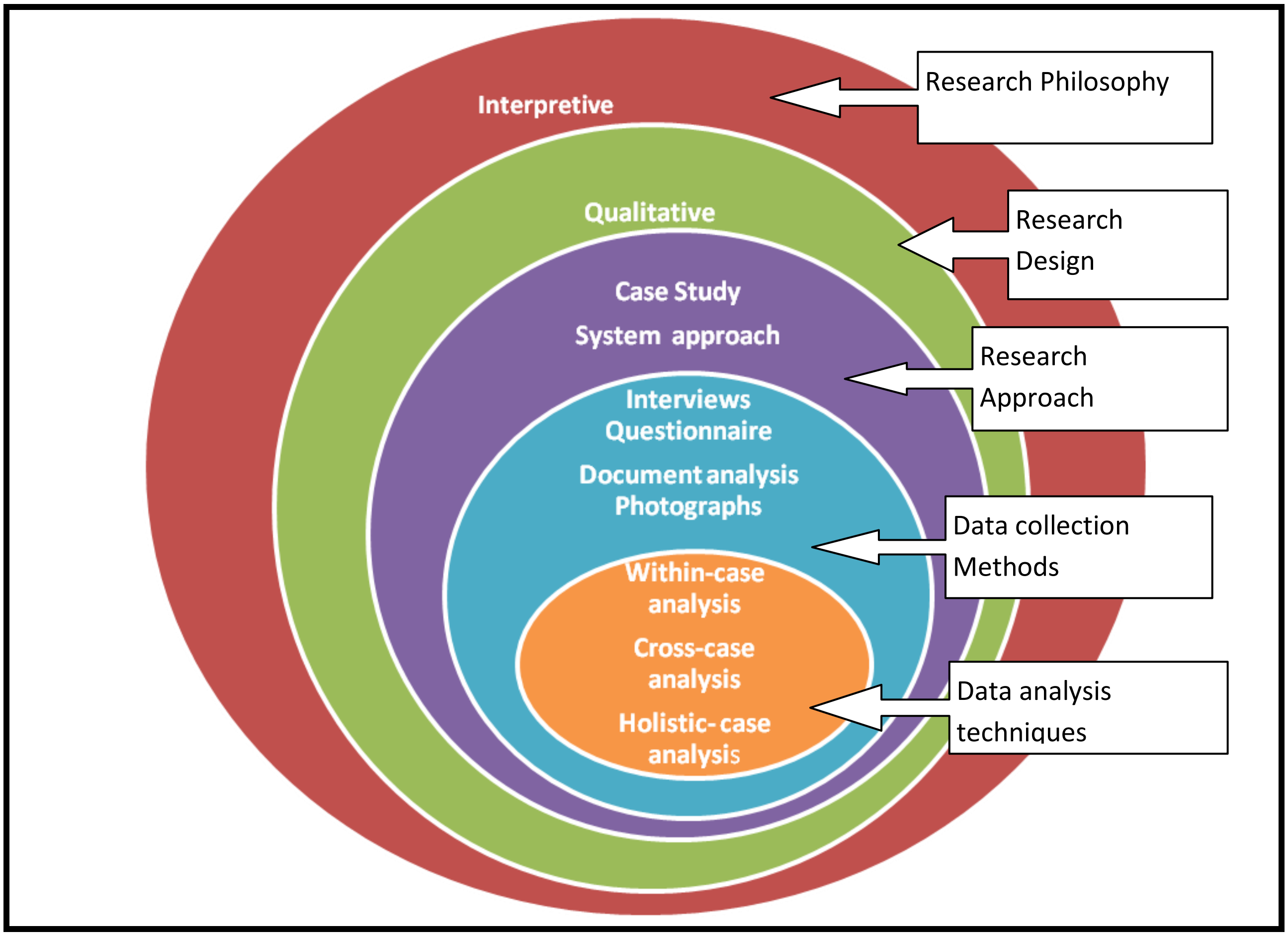


Figure 4.1: The research process onion

The research onion presented above, compares the research processes to peeling the different layers of an onion until the centre has been reached (Saunders *et al*., 2000). According to Saunders *et al*. (2000), the centre of the research process is the analysis of the collected data. The analysis of data is, however, the result of reflection on the preceding layers. The first layer to be peeled off is the research philosophy underpinning the whole research. This is followed by the research design, research approach, data collection methods and data analysis techniques. The next section discusses the philosophical assumptions of the research and the subsequent layers found in the onion.

4.3 Philosophical assumptions underlying the research

This research study is supported by an extensive preliminary review of the literature on research philosophy and methodology, and methods in qualitative research, which contributed to the general shaping of the research approach. Some of the noteworthy contributions in this regard are Banville and Landry (1989); Barrett and Walsham (2004); Baskerville and Lee (2003); Baskerville and Myers (2001); Baskerville and Wood-Harper (1998); Boland (1985); Eisenhardt (1989); Fitzgerald and Howcroft (1989); Flyvbjerg (2006); Forsythe (1999); Golden-Biddle and Locke (1993); Harper (2000); Hirschheim (1992); Hirschheim and Klein (1989); Howcroft, and Trauth (2004); Kaplan and Maxwell (1994); Klein and Myers (1999); Locke and Golden-Biddle (1997); Markus (1983); Myers and Newman (2007); Myers (1994); Nandhakumar and Jones (1997); Oates (2008); Orlikowski (2000); Orlikowski and Baroudi (1991); Pozzebon and Pinsonneault (2005); Pozzebon (2004); Roode (1993); Schultze (2000); Thomas (2003); Trauth and Howcroft (2006); Van Maanen (1979); Walsham and Sahay (1999); Walsham (1995, 2006); Whetten (1989); and Whittington (1992).

The study was conducted from interpretivist philosophical perspective; and several literature resources were accessed to provide general orientation and guidance to the practical implementation of the study (Benbasat, Goldstein and Mead, 1987; Bliecher, 1980; Boland, 1991; Cavaye, 1996; Darke, Shanks and Broadbent, 1998; Deetz, 1996; Dubé and Paré, 2003; Eisenhardt, 1991; Kaplan and Maxwell, 1994; Klein and Myers, 1999; Nandhakumar and Jones, 1997; Orlikowski and Baroudi, 1991; Walsham, 2006; and Yin, 1994).

It is pointed out (Myers, 1997) that all research (whether quantitative or qualitative) is based on some underlying assumptions about what constitutes valid research and which research methods are appropriate. Therefore, to conduct and evaluate qualitative research, it is essential to know what these (sometimes hidden) assumptions are. In this research, the most pertinent philosophical assumptions are those which relate to the underlying epistemology which guides the research. Epistemology, according to Hirschheim (1992), refers to the assumptions about knowledge and how it can be obtained. Orlikowski and Baroudi (1991) have suggested three underlying research epistemologies, namely, interpretive, positivist and critical epistemology. Figure 4.2 illustrates this.

Source: Myers (1997)

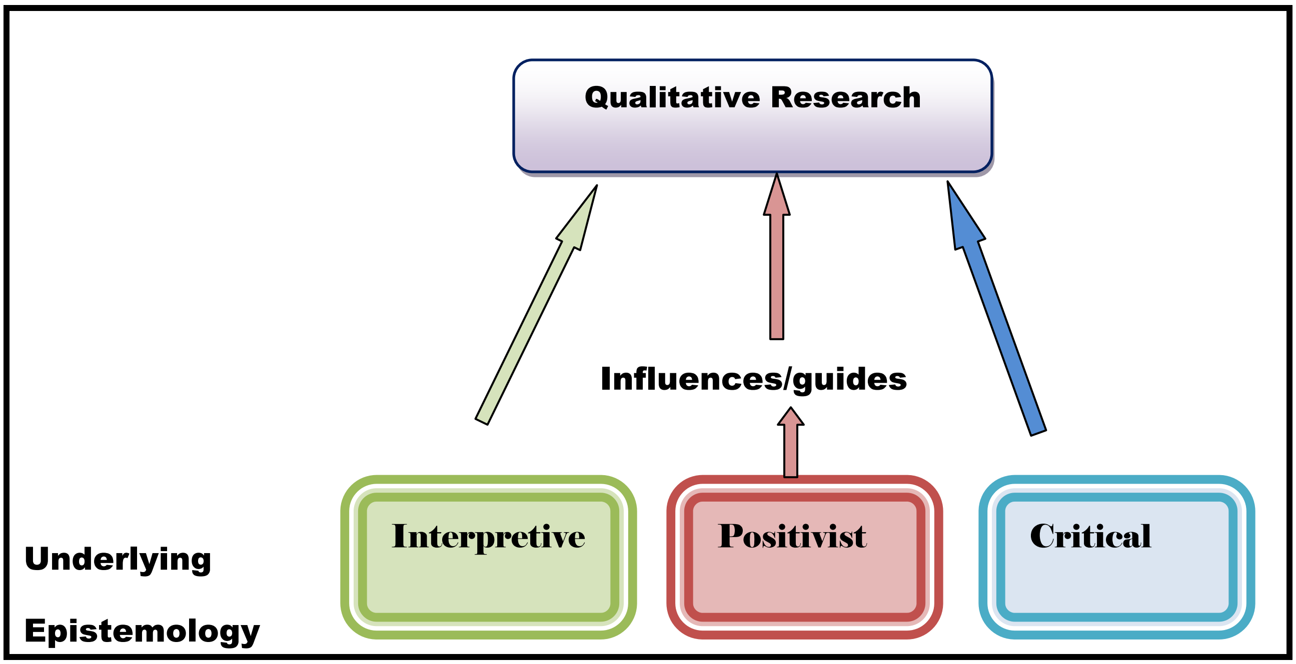


Figure 4.2: Philosophical assumptions

The proceeding sections expound on these philosophies by firstly elaborating on the interpretive philosophy and this is followed by the positivist and the critical philosophical assumptions.

4.3.1 Interpretive Philosophy

In interpretive research it is assumed that the knowledge of reality is gained through social constructions such a language, consciousness, shared meanings, documents, tools, and other artifacts. Interpretive research does not predefine dependent and independent variables, but focuses on the complexity of human sense making as the situation emerges (Kaplan and Maxwell, 1994). It attempts to understand phenomena through the meanings that people assign to them (Boland 1985, 1991; Deetz 1996; Orlikowski and Baroudi 1991). Interpretive methods of research in IS are “aimed at producing an understanding of the context of the information system, and the process whereby the information system influences and is influenced by the context” (Walsham 1993:4). Examples of an interpretive approach to qualitative research include the work of Boland (1991) and Walsham(1993).

Closely related and supporting interpretivism is hermeneutics. Hermeneutics is defined as a theory or philosophy of the interpretation of meaning (Bliecher, 1980). Walsham (1995:77) also makes the link between hermeneutics and interpretivism when he contends that interpretive researchers attempt the difficult task of assessing other people’s interpretations, filtering them through their conceptual apparatus and reporting a version of events back to others, including in some cases, interviewees and other audiences. Thus, interpretive researchers should have a view of their role in this complex process; this is further outlined in the data analysis section.

Furthermore, Burrell and Morgan (1979:22) present a sociological paradigm to explain the position and nature of interpretive philosophy. The graphical representation of the paradigm is illustrated in Figure 4.2.1.

Source: Burrell and Morgan (1979)

Figure 4.2.1: Interpretive Paradigm

According to Burrell and Morgan (1979:22), the functionalist paradigm views the social world as consisting of concrete artifacts and relationships that can be identified, studied and measured through natural science from an objectivist point of view. The interpretivist paradigm, on the other hand, is concerned with understanding the world as it is. The interpretivist views the social world from the subjective experiences of individuals. The radical humanist paradigm views the social world from an ideographic perspective, as does the interpretive paradigm, but the frame of reference focuses on overthrowing the limitations of existing social structures. The radical structuralist paradigm focuses on structural relationships within a social world, providing explanations for the basic interrelationships within the context of social formations. Again the radical structuralist paradigm is concerned with radical change. This research study is situated in the interpretivist paradigm. The positioning of this research study in the interpretive paradigm is suitable because it provides a deeper understanding of the usage of information system in hospitals in the North West Province. An information system is a social system making use of IT. Thus, the relationship among information, data and meaning can only be explored through communication and negotiations between humans.

4.3.2 Positivist Philosophy

The positivists generally assume that reality is objectively given and can be described by measurable properties which are independent of the observer (researcher) and his or her instruments (Myers, 1997). The characteristics of the positivist approach are explained as follows (Oates 2008: 287):

- **The world exists independently of humans**: There is a physical and social world that exists externally to the mind of man, that needs to be studied, captured and measured.
- **Measurement and modeling**: The researcher discovers this world by making observations and measurements and produces models of how it works.
- **Objectivity**: The researcher is neutral and objective and an impartial observer. Thus, facts about the world can be discovered independently of the researcher's personal values and beliefs;
- **Hypothesis testing**: Research is based on the empirical testing of theories and hypotheses which lead to confirmation or refutation of them;

- **Quantitative data analysis**: There is often a strong preference for mathematical modeling and proofs of statistical analysis. The use of mathematics provides a logical, objective means of analyzing observations and results; and
- **Universal laws**: Researchers look for generalizations, universal laws, patterns or irrefutable facts that can be shown to be true regardless of the researcher and the occasion.

This approach yields effective results but fails to take into account the human aspect which may be explored by the interpretive approach. Oates (2008) argues that the positivist approach is less suited to researching the social world which is the world of people, organizations or group structures that people build, the culture they develop and the meaning they impose on things. Therefore, this paradigm may offer less value to this research study.

4.3.2 Critical Philosophy

Another perspective of the philosophical assumption comes from the critical researchers view. Critical researchers assume that social reality is historically constituted and that it is produced and reproduced by people (Myers, 2004). Although people can consciously act to change their social and economic circumstances, critical researchers recognize that their ability to do so is constrained by various forms of social, cultural and political domination (Myers, 1997). Lee (1989) states that while these three research epistemologies are philosophically distinct (as ideal types), in the practice of social research, these distinctions are not always clear cut. In this research study, the interpretive philosophical assumption applies since this research aims at assessing the social readiness of the people for the implementation of e-healthcare services, as well as the technological readiness of the healthcare institutions. The next section focuses on the research design, research approach, the area of study, data collection methods and measures to ensure trustworthiness of the study.

4.4 Research design

Mouton (2003: 8) contends that a research design is a blue-print that needs to be followed in order to achieve the research objectives. Burn and Grove (2003: 195) explain that a research design is a blue-print for conducting a study to maximize control over factors that could interfere with the validity of the findings. The control provided by the design increases the probability that the study results are an accurate reflection of reality. Therefore, the researcher must select the most appropriate design to meet the aims and objectives of the study (Parahoo, 1997:143). Research methods, on the other hand, consist of the systematic, methodological and accurate execution of the research design (Babbie and Mouton, 2002:74). In this research study, a qualitative research design employing a case study approach is used. The case study approach is supported by system approach strategy. The next section gives a brief explanation of a qualitative research design, and case study approach.

4.4.1 Qualitative research

According to Creswell (2007:249), qualitative research involves an inquiry process of understanding based on a distinct methodological tradition of inquiry that explores a social or human problem. The researcher builds a complex, holistic picture, analyses words, reports the detailed views of informants, and conducts the study in a natural setting. Furthermore, Strauss and Corbin (1998:10) state that qualitative research refers to the type of research that produces findings not arrived at by statistical procedures or other means of quantification. Thus qualitative research refers to a non-mathematical process of interpretation of data. Welman and Kruger (2005:182) emphasize that qualitative research explores the attitude, behavior and motives of people in more depth and it usually involves small numbers. The techniques normally used in collecting data in qualitative research include group discussions, in-depth interviews and observations (Mouton, 2003:162). Qualitative and quantitative research methods are not mutually exclusive (De Villiers, 2005). Trauth and Jessup (2000) note that a variety of research benefits are derived from adopting mixed research method approaches, as each research method has different assumptions and procedures and thus complement each other. Figure 4.3 shows an overview of research methods including both qualitative and quantitative methods.

Source: De Villiers (2005)

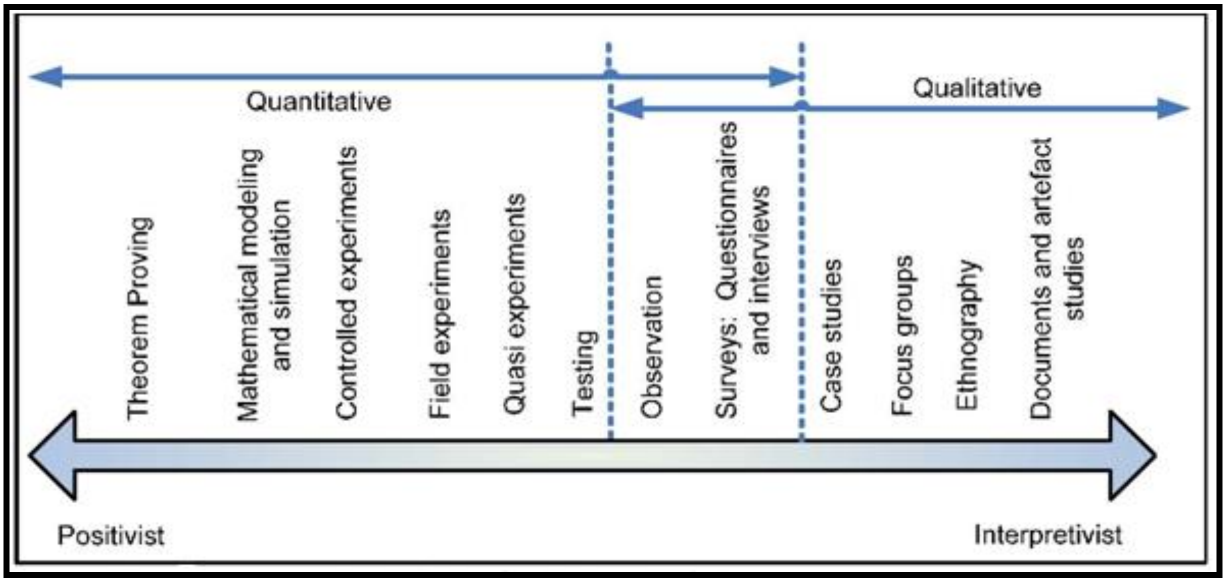


Figure 4.3: Qualitative and quantitative approach

However, qualitative research design has been chosen as appropriate for this study because the researcher intends assessing and describing e-health readiness of rural and urban hospitals/clinics in the North West Province and the social impact of ICT usage in these hospitals/clinics.

4.5 Research approach

Two research approaches are subsequently discussed with specific reference to the research question and the sub-research questions. The approaches used in this study are case study approach which is supported by systems approach. The different approaches are summarized below.

4.5.1 Case study approach

Case studies are an important research method in areas where innovations are studied, such as in the field of Information Systems (IS). They enable the study of contemporary and complex social phenomena in their natural context (Yin, 1994; Walsham, 1995). Over the years, researchers working from both epistemological perspectives have addressed important methodological issues (Benbasat, Goldstein and Mead 1987; Eisenhardt 1991; Yin 1994; Walsham 1995; Cavaye 1996; Darke, Shanks and Broadbent 1998; Nandhakumar and Jones 1997; Klein and Myers 1999), and several studies have also evaluated the operational use of the case study method in the IS field (Benbasat *et al.* 1987; de Vries and Roest 1999; Dubé and Paré 2003). Case studies can be done from a positivist or interpretivist epistemological perspective (Cavaye 1996) but the nature and purpose of both perspectives differ (Orlikowski *et al.* 1991; Klein *et al*. 1999). Positivists believe that the world conforms to the laws of causation, which can be objectively tested (Benbasat et al. 1987). Their research approach is hypothetico-deductive and confirmatory (Fitzgerald and Howcroft, 1998; Lacity *et al*., 1994; Orlikowski and Baroudi, 1991). Interpretists believe that multiple realities exist as subjective constructions of the mind. They see the world as socially constructed. They attempt to understand phenomena through analyzing the meanings people assign to these phenomena. Their research approach is inductive and is concerned with discovering and interpreting social patterns (Fitzgerald et al. 1998; Klein et al. 1999; Lacity et al. 1994; Orlikowski and Baroudi 1991; Walsham, 1995). As both perspectives are incommensurable (Fitzgerald et al., 1998), differentiation in the criteria which apply to both perspectives should be highlighted (Gummesson, 1991). For the purpose of this study, interpretive case studies were conducted. Case study research is sensitive to hermeneutics. The procedure for conducting case study research is discussed next.

4.5.2 Procedures for conducting case study research

There are several procedures available for conducting case study research (Stake, 2005 and Yin, 2003). However, Creswell (2007:74) emphasizes the approach that is indicated by Stake (2005) for conducting case study research. The approach by Stake (2005) proposes the following six steps:

1. **Determine and define the research question**: This is the first step in case study research which is to establish a firm research focus that the researcher can refer to over the period of the study.
2. **Select the case and determine data gathering and analysis techniques**: During the design phase of the case study research the researcher selects a single case or multiple real-life cases and examines them in depth. When using multiple cases, each case is treated as a single case. The conclusion of each case can be used as information contributing to the whole study.
3. **Prepare to collect the data**: Case study research generates a large amount of data from multiple sources and therefore, systematic organization of data is important. This prevents the researcher from losing sight of the original research purpose and question.
4. **Collect data in the field**: The researcher must collect and store multiple sources of evidence comprehensively and systematically in formats that can be referenced and sorted so that converging lines of inquiry and patterns can be uncovered. The researcher should carefully observe the object of the case study and identify causal factors associated with observed phenomenon.
5. **Evaluate and analyze the data**: The raw data is examined using many interpretations to find linkages between the research object and the outcomes with reference to the original research question. The case study method with its multiple data collection and analysis techniques provides the researcher with opportunity to triangulate the data in order to strengthen the research findings and conclusions.
6. **Prepare report**: The researcher reports the various case studies in a way that transforms a complex issue into one that can be understood, allowing readers to question and examine the study and reach an understanding independent of the researcher.

Mohd-Noor (2008) presents a diagram indicating the steps involved in conducting a case study research. This is represented in Figure 4.4.

Source: Mohd-Noor (2008)

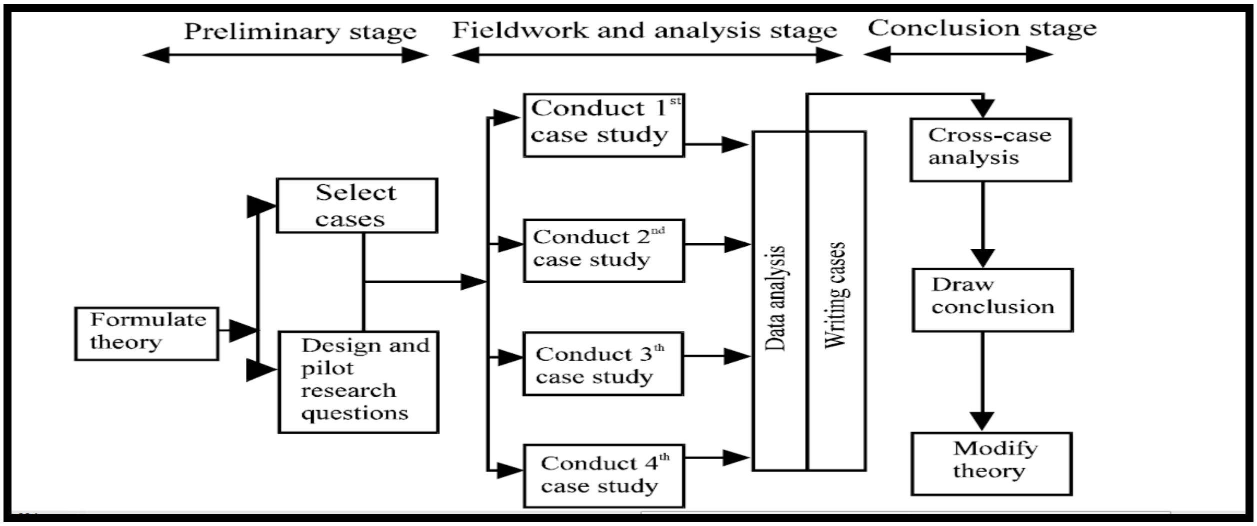


Figure 4.4: Case Study research process

The next section elaborates on how the researcher gained entry into the site of study.

4.5.3 Entry into site of study

This section focuses on describing the background to the case study to indicate how the data collection and the sampling of participants was carried out. Creswell (2007:118) states that an important step leading to data collection is to find the people or place of the study and to gain access to it. This is necessary because it helps the researcher to establish rapport with participants so that they do not feel threatened to provide the required data. However, Holloway and Wheeler (2002:38) note that access is sought in various forms. Holloway and Wheeler (2002:40) further state that researchers need to negotiate with ‘’gatekeepers”, the people who have the power to grant or withhold access to the site. There may be a number of gatekeepers at different places and levels in the hierarchy of an organization. Therefore, researchers should ask permission from the person directly in charge and from others who hold the power to start and stop the research (Holloway and Wheeler, 2002:40). Creswell (2007:125) indicates that these gatekeepers are the initial contact for the researcher and they lead the researcher to other participants. In this research study, the Deputy Director General of Health in the North West Province and the hospital administrators at the selected hospitals and clinics, were approached with formal written requests to conduct this research (see Appendix E). In addition, permission from the Ethics Committee of NMMU was sought and obtained before entry to the site.

The site which constitutes the geographical area where the research was conducted in the North West Province in South Africa is indicated in the map presented below. There are five regions within this province and all the regions were taken into consideration by selecting two health institutions, one hospital and one clinic, from each region. Figure 4.5 shows the boundary of the North West province.

Source: Statistics South Africa (2006)

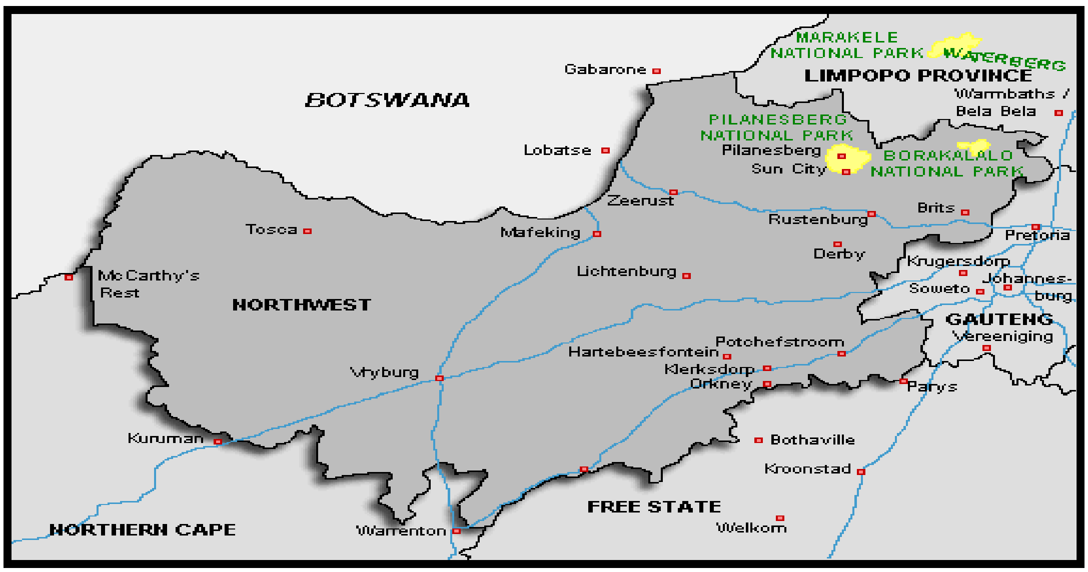


Figure 4.5: Map of North West Province

The healthcare institutions that were selected from the North West rural and urban areas are indicated in Table 4.1.

Source: DoH (2005)

	REGIONS IN NORTH WEST PROVINCE	HOSPITALS AND CLINICS
1	Bojanala Region	Rustenburg Hospital
		Classic House Clinic
2	Bophirima Region	Taung Hospital
		Ganyesa Hospital
3	Central Region	Klerksdorp Hospital

		Empilisweni Clinic
4	Southern Region	Christiana Hospital
		Boitumelong Clinic
5	Cross Border Region	Reivilo Hospital
		Reivilo Gateway Clinic

Table 4.1: Healthcare institutions

The selection of these hospitals and clinics gives a total of 10 healthcare institutions in the North West Province for the research. The next section discusses the systems approach as applied in this research study.

4.5.4 Research methods

Babbie and Mouton (2002:74) state that a research method consists of a systematic, methodological and accurate execution of the research design. In the process of this research, various methods and tools are used to perform different research tasks. This research was conducted in two phases. The first phase is the e-health readiness assessment phase and the second phase focuses on the compilation of the e-health framework. The first phase consists of five steps which start with the literature study and end with the data collection; while the second phase utilize three steps, beginning with the compilation of the e-health framework which is based on the first phase and end with the compilation of the final Provincial E-Health Framework (PEHF) for the North West Province. The two phases together utilize eight steps. The first phase consists of:

Step 1. Literature study

Step 2. General E-Readiness Assessment Model

Step 3. Expert opinion

Step 4. Specific E-Readiness Assessment Model

Step 5. Data collection

The second phase comprises of:

Step 6. Compilation an E-Health Framework based on the first phase

Step 7. Expert review

Step 8. Final Provincial E-Health Framework (PEHF).

Figure 4.6 summarizes the research process.

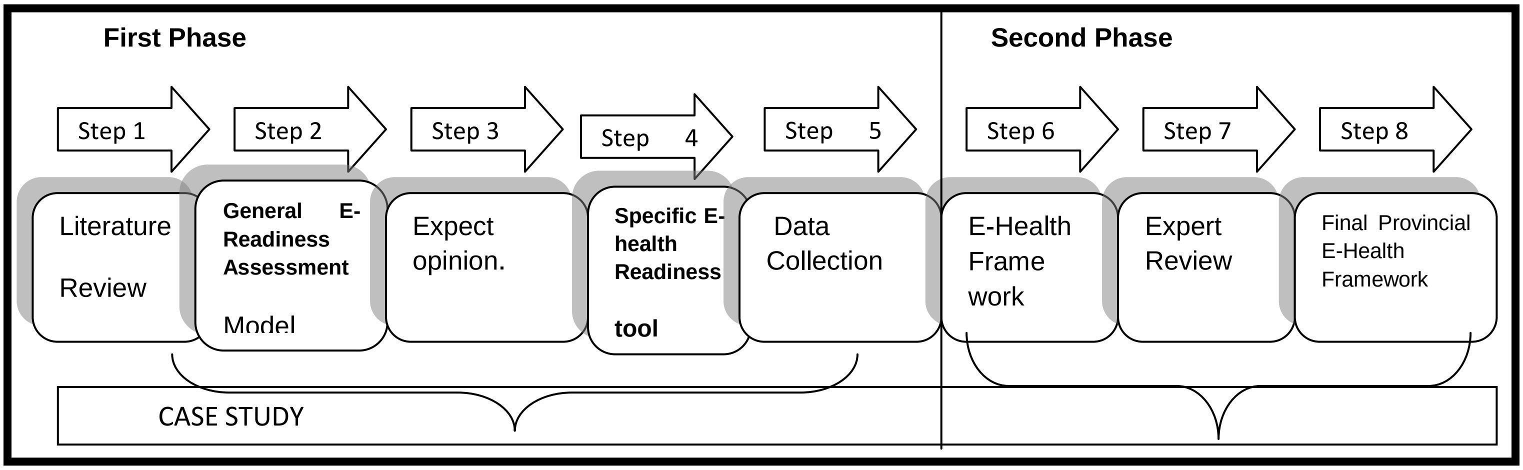


Figure 4.6: Research process

Reflecting on the research process (c*f* figure 4.6), the actual process towards the compilation of the framework begins with the literature study which assisted in the conceptualization of the general e-readiness assessment model (steps 1 and 2). Expert opinion (step 3) was sought to validate the general e-readiness assessment model. A specific e-health assessment readiness tool was developed (step 4). The specific e-health readiness tool which include interview and questionnaire questions was used to collect data in the selected hospitals and clinics for comparative processing and analysis (step 5). The results were analyzed for the compilation of the E-Health Framework (step 6).The E-Health Framework was reviewed by a panel of e-health experts from the North West Health Department (step 7). The feedback was used to improve upon the framework and finally the PEHF was complied (step 8). Goodman (2004:35) contends that there is no standard method for conducting e-health research. This means that the particular research method that is selected depends upon the appropriate methodological approach that answers the research questions effectively and efficiently. In this research study, the methodological process was customized to respond to the objectives of the research study, taking into account the specific needs of each of the communities.

4.6 Data collection methods

McNiff (2002) states that there are several sources for data collection, but points out that the method of data collection must always be appropriate to the particular research project, and that the point of collection must be to gather evidence for the improvement of practice. For the purpose of this research, more than one method of gathering data was chosen. Oates (2008:37) explains that using more than one data gathering method enables the researcher to look at the phenomenon of interest in different ways. Again using more than one method of data gathering allows the findings to be corroborated or questioned by comparing it with data from another method. Therefore, the researcher used interviews, questionnaires, photographs and document analysis to gather the required data. How the interviews and the questionnaires were administered is discussed in the following sections.

- **Interviews**

This is a data collection technique that involves the oral questioning of respondents, either as individuals or as a group (Denscombe, 2001). The interviews were conducted in a form of group interviews and were guided by open-ended questions. The interviews drew from the participants the following:

- Social impact of the e-health framework proposed in chapter 6; and
- The acceptance and use readiness items of the e-health framework.

Oates (2008:195) indicates that using group interviews can generate more responses and more varied responses as one participant's views are challenged by others or stimulate others to new ideas.

- **Questionnaires**

The questionnaires used in the paper phase of the research and administered to the participants, the hospital administrators, doctors, nurses, and ward assistants are indicated in Table 4.2.

		Hospital Administrators	Doctors	Nurses	Ward Attendants	Totals
1	**Rustenburg Hospital**	2	2	2	2	N=8
2	**Classic House Clinic**	2	2	2	2	N=8
3	**Taung Hospital**	2	2	2	2	N=8
4	**Ganyesa Health Centre**	2	2	2	2	N=8
5	**Klerksdorp Hospital**	2	2	2	2	N=8
6	**Empilisweni Clinic**	2	2	2	2	N=8
7	**Christiana Hospital**	2	2	2	2	N=8
8	**Boitumelong Clinic**	2	2	2	2	N=8
9	**Reivilo Hospital**	2	2	2	2	N=8
10	**Reivilo Gateway Clinic**	2	2	2	2	N=8
	Total	20	20	20	20	N=80

Table 4.2: Questionnaire distribution table (N=80)

The questionnaires solicited answers to questions drawn from the literature on e-health assessment, specifically the e-health readiness assessment models. The questionnaire includes the aspects of Need-Change Readiness, Engagement Readiness, Technological Readiness, Acceptance and Use Readiness and Learning readiness. Each of these aspects has detailed dimensions which the questionnaires address (see Appendices A and B). The next section discusses the document analysis used.

- **Document analysis**

Document analysis was used to gather information about the North West provincial government's policies regarding e-healthcare and information about the level of e-health initiatives in the province. This includes:

- An openly-declared, resolute and ongoing readiness to take action at the highest level to strengthen e-health strategies;
- Specific measures involving financing and the creation of basic infrastructure, e.g. broadband communication; and
- The legal and regulatory framework which are in place as pertaining to e-healthcare readiness.

Such written data sources include published and unpublished documents, hospital reports, memos, letters, reports, e-mail messages, faxes, newspaper articles and archival materials. These serve as supportive and confirmative evidence of the interview and questionnaire data collected.

- **Expert opinion**

Expert opinion is defined as a data collection method that involves using the perceptions and knowledge of experts in functional areas as indicators of program outcome (Center for the Advancement of community-Based public Health-CACBPH, 2000). In this research study, experts in the field of medical research, health technology assessment and the development of e-health models were consulted. The researcher refined his research questions and interviews after interaction with experts. When the e-health framework was compiled the researcher consulted with these experts for their input to improve the framework. Triangulation is discussed in the next section.

4.6.1 Triangulation

Triangulation refers to the application and combination of several research methodologies in the study of the same phenomenon (Bogdan and Biklen, 2006). It is a powerful technique that facilitates the validation of data through cross verification from multiple sources. Creswell (2009) highlights that the purpose of triangulation is to ensure that the research findings accurately reflect people's perceptions, and help researchers increase their understanding of the probability that their findings are seen as credible or worthy of consideration by others. Other scholars define triangulation as follows:

- Cohen and Manion (2000) define triangulation as an "attempt to map out, or explain more fully, the richness and complexity of human behavior by studying it from more than one standpoint".
- Altrichter, Feldman, Posch and Somekh (2008) contend that triangulation "gives a more detailed and balanced picture of a situation."
- O'Donoghue and Punch (2003) state that triangulation is a "method of cross-checking data from multiple sources to search for regularities in the research data."

Denzin (2006) identifies several types of triangulation. One type involves the convergence of multiple data sources. Another type is methodological triangulation, which involves the convergence of data from multiple data collection sources. A third triangulation procedure is investigator triangulation, in which multiple researchers are involved in an investigation. In this study, two of these triangulation approaches are employed. Multiple sources for data collection (convergence triangulation), and multiple measures for data collection (methodological) were employed. The methodological triangulation used to gather data in this study considered the convergence of data gathered through interviews, questionnaires, and documents supported by expert opinions. This increases the credibility and validity of the results of this qualitative study. The next section reports on population sampling.

4.6.2 Research population and sampling

According to Babbie (2006:196), a study population is the entire aggregation of elements from which a sample is actually selected. The research population for this study is comprised of four groups. These are the hospital administrators, doctors, nurses and ward assistants at the selected hospitals and clinics. Cormack (2002:263) on the other hand, refers to a sample as a group of people that a researcher selects from a defined population. These are individuals who provide information for the research. According to Holloway and Wheeler (2002:122), sampling strategies of qualitative research are guided by the principle of gaining in-depth information. In this research study, a purposive sampling technique was used to select the participants from the population. Babbie (2006:189) refers to purposive sampling as where the researcher selects the units or elements which are most useful or representative to the research. Therefore, a number of 80 participants were selected, with 8 participants from each hospital and 8 from each clinic. Their categories include the hospital/clinic administrators, doctors, nurses, and ward assistants. The participants were selected by their professions which was relevant to answer the research question. Each category had two participants as indicated in Table 4.3. Two participants from each category were selected because they had volunteered to participate unconditionally.

Source: DoH (2005)

PARTICIPANTS	**HOSPITALS AND CLINICS**										
	Rustenburg Hospital	**Classic House Clinic**	**Taung Hospital**	**Ganyesa health Centre**	**Klerksdorp Hospital**	**Emphilisweni clinic**	**Christiana clinic**	**Boitumelong clinic**	**Reivilo Hospital**	**Reivilo Gateway clinic**	**TOTAL**
Administrators	2	2	2	2	2	2	2	2	2	2	N=20
Doctors	2	2	2	2	2	2	2	2	2	2	N=20
Nurses	2	2	2	2	2	2	2	2	2	2	N=20
Ward Attendants	2	2	2	2	2	2	2	2	2	2	N=20
Total	8	8	8	8	8	8	8	8	8	8	N=80

Table 4.3: Category of participants (n=80)

The total number of the participants was 80. The next section focuses on the data analysis techniques.

4.7 Data analysis techniques

The goal of analysis in interpretive studies is to produce an understanding of the context and the interaction of specific systems (like e-health) with their contexts. The strength of analysis in interpretive studies is derived from the strength of the explanation of the phenomena based on the interpretation of data. Myers (1998) discusses some modes of analysis associated with interpretive research. Hermeneutics suggests a way of understanding the meaning of data or text analogues. The most fundamental tenet of hermeneutics is that understanding has a circular structure as understanding relates to some or other phenomenon. The idea of the hermeneutic circle suggests that the understanding of a complex whole arises from preconceptions about the meanings of its parts and their interrelationships. To clarify its generality, it is best to relate to Gadamer's (1976) example about how the meaning of a sentence is translated into a foreign language. The hermeneutic circle of understanding posits that the researcher pre-understands how the system should or could be developed and is based on his prejudice, followed by the fusion of horizons of understanding as expressed through world views, explanation, and appropriation which forms a continuous circle of ensuring that meaning and biases are eliminated in data analysis.

Source: Gadamer (1976)

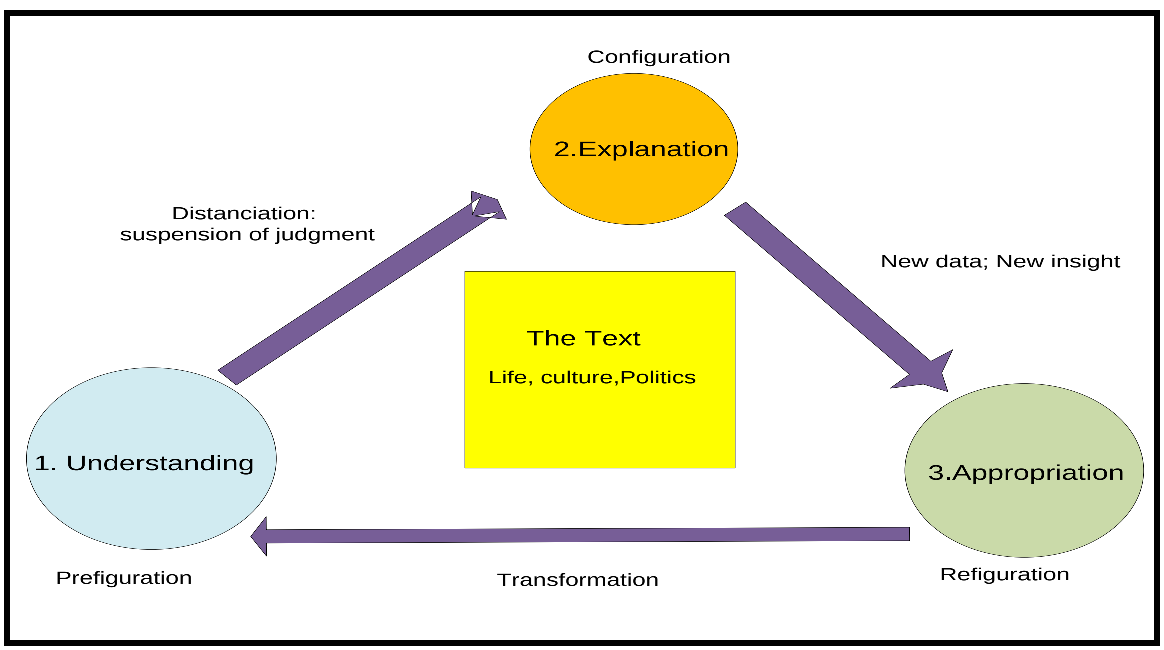


Figure 4.7: The Hermeneutical Circle

Biases in the researcher's collection and analysis of data can be counteracted by using multiple sources of evidence (triangulation of data) to provide multiple instances from different sources (Miles and Huberman, 1994:234). The case study findings are strengthened by the convergence of information from a variety of sources to provide multiple measures of the same phenomenon (Yin, 1994:92). Walsham (1995) recommends several methodological issues to be taken care of in interpretive case studies: to make the epistemological stance explicit; to provide a 'thick description' in the anthropological tradition; and to discuss how theory is used as an initial guide for data collection, as part of an iterative process of data collection and analysis, or as a final product of the research.

Researchers are further advised to discuss their role in data collection: that of outside observer or that of involved researcher. Furthermore, Walsham (1995) recommends providing details on research sites; site selection criteria; the number of people interviewed and their organizational positions; data sources (including the amount of cases); period of study; and data analysis techniques. These are provided in this research study in sections 4.5.3; 4.6; and 4.6.2.

Klein et al. (1999) propose a set of principles to conduct and evaluate interpretive case research) which are based on the philosophical perspective of hermeneutics and which mostly apply to studies of this nature. Table 4.4 indicates these principles and how they have been applied to this research study.

Fundamental principle for conducting and evaluating interpretive studies	**How and where applied in this study**
1. The Fundamental Principle of the Hermeneutic Circle This principle suggests that all human understanding is achieved by iterating between considering the interdependent meaning of parts and the whole that they form. This principle of human understanding is fundamental to all the other principles.	Applied in data analysis in chapter 5. The situations in the hospitals/clinics were analyzed in parts and whole using Creswell's (2007:75) within-case, cross-case and holistic-case analysis template.
2. The Principle of Contextualization Requires critical reflection of the social and historical background of the research setting, so that the intended audience can see how the current situation under investigation emerged	Applied in section 5.2 - highlights the background history of the multiple case studies (hospitals/clinics) which led to the positioning of the research question.

3. The Principle of Interaction Between the Researchers and the Subjects Requires critical reflection on how the research materials (or "data") were socially constructed through the interaction between the researchers and participants	The role of the researcher is positioned - observer as participant. This is reflected when the researcher, during his field visits to the hospitals/clinics, observed the physical conditions of the hospitals/clinics and interacted with the participants (doctors, nurses, assistant nurses and hospital administrators)
4. The Principle of Abstraction and Generalization Requires relating the idiographic details revealed by the data interpretation through the application of principles one and two to theoretical, general concepts that describe the nature of human understanding and social action.	No generalization, the details revealed by the data were content specific based.
5. The Principle of Dialogical Reasoning Requires sensitivity to possible contradictions between the theoretical preconceptions guiding the research design and actual findings ("the story which the data tell") with subsequent cycles of revision.	The interpretations of the data in chapter 5 were done in light of the literature in chapters 2 and 3.
6. The Principle of Multiple Interpretations Requires sensitivity to possible differences in interpretations among the participants as are typically expressed in multiple narratives or stories of the same sequence of events under study. Similar to multiple witness accounts even if all tell it as they saw it.	Expert review was sought from the North West Health Department officials, and other groups (doctors, nurses and hospital administrators).
7. The Principle of Suspicion Requires sensitivity to possible "biases" and systematic "distortions" in the narratives collected from the participants.	Data collected from participants was done anonymously. Multiple sources for data collection were employed and multiple measures for data collection were employed (Interviews, Questionnaires and document analysis)

Table 4.4: Principles for conducting and evaluating interpretive research

The principle of the hermeneutics circle and multiple interpretations requires the researcher to understand and examine situations in parts and as a whole to assign reasons to them. Therefore, any research data needs to be processed and analyzed in some systematic fashion so that trends and patterns of relationships are detected (Polit and Hungler, 1993:269). The process of data analysis involves making sense out of text and image data. Therefore, in this study the researcher has employed Creswell's (2007) template for case study analysis namely: within-case, cross-case and holistic-case analyses. Creswell (2007:75) explains these three methods as follows:

- **Within-case analysis**: This type of analysis may apply to either a single case or multiple collective case studies. In within-case analysis the researcher analyzes each case for themes. In the study of multiple cases, the researcher may compare the within-case themes across multiple cases in cross-case analysis.
- **Cross-case analysis**: This form of analysis applies to a collective case in which the researcher examines more than one case. It involves examining themes across cases to discern themes that are common to all cases.
- **Holistic-case analysis**: In this approach to data analysis, the researcher examines the entire case and presents descriptions, themes and interpretations or assertions related to the whole case.

In this study, all the three methods of data analysis are used because the e-healthcare assessment sets out to investigate the strengths and weaknesses of each hospital/clinic in terms of ICT availability and usability. Data from the individual hospitals/clinics were analyzed separately. Further comparisons of e-health assessment between selected rural and urban hospitals/clinics were conducted. The data were analyzed under rural and urban categories. Data from all the hospitals/clinics were also analyzed as a single category. To achieve a comprehensive analysis, coding and categorization of data is implemented throughout the research. The coding process and data analysis were conducted according to the steps suggested by Tesch (1990) as follows:

- Get a sense of the whole: Read all the transcriptions carefully and make short notes;
- Pick one document at a time, go through it and try to make meaning of its contents; write notes in the margin;
- When this action has been completed for several documents, make a list of all the topics. Cluster similar ones together and form them into columns that can be arranged as major topics, unique topics and leftovers;

- Take the list and go back to the data. Abbreviate the topics as codes and write the codes next to the appropriate segments of the text to see whether new categories and codes emerge;
- Find the most descriptive wordings for the topics and turn them into categories. Reduce the total list of categories by grouping topics that relate to one another. Lines can be drawn between categories to show interrelationships;
- Make a final decision on the abbreviation for each category and arrange these categories alphabetically;
- Assemble the data material belonging to each category in one place and perform a preliminary analysis; and
- Re-code existing data if necessary.

In this study transcripts of audio-taped interviews were made and sent to an independent coder with a data analysis guide. The independent coder was instructed to use the data analysis guide to analyze data from the transcribed interviews to exclude biases by the researcher and to control haphazardness with the data analysis.

4.8 Measures to ensure trustworthiness

Oates (2008:294) indicates that trustworthiness is about how much trust can be placed in a research output. According to Holloway and Wheeler (2002:256), a study is authentic when the strategies used are appropriate for the true reporting of the ideas of the participants, when the study is fair; and when it helps participants and similar groups to understand their world and to improve it. Authenticity was achieved by the researcher's fairness to all the participants and gaining their acceptance throughout the study. Furthermore, continued informed consent was obtained in this research. Holloway and Wheeler (2002:254) point out that trustworthiness in qualitative research means methodological soundness and adequacy. The researcher made judgments of trustworthiness possible through developing the following:

- **Credibility**

Credibility corresponds to the notion of internal validity (Oates 2008:294). This means that the participants are able to recognize the meaning that they give to a situation and the truth of the findings in their own social context. The researcher ensures that the findings are compatible with the perceptions of the participants (Holloway and Wheeler, 2002:255). Credibility was ensured by doing prolonged and varied field work, the interviewing process, peer review, reflexivity and triangulation. The researcher ensured prolonged and varied field experience by spending time in establishing rapport with the participants before commencing the interview so that the participants could become accustomed to the researcher. The researcher stayed for a while after the interviews because the participants continued talking after the conclusion of the interviews. This is important because as the rapport increased, participants volunteered new information. Credibility was also enhanced in the interviewing process as the researcher reframed questions, repeated or expanded questions on different occasions during the course of the interview process.

Triangulation is a powerful strategy for enhancing the quality of research (Krefting, 1991:9). Triangulation of data gathering methods and sources is used to ensure trustworthiness. Data was obtained from five different groups of participants, namely, hospital administrators, doctors, nurses and ward assistants in order to cross-check data and interpretation. The data obtained was analyzed twice by both the independent coder and the researcher.

- **Relevance**

Relevance is defined as “being pertinent, having direct bearing” (Oates 2008:295). The knowledge acquired in this study is relevant to other situations, and those who will carry out the research in another context will be able to apply the concepts originally developed in this research (Holloway and Wheeler, 2002:255). A dense description of the background information is provided about the participants and the research context and setting to allow others to assess how the findings can be used.

- **Dependability**

Oates (2008:294) refers to dependability as how well the research process is recorded and the data documented. If the findings of a study are to be dependable, they should be consistent and accurate. In this study the strategies used to ensure trustworthiness include detailed description, triangulation and peer review. An independent coder was utilized to increase dependability.

- **Confirmability**

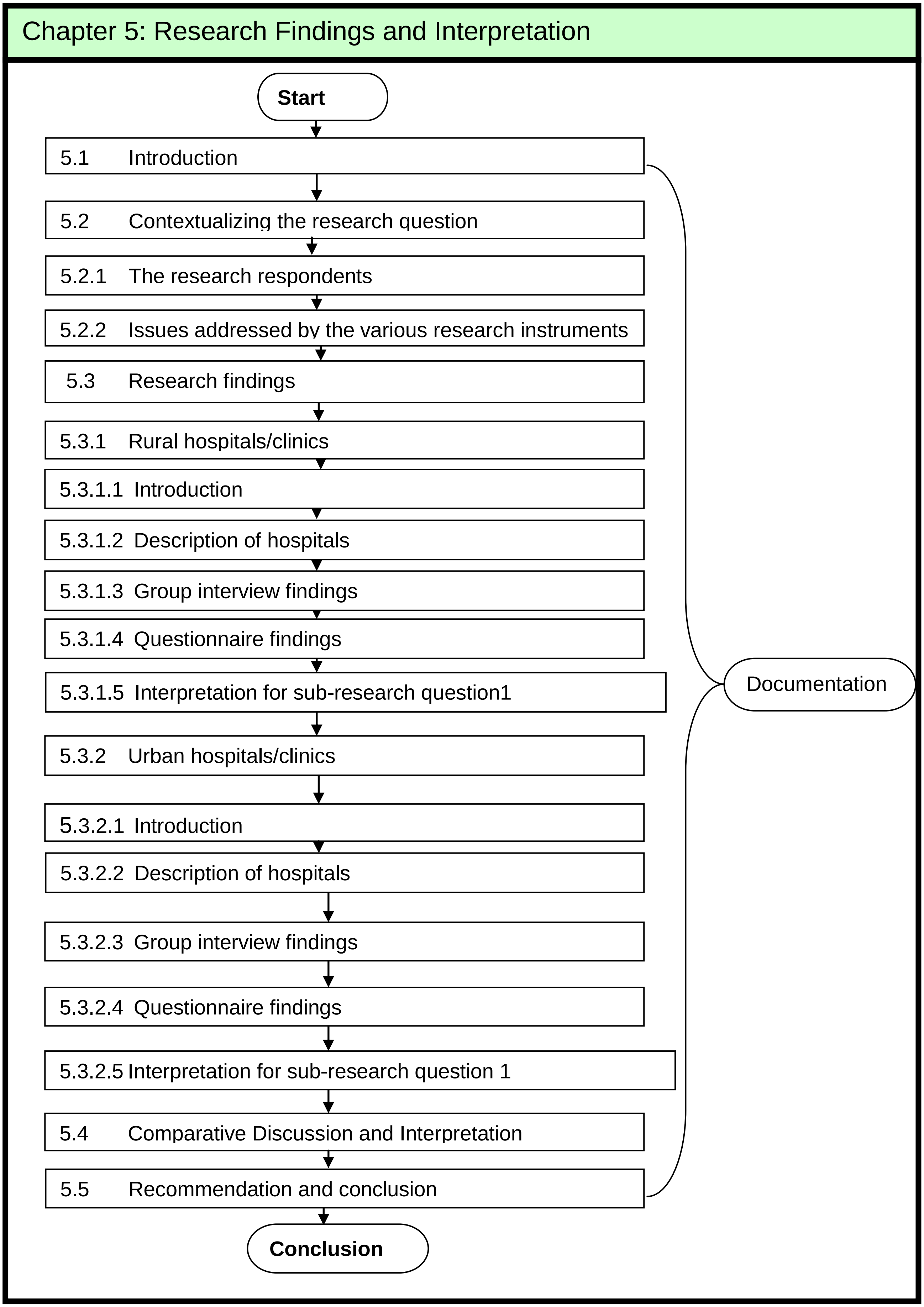
Oates (2008:294) further states that confirmability answers the question: Have the audience been told enough about the study to judge whether the findings do flow from the data and the experiences in the setting? This means that the research must be able to show how the researcher arrives at the constructs, themes and their interpretations. Thus, Holloway and Wheeler (2002:255) maintain that the details of the research, the background and the feelings of the researcher need to be made open for public scrutiny. Triangulation of methods and sources and reflexivity are used to ensure trustworthiness in this research.

4.9 Conclusion

This chapter discusses the three philosophical assumptions, the positivist, interpretive and the critical researcher views that underlie all research. This research opted for the interpretive philosophical assumption because the research aims to assess the social readiness of the people for the implementation of e-healthcare services and the technological readiness of the healthcare institutions.

Furthermore, the research design selected is a qualitative research design employing a case study approach to achieve the research objectives. The research method was outlined containing steps leading to the compilation of the E-Healthcare Framework for the North West Province.

Moreover, the chapter highlights how the participants were purposefully selected from the various regions to achieve the research objectives. The methods of collecting data from the participants are stated as group interviews, questionnaires and document analysis. The chapter explains how the data analysis was carried out. Finally, measures to ensure trustworthiness of the research were discussed under the headings, credibility, transferability, confirmability and dependability. The next chapter (chapter 5) discusses the research findings and interpretation.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5.3.2.2 Description of hospitals
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CHAPTER 5

RESEARCH FINDINGS AND INTERPRETATION

5.1 Introduction

The research design and method were discussed in chapter 4. This chapter presents the findings, analysis and interpretation of data which emanate from the data collection instruments, namely, the group interviews, questionnaires and photographs. The findings and analysis presented in this chapter are based on Creswell's (2007:75) template for analyzing multiple or collective case studies (cf. Section 4:7). The four steps (steps 1-4) which are required in Creswell's (2007:75) template for analyzing multiple or collective case studies are linked with the various subheadings within this chapter. Steps 1-4 are linked with the subheadings 5.2 to 5.5 respectively as illustrated in Figure 5.1.

Source: Creswell (2007)

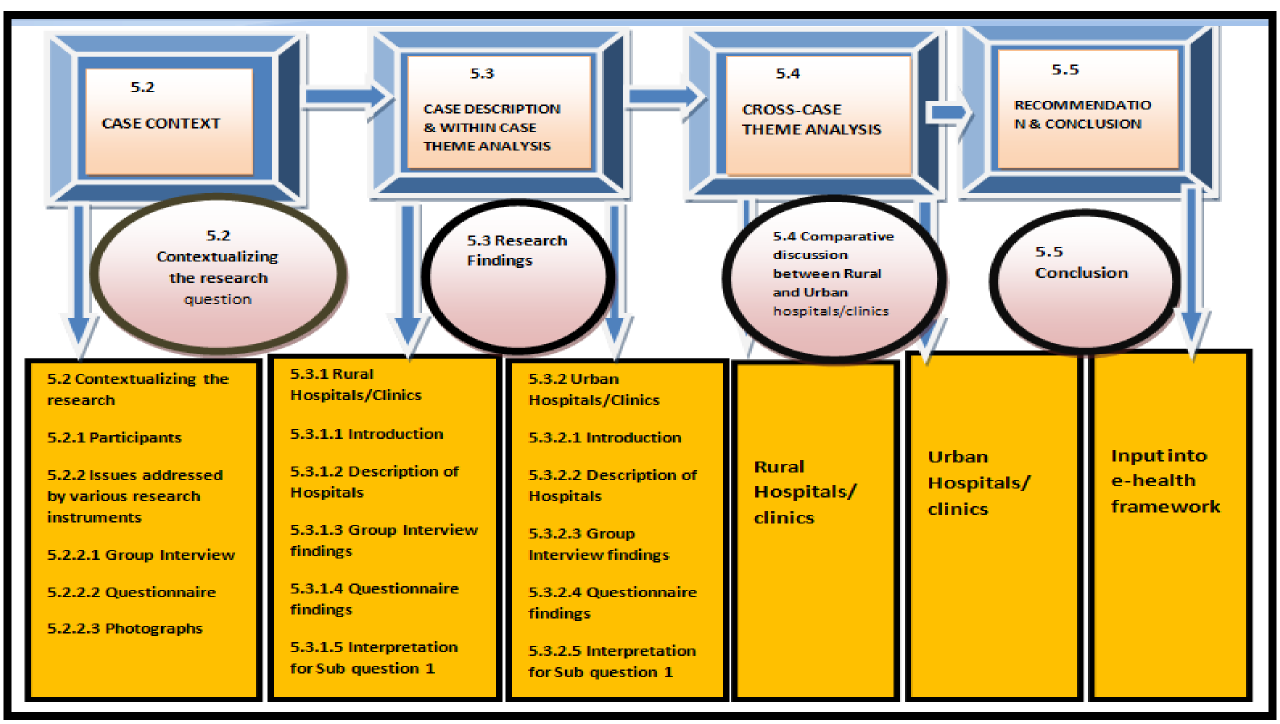


Figure 5.1: Creswell's template for analyzing multiple or collective case studies

Creswell (2007:75) describes the process of analysis as breaking down information into smaller pieces and then putting them together again to form a large consolidated whole or picture. The process of analysis in this chapter follows that of Creswell (2007:75) in the sequence which is indicated in Figure 5.1. It starts with step 1 and focuses on subheading 5.2. This is followed by step 2 which focuses on subheading 5.3 whilst steps 3 and 4 focus on subheadings 5.4 and 5.5 respectively.

These four steps, together with the subheadings (5.2-5.5) that they focus on, are discussed in the proceeding sections.

5.2 Step 1: Contextualizing the research question

The main research question which is addressed in this study is:

> How can an E-Health Framework with the objective of improving the delivery of electronic healthcare services to the people in the North West Province be compiled?

The main research question was broken down into two sub-research questions and different measuring instruments were applied to make the data collection effective. The researcher applied multiple measuring instruments to provide an in-depth view for analysis of the main subject of investigation. Oates (2007:142) emphasizes that using multiple measuring methods assists the researcher to obtain more detailed information about the phenomenon under investigation. Therefore, data collection instruments such as group interviews, questionnaires, observations, expert reviews, document analysis and photographs were used to solicit answers to the two sub-research questions. The first sub-research question is elaborated in Table 5.1. The corresponding data collection instruments used to obtain answers to sub-research question 1 are indicated against the question.

Sub-research question 1	Data collection instruments		
	Group Interviews	Questionnaires	Photographs
How can E-Health Readiness Assessment Models be applied to identify the strengths and areas of improvement in a particular healthcare institution?	√	√	√

Table 5.1: Data collection instruments

The overall e-health readiness assessment construct was applied in drawing up the questions for the data collection instruments, namely; the interviews and the questionnaires (*cf* Figure 3.17). The overall e-health readiness assessment construct that was used applied five main domains for drawing up the questions. These domains are need-change readiness, engagement readiness, technological readiness learning readiness and acceptance readiness. (*cf* Figure 3 17).This framework provided the criteria for compiling questions for the group interview and questionnaire data collection instruments The group interview data collection instrument, which was utilized as indicated above, was supported by audio tape recordings. The next section deals with the categorization and involvement of the respondents in this research.

5.2.1 The research respondents

As stated in chapter 4, purposive sampling was applied to select the respondents from rural and urban hospitals/clinics to achieve the goals of the study. A total of 80 respondents were selected from both rural and urban hospitals/clinics. The selected respondents from each hospital/clinic are in the following categories: 2 administrators, 2 doctors, 2 professional nurses and 2 ward attendants. Ward attendants are now called assistant nurses according to the new post structure in the North West Health Department.

The respondents from both the rural and urban hospitals/clinics were informed prior to the group interviews and the completion of the questionnaires that participation in the research was voluntary and that any information provided would be treated as confidential. All 80 respondents, who were purposively selected, voluntarily agreed to participate in the research. The ten hospitals/clinics selected in the North West Province were grouped as rural and urban hospitals/clinics and were numbered as cases. These hospitals/clinics and their locations are listed in Tables 5.2 and 5.3 as rural and urban hospitals/clinics respectively. The e-health solutions assessed in both the rural and urban hospitals/clinics are indicated in the last column of each of the tables.

Case No	Case description (Hospital/Clinic)	Location	E-health Solutions
1	Taung Hospital	Bophirima Region	●E-Patient Health Record. ●E-Consultation. ●E-Referrals ●E-Prescription ●E-Training
2	Christiana Hospital	Southern Region	
3	Ganyesa Hospital	Bophirima Region	
4	Reivilo Hospital	Cross Border Region	
5	Boitumelong Clinic	Southern Region	
6	Reivilo Gateway Clinic	Cross Border Region	

Table 5.2: Rural hospitals/clinics

Table 5.3 indicates the urban hospitals/clinics with their locations and the e-health solutions that were assessed.

Case No	Case description (Hospital/Clinic)	Location	E-health Solutions
7	Rustenburg Hospital	Bojanala Region	●E-Patient Health Record. ●E-Consultation. ●E-Referrals ●E-Prescription ●E-Training
8	Classic House Clinic	Bojanala Region	
9	Klerksdorp Hospital	Central Region	
10	Empilisweni Clinic	Central Region	

Table 5.3: Urban hospitals/clinics

It can be observed from both tables, Table 5.2 and Table 5.3, that this study is a multiple case study which investigates 10 cases. The next section presents the issues that are addressed by each of the data collection instruments utilized in this research study (*cf* Table 5.1).

5.2.2 Issues addressed by the various research instruments

The purpose of this section is to present the objectives of each research instrument in detail.

5.2.2.1 Group interviews

The data collection process includes group interviews at each hospital/clinic. The interviewees were of diverse age groups, ethnicity, gender and educational levels. As indicated in chapter 4, the interviewees in each hospital/clinic included 2 administrators, 2 doctors, 2 nurses and 2 ward attendants (assistant nurses). The interviews were held in the boardroom or the hospital administrator's office in each hospital/clinic. Table 5.4 summarizes the themes and objectives of the group interview questions.

GROUP INTERVIEW	QUESTION NUMBER	THEMES	OBJECTIVES
Appendix C: Administrators, doctors, nurses and ward attendants (assistant nurses)	1	E-patient health record system E-consultation system E-prescription system E-referral system	To determine the acceptance and expected benefit if installed in the hospital/clinic in relation to: ●Time for recording patient information ●Time for retrieving patient information ●Keeping patient information confidential
	1	E-training system	To determine the acceptance and expected benefit if installed in the

			hospital/clinic in relation to: ●Improving work processes. ●Ease of system usage
	2	Current hospital/clinic e-health problems	To determine the specific e-health application needs for each hospital/clinic in relation to their specific problems
	3	Anticipated problems	To establish any anticipated problem that is likely to arise when the specific system is implemented.
	4	Basic e-health technologies available	To determine the available e-health technologies that already exist in the hospital/clinic.
	5	Training needs	To establish if staff members are computer literate and need training in using e-health applications
	6	Access to e-health applications outside work environment	To determine if healthcare professionals will like to be given access to any of the e-health applications after working hours.
	7	Suggestions and comments	To solicit further ideas that could help in developing the e-health framework which may not have been covered by the questionnaire or interview

Table 5.4 Themes and objectives of the interview questions

The next section elaborates on the questionnaire data gathering instrument.

5.2.2.2 The questionnaire

The questionnaires (*cf* Appendices A and B) consist of two sets of questions. The first set of questions (*cf* Appendix A) was designed for the hospital/clinic administrators whilst the second set of questions (*cf* Appendix B) was constructed for the doctors, nurses and ward attendants (assistant nurses).The two sets of questions were drawn up using the five domains of the overall e-health readiness assessment construct (*cf* Figure 3.17). The questions in the questionnaire were grouped according to their relevance and relation to sub-research question 1. Table 5.5 summarizes the themes and the objectives of the questions in the questionnaire instrument.

QUESTIONNAIRE	QUESTION NUMBER	THEMES	OBJECTIVES
Appendix A: Hospital Administrators	1-4	General information.	To establish background history and settings of the various hospitals
	5-9	ICT facilities	To establish ICT infrastructure available in the various hospitals
	10-14	E-health Solutions	To elicit e-health resources and programs currently operational in the various hospitals
	15-19	Work processes of the health professionals	To determine services provided by the various hospitals and how the health professionals execute these services
	20-23	Linkage to other hospitals/clinics	To establish the frequency of referral cases and how consultations with other healthcare professionals are done

Table 5.5: The structure of the questionnaire in Appendix A

Table 5.6 elaborates on Appendix B which is the questionnaire instrument administered to the doctors, nurses and ward attendants (assistant nurses).

QUESTIONNAIRE	QUESTION NUMBER	THEMES	OBJECTIVES
Appendix B: Doctors, nurses and ward attendants (assistant nurses).	1.1-1.3	Procedures in using patient health records	To establish if doctors conduct their practices in a multidisciplinary clinical team and share patient health records.
	2.1-7	Patient health record	To find out the current methods of creating, maintaining and storing patient health records.
	8-10	Consultation	To determine the methods of consultation between healthcare professionals for professional advice
	11-12	Referrals and prescription	To establish the procedures and methods of referral of patients from one department to another department within and outside the hospital and how referrals of patients to the pharmacy in the same hospital is done
	13-18	Training opportunities	To establish the level of ICT competence and post implementation training needs in the various hospitals/clinics

Table 5.6: The structure of the questionnaire in Appendix B

The number of questionnaires (*cf* Appendix A) distributed to hospital/clinic administrators were 20 and 18 were returned. This constitutes 90% of completed questionnaires returned by the hospital/clinic administrators. 60 questionnaires *(cf* Appendix B) were distributed to doctors, nurses and ward attendants. Out of the 60 questionnaires, 55 were completed and returned. This constitutes about 92 % of the questionnaires. The findings from these questionnaires are presented in section 5.3. The next section focuses on the use of photographs as a data gathering instrument.

5.2.2.3 Photographs

Photographs were taken to provide visual descriptions of the hospitals/clinics and to disseminate information at colloquiums and research workshops about the research study.

5.3 Step 2: Research findings

This section presents the research findings in two parts. The first part (5.3.1) deals with the findings obtained from the rural hospitals/clinics, while the second part (5.3.2) focuses on the findings obtained from the urban hospitals/clinics. Figure 5.3 presents the headings and the subheadings pertaining to the research findings from both the rural and the urban hospitals/clinics.

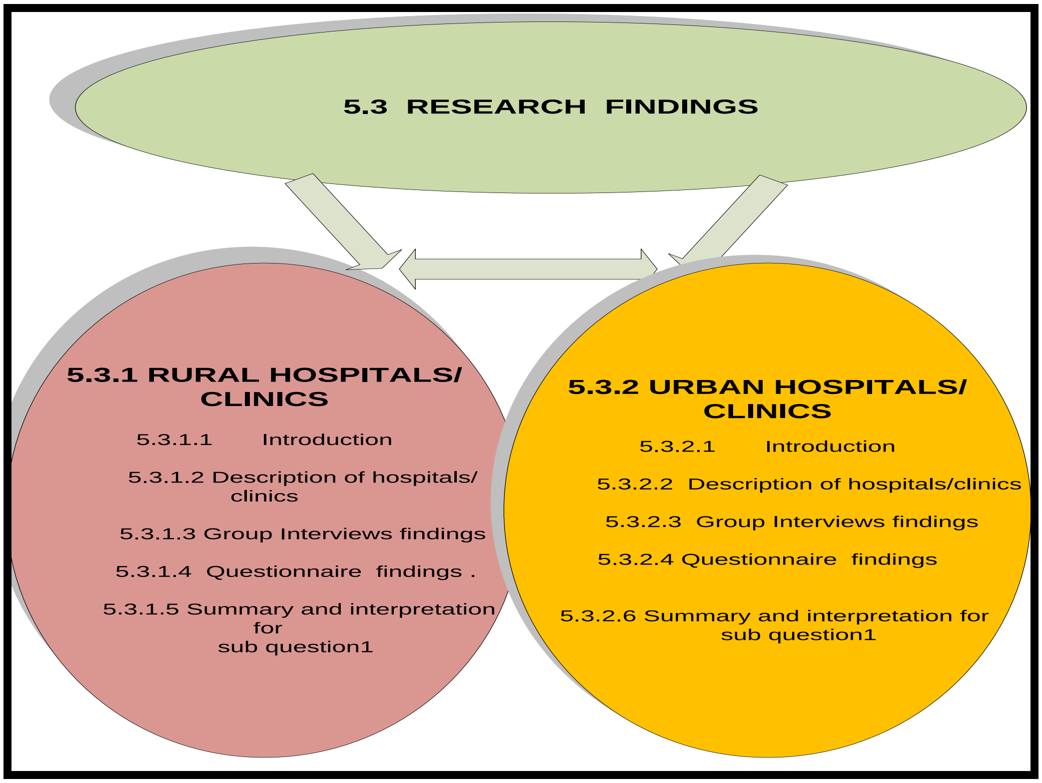


Figure 5.3: Research findings

The next section presents the first part of the research findings which deals with the rural hospitals/clinics.

5.3.1 Research findings: rural hospitals/clinics

5.3.1.1 Introduction

This section deals with the research findings from the rural hospitals/clinics (*cf* Figure 5.3). These hospitals/clinics together with their locations are listed in Table 5.7. This is followed by a description of each of the rural hospitals/clinics. When the researcher went into the field to gather data, it was found that some of the hospitals/clinics have new names which are indicated in Table 5.7.

NO	HOSPITAL/CLINIC	NEW NAME	LOCATION
1	Taung Hospital(A)	Taung District Hospital	Bophirima Region
2	Christiana Hospital(B)	Christiana District Hospital	Southern Region
3	Ganyesa Health Centre (C)	Ganyesa District Hospital	Bophirima Region
4	Reivilo Hospital (D)	Reivilo Health Centre	Cross Border Region
5	Reivilo Gateway Clinic (E)	___	Cross Border Region
6	Boitumelong Clinic (F)	___	Southern Region

Table 5.7: List of rural hospitals/clinics

5.3.1.2 Description of rural hospitals/clinics

In this section, the responses from the questionnaire instrument which was given to hospital/clinic administrators (*cf* Appendix A) together with the photographs taken during the field visits are used to describe the rural hospitals/clinics. These questionnaires aimed to elicit data such as the background history and the hospital/clinic infrastructure as listed under the relevant headings. The rural hospitals/clinics are described according to the following headings:

- Background/history of the hospital/clinic;
- Hospital infrastructure;
- ICT access level including ICT availability, accessibility and usability; and
- E-health solutions including availability, accessibility and usability.

The description of each hospital/clinic presents a photograph of the particular hospital/clinic which was taken at the time the data (interview, questionnaire, etc) was collected.

5.3.1.2.1 Taung Hospital (A)

Background/history of the hospital

Taung Hospital is in Taung, a rural community which is located in the Bophirima South District of the Bophirima Region. The hospital is situated 60km south of Vryburg and 20km north of Hartswater as shown in the map of the North West Province *(cf* Figure 4.5). The hospital serves the whole Taung community. The size of the hospital is approximately 0.9km^2 and the number of residents the hospital serves is approximately 200,000 people. Figure 5.4 presents a photograph of Taung Hospital.

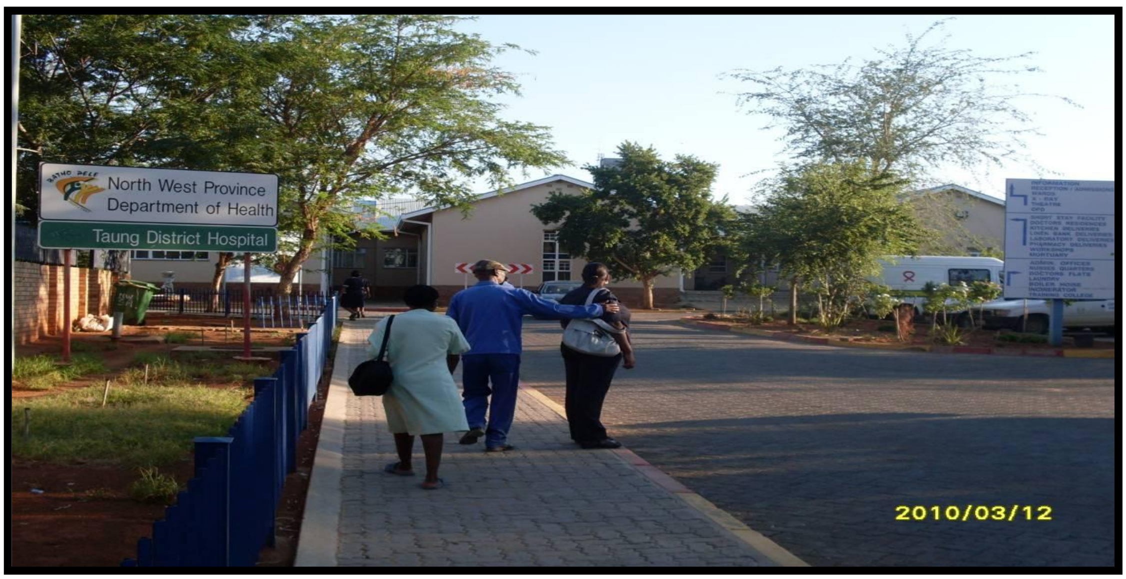


Figure 5.4: Taung Hospital

Hospital infrastructure

The hospital has newly built structures and the buildings are well maintained. It has four general consulting rooms and six specialist consulting rooms which are used by eight general practitioners (doctors) and one specialist doctor. There are four general wards which can accommodate 200 patients and nine special wards that can accommodate 50 patients each. The special wards include surgical, pediatric, high care, maternity, gynecology and psychiatric wards. Moreover, the hospital offers general services to outpatient clients who visit the hospital. These services include dental, physiotherapy, occupational therapy, oncology, psychological, counseling, x-ray, dietetics, pharmacy, speech therapy and social services. Despite the wide range of services which the hospital offers, there is limited high care equipment and as a result many emergency cases are referred to Klerksdorp Hospital.

ICT access level including availability, accessibility and usability

The ICT access level in relation to its availability, accessibility and usability in this hospital is as follows. The hospital has 16 laptop computers which are available mostly to the administrators of the hospital. There are 46 desktop computers, 45 printers, 3 fax machines and 3 photocopiers (*cf* Table 5.8). The ratio of doctors to desktop computers is 1:5. However, this ratio does not represent the utilization of computers as evidenced from the e-health readiness assessment done at the hospital. It was revealed that there were no computers in the consultation rooms of the doctors. This indicates that doctors do not use computers in the execution of their daily clinical duties. Nurses and assistant nurses do not use computers for their clinical work.

The computers are used by the hospital administrative staff for capturing patients' demographic information and revenue collection. This means that even though there are computers in the hospital, they are used for activities which are not directly related to clinical work like e-patient health record keeping, e-consultation, e-prescription or e-referrals. The computers operate on Windows XP. Internet access is available in the hospital but not all the healthcare professional workers have access to the Internet connection. The main purpose of the Internet connection is to link the hospital administrators to the North West Health Department's database where patient demographic information is transferred and stored on a monthly basis. Despite the Internet facility which is available in the hospital, its connectivity is slow and often down at an average of three times per week due to poor electricity supply and broken telephone lines. There are no T.V based conference facilities and digitalized X-ray equipment in the hospital.

E-health solutions including availability, accessibility and usability

The transmission of patient data from the hospital to the database of the North West Health Department is done through a Patient Administration and Billing (PAAB) system, which is the only e-health solution system available in the hospital. The PAAB system was implemented to support and enhance revenue collection and patient administration by capturing patient personal and geographical information and transmitting this information to the provincial database on a monthly basis. Apart from the PAAB system, the hospital does not have any other e-health solution system like e-patient health record, e-consultation, e- prescription, e-referrals nor an e-training system. The next section focuses on Christiana Hospital.

5.3.1.2.2 Christiana Hospital (B)

Background/history of the hospital

The Christiana Hospital is located in the southern region of the North West Province and lies between Kimberly and Bloemhof. The hospital serves a population of approximately 19000 people. The hospital is about 0.8Km^2 and attends to about 400 patients per day. Figure 5.5 presents a view of the Christiana Hospital.

Figure 5.5: Christiana Hospital

Hospital infrastructure

The Christiana Hospital has well constructed buildings and a clean environment. The hospital has both male and female wards and each ward has 51 beds. In addition, there are four general consulting rooms with five general practitioners (doctors) but there is no specialist doctor in the hospital. The general practitioners (doctors) conduct their practice as a team. The hospital offers the following services: 24 hour casualty services, X-ray, laboratory, pharmacy, reproductive health and maternity, outpatient and inpatient, voluntary counseling and HIV testing services.

ICT access level including ICT availability, accessibility and usability

There are five laptop computers which are used by the hospital administrators. In addition, there are twenty five desktop computers, eight printers, two fax machines, and one photocopier. The ratio of doctors to desktop computers is 1:5. However, this ratio does not represent the utilization of computers as evidenced from the e-health readiness assessment done in the hospital. It was noted that there was no computer in the doctors' consultation rooms and therefore, doctors do not use computers for their clinical duties. The computers in the hospital operate on Windows XP (*cf* Table 5.8).

Internet access is available in the hospital but not all the healthcare professional workers have access to the Internet connection. The main purpose of the Internet connection is to link the administrators to the database of the North West Health Department where patient demographic information is transferred monthly through the PAAB system. However, the Internet connectivity is slow and often down at an average of three times per week due to poor electricity supply and broken telephone lines in the area. There is no TV based conference facilities nor digitalized X ray equipment in this hospital. The next section focuses on e-health solutions in Christiana Hospital.

E-health solutions including availability, accessibility and usability

The Christiana Hospital, like Taung Hospital, has only one e-health solution system, which is the PAAB system that is used for the transmission of patient data, such as revenue collection and patient demographical information, to the database of the North West Health Department on a monthly basis. The next section gives the description of Ganyesa Hospital.

5.3.1.2.3 Ganyesa Hospital (C)

Background/history of the hospital

The geographical location and setting of Ganyesa Hospital is presented as follows. The hospital is located at about 70km north of Vryburg and serves a population size of about 150000 inhabitants of Ganyesa. The hospital treats about 230 outpatients per day. The hospital is about 10 km from the main shopping center of the village and patients need to take transport (taxis) to visit the hospital. Figure 5.6 shows Ganyesa Hospital.

Figure 5.6: Ganyesa Hospital

Hospital infrastructure

The Ganyesa Hospital has well constructed buildings with a clean environment. The hospital has both male and female wards and each ward has 51 beds. There are four general consulting rooms with six general practitioners (doctors). However, there is no specialist doctor in the hospital. The doctors in this hospital conduct their practice as a team. The services offered by this hospital include 24 hour casualty services, X-ray, laboratory, pharmacy, reproductive health and maternity, outpatient and inpatient, voluntary counseling and HIV testing, physiotherapy and occupational health services.

ICT access level including availability, accessibility and usability

The Ganyesa Hospital has seven laptop computers which are available to the hospital administrators. In addition, there are 27 desktop computers, 28 printers, one fax machine and three photocopiers (*cf* Table 5.8).The ratio of 1 doctor to 4 computers is observed in this hospital if doctors were to use the computers for their clinical work. However, this is not the case, as evidence obtained from the e-health readiness assessment done in the hospital showed that there were no computers in their consultation rooms. This means that doctors do not use computers for their daily clinical duties. The computers operate on Windows XP. There is Internet access in the hospital but, like Taung and Christiana Hospitals, not all the health professional workers have access to the Internet connection. Most consultations and referrals are done through the telephone and print media. There is no TV based conference facilities nor digitalized x-ray equipment in the hospital.

E-health solutions including availability, accessibility and usability

The Ganyesa Hospital, like Taung and Christiana Hospitals, has only one e-health solution system, the PAAB system, which is also used for the transmission of patient data such as revenue collection and patient demographical information, to the database of the North West Health Department on a monthly basis. The next section focuses on Reivilo Hospital.

5.3.1.2.4 Reivilo Hospital (D)

Background/history of the hospital

The Reivilo Hospital is in Reivilo, a small town which is situated about 70 km north of Taung. The health centre is about $0.8km^2$ and serves about 370 patients per week. Figure 5.7 below shows the Reivilo Hospital.

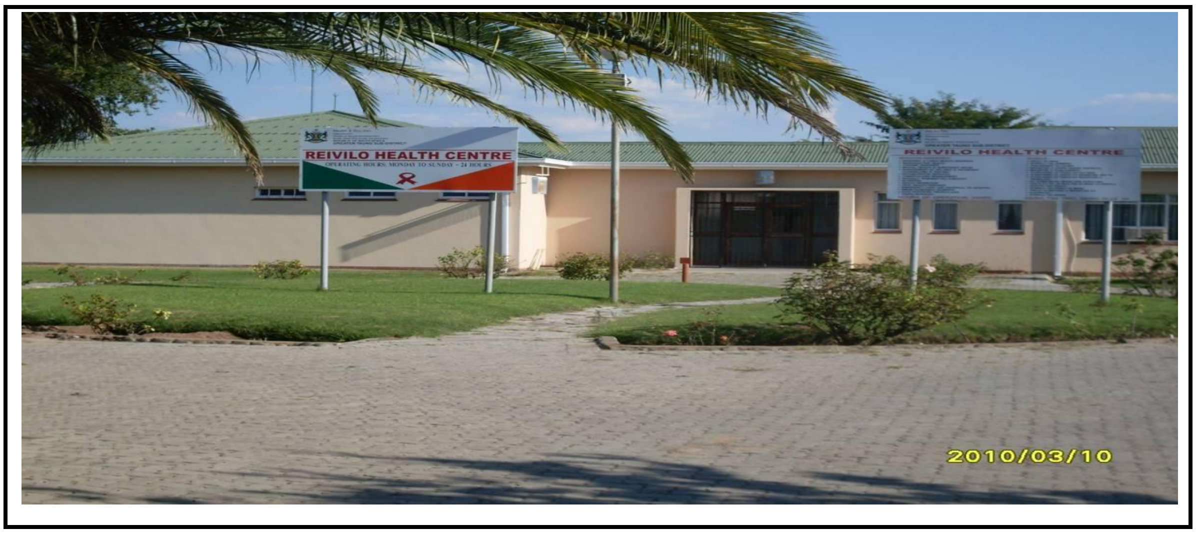


Figure 5.7: Reivilo Health Centre

Hospital infrastructure

The Reivilo Health Centre has well constructed buildings and a clean environment. The health centre has both male and female wards which can accommodate twenty four patients each. There are four general consulting rooms with two general practitioners (doctors), but there is no specialist doctor in the health centre. All cases which need a specialist doctor are referred to Klerksdorp Hospital. The two doctors conduct their practice as a team. The health centre renders services such as maternal and child health services, oral health, emergency care, pharmacy, nutrition, mental health and substance abuse; and other services such as tuberculosis management and post exposure prophylaxis.

ICT access level including availability, accessibility and usability

The ICT access level in relation to its availability, accessibility and usability in Reivilo Health Centre is quite low. The health centre has one laptop computer, four desktop computers, a printer, a photocopier, a fax machine and nine telephones (*cf* Table 5.8). A ratio of one doctor to two computers is observed in this hospital if doctors were to use computers for their clinical work. However, the evidence obtained from the e-health readiness assessment done in the hospital showed that there were no computers in the doctors’ consultation rooms, which means that doctors do not use computers for their clinical duties. The computers operate on Windows XP. There is Internet access in the hospital but not all the health professional workers have access to the Internet connection. The main purpose of the Internet connection, like the other hospitals, is to link the administrators to the database of the North West Health Department where patient demographic information is transferred monthly through the PAAB system. The hospital has no TV based conference facilities nor digitalized X-ray equipment.

E-health solutions including availability, accessibility and usability

The Reivilo Hospital has the PAAB system but does not have any other e-health application, like e-patient health record, e-consultation, e-referral nor e-prescription system in the health centre. Most consultations between healthcare professionals are done telephonically or face to face, and sometimes through the use of written memos. Moreover, patients who are referred to other departments in the hospital or outside the hospital have their appointments made through the telephone or referral letters. The next section is focused on Reivilo Gateway Clinic.

5.3.1.2.5 Reivilo Gateway Clinic (E)

Background/history of the clinic

The Reivilo Gateway Clinic which is in Reivilo is situated about 500m from the Reivilo Health Centre and serves about 400 patients per week. The clinic treats minor cases and refers any major case to the Reivilo Health Centre. Figure 5.8 presents the clinic.

Figure 5.8: Reivilo Gateway Clinic

Hospital infrastructure

The Reivilo Gateway Clinic has well-constructed buildings. The clinic has no ward facilities and can only serve day patients. There are six small general consulting rooms with two general practitioners (doctors) who usually come from the main Reivilo Health Centre. There is no specialist doctor in this clinic. The two doctors who visit this clinic conduct their practice as a team. The doctors visit the clinic twice a week The clinic offers the following services: minor ailments services, ante-natal care, HIV/AIDS voluntary counseling and testing, anti-retroviral screening, TB and other communicable diseases management, immunization and well baby services, cervical smear and child transmission (HIV) services.

ICT access level including availability, accessibility and usability

The Reivilo Gateway Clinic has got the following ICT facilities: one laptop computer, six desktop computers, one printer, one fax machine, and one photocopier. The figures indicate that the ratio of doctors to the number of computers is 1:3. However, this ratio does not represent the utilization of computers as evidenced from the e-health readiness assessment done in the clinic It was noted that there was no computer in the doctors' consultation rooms and therefore, the doctors do not use computers for their clinical duties. All these facilities are operational. The computers operate on Windows XP. The clinic is not heavily resourced with ICT equipment because it serves as a gateway to the Reivilo Health Centre where most cases are referred to. The clinic has telephone facilities and communication between the healthcare staff of the clinic and the Reivilo Health Centre is done through the telephone and written notes or referral letters. Sometimes the communication is done face to face resulting in four meetings per week at an average. There are no TV based conference facilities nor digitalized X-ray equipment in the clinic.

E-health solutions including availability, accessibility and usability

The clinic has the PAAB system which is used to support revenue collection and to capture patient demographics. There is no e-health solution system in this clinic However, there are telephone lines and Internet connectivity which unfortunately are down at an average of about two to three times per week. Therefore, the concept of an e-patient health records, e-consultation and e-referrals framework was well received by the health professionals in the clinic. The next section discusses Boitumelong Clinic.

5.3.2.2.6 Boitumelong Clinic (F)

Background/history of the clinic

Boitumelong Clinic is in Bloemhof which is situated in the southern region. The clinic serves about 2800 people per month and the size of the clinic is about $0.3km^2$. The clinic serves as a gateway to the Bloemhof District Hospital. Figure 5.9 presents Boitumelong Clinic.

Figure 5.9: Boitumelong Clinic

Hospital infrastructure

The clinic has well-constructed buildings with four consulting rooms. There are two general practitioners (doctors) from Bloemhof District Hospital who render healthcare services to the clinic. The clinic offers the following services: minor ailments services, ante-natal care, HIV/AIDS voluntary counseling and testing and others which are displayed on their sign post in Figure 5.10.

Figure 5.10: Boitumelong Clinic: Service rendered

ICT access level including availability, accessibility and usability

The ICT access level in relation to its availability, accessibility and usability in Boitumelong Clinic is summarized as follows: The clinic has seven laptop computers which are accessible to the clinic administrators, one desktop computer, one printer, and one photocopier (*cf* Table 5.8). The ratio of doctors to the number of computers is 1:0.5. Even though this ratio is stated, doctors do not have computers in their consultation rooms. The computers are used by the administrators of the clinic. The computers operate on Windows XP.

The clinic is not heavily resourced with ICT equipment but it has telephone facilities and communication between the healthcare staff of the clinic and the Bloemhof District Hospital is done through telephone, written notes and referral letters. Sometimes the communication is done face to face resulting in three to four meetings per week. Again there are no TV based conference facilities nor digitalized X-ray equipment in this clinic.

E-health solutions including availability, accessibility and usability

The Boitumelong Clinic, like the Reivilo Gateway Clinic, has no e-health solution systems in the clinic. However, there are telephone lines and Internet connectivity but most of the time the lines are down. The next section gives a brief summary of the description of the rural hospitals/clinics.

5.3.1.2.7 Summary of background/history of the rural hospitals/clinics

The rural hospitals/clinics described have good building infrastructures and serve a large number of people in the communities in which they are located. The ICT access level in relation to its availability, accessibility and usability in all the hospitals/clinics in the rural areas is summarized in Table 5.8 below.

Hospitals		Taung Hospital(A)		Christiana Hospital(B)		Ganyesa Hospital (C)		Reivilo Hospital (D)		Gateway Clinic (E)		Boitumelong Clinic (F)	
Indicators		**Availability**	**Accessibility and Usability**	**Availability**	**Accessibility and Usability**	**Availability**	**Accessibility and Usability**	**Availability**	**Accessibility and Usability**	**Availability**	**Accessibility and Usability**	**Availability**	**Accessibility and Usability**
Hardware	**1. Laptop**	16 laptops and available to only administrators	Accessible to administrators but not frequently used.	5 laptops and available to only administrators	Accessible to administrators but not frequently used.	7 laptops and available to only administrators	Accessible to administrators but not frequently used.	1 laptop and available to only administrator	Accessible to administrator but not frequently used.	Laptop and available to only administrator	Accessible to administrator but not frequently used.	7 laptop and available to only administrator	Accessible to administrators but not frequently used.
	2. Desktop	46 desktops	Accessible to only hospital administrators.	25 desktops	Located in the offices of the administrators.	27 desktops	Located in the offices of the administrators.	4 desktops	Located in the offices of the administrators.	6 desktops	Located in the offices of the administrators.	1 desktops	Located in the offices of the administrators.
	3. Monitor	46 monitors available	Accessible to only hospital administrators	25 monitors available	Accessible to administrators	27 monitors available	Accessible to administrators	4 monitors available	Accessible to administrators	6 monitors available	Accessible to administrators	1 monitors available	Accessible to administrators
	4. Printer	45 printers are available	Accessible	8 printers are available	Accessible	28 printers are available	Accessible	1 printers are available	Accessible	1 printers are available	Accessible	1 printers are available	Accessible
	5. Document scanner/ fax	3 fax machines	Accessible	2 fax machines	Accessible	1 fax machines	Accessible	1 fax machines	Accessible	0 fax machines	Accessible	0 fax machines	Accessible
	6. Photocopier	3 photocopiers are available	Accessible	1 photocopier	Accessible	3 photocopier	Accessible	1 photocopier	Accessible	1 photocopier	Accessible	1 photocopier	Accessible
	7. Telephone	Available	Accessible and frequently used	Available	Accessible and frequently used	9 telephone are available	Accessible and frequently used	Available 9 in number	Accessible and frequently used	Available	Accessible and frequently used	Available	Accessible and frequently used
	8. TV based conferencing	Not available	Not accessible	Not available	Not accessible	Not available	Not accessible	Not available	Not accessible	Not available	Not accessible	Not available	Not accessible
	9. PC based conferencing	Not available	Not accessible	Not available	Not accessible	Not available	Not accessible	Not available	Not accessible	Not available	Not accessible	Not available	Not accessible
	10. Web cam connected	Not available	Not accessible	Not available	Not accessible	1 is available	Not frequently use.	Not available	Not accessible	Not available	Not accessible	Not available	Not accessible

	Hospitals	**Taung Hospital(A)**		**Christiana Hospital(B)**		**Ganyesa Hospital (C)**		**Reivilo Hospital (D)**		**Gateway Clinic (E)**		**Boitumelong Clinic (F)**	
	Indicators	**Availability**	**Accessibility and Usability**	**Availability**	**Accessibility and Usability**	**Availability**	**Accessibility and Usability**	**Availability**	**Accessibility and Usability**	**Availability**	**Accessibility and Usability**	**Availability**	**Accessibility and Usability**
	11. Digitalized X-ray equipment	Not available	Not accessible	Not available	Not accessible	Not available	Not accessible	Not available	Not accessible	Not available	Not accessible	Not available	Not accessible
	12. High resolution digital cam monitored on a Microscope	Not available		Not available	Not accessible	Not available	Not accessible	Not available	Not accessible	Not available	Not accessible	Not available	Not accessible
Network	**1. Internet access**	Available	Used by administrators and doctors	Available	Used by administrators and doctors	Available	Used by administrators and doctors	Available	Used by administrators and doctors	No Internet available	No accessibility	No Internet availability	No accessibility.
IT support Personnel	**1. Provision of technical support**	Available	Not always accessible	Available	Not always accessible	Available	Not always accessible	Available	Not always accessible	Available	Not always accessible	Available	Not always accessible
	2. Technical support personnel	Available	Not always accessible	Available	Not always accessible	Available	Not always accessible	Available	Not always accessible	Available	Not always accessible	Available	Not always accessible
Healthcare Providers past IT experience	**1. Frequency of using PC**	Not often		Not often		Not often		Not often		Not often		Not often	
	2. Frequency of using e-media	Seldom		Seldom		Seldom		Seldom		Seldom		Seldom	
	3. Computer usage for E-Health	Only for PAAB	Accessible occasionally	Only for PAAB	Accessible occasionally	Only for PAAB	Accessible occasionally	PAAB is available	Accessible	None	None	None	None
	4. Training or direct experience in using e-health software	Not available	Not accessible	Not available and most staff member are computer illiterate	Not accessible	Not available and most staff member are computer illiterate	Not accessible			Not available and most staff member are computer illiterate	Not accessible	Not available and most staff member are computer illiterate	Not accessible

Table 5.8: Summary of ICT access level of rural hospitals/clinics

Notably the hospitals, unlike the clinics in these rural communities, use the PAAB system for capturing and transmitting patient demographic information to the provincial office of the Health Department on a monthly basis. The following challenges are faced by the rural hospitals/clinics:

- There is a widespread shortage of general practitioners (doctors) in these rural hospitals/clinics with an average of 1 doctor per 18000 people;
- Heavy workload for doctors;
- Lack of computer equipment (e.g. laptop and desktop computers, printers, photocopiers or fax machines) in consulting rooms and wards;
- Unreliable telephone services such as frequent out of service telephone lines;
- Poor Internet connectivity;
- Lack of prompt technical IT support;
- Lack of basic ICT skills and training;
- Constant interruption and cut off of electricity supply; and
- Lack of e-health solutions like e-patient health records, e-consultation, e-prescription and e-referrals.

The proceeding sections presents the findings obtained from the group interviews administered in the rural hospitals/clinics.

5.3.1.3 Group interview findings

The group interviews in the rural hospitals/clinics were conducted in the hospitals' boardrooms or in the offices of the clinic administrators. The participants who completed the questionnaires (hospital administrators, doctors, nurses and ward attendants) were in the group that responded to the interview questions. Table 5.9.1 presents a summary of the responses from the respondents from the rural hospitals/clinics. The interview questions were aimed at establishing the acceptance level, perceived usefulness and the potential benefits that the hospitals/clinics would accrue if e-health applications were installed in those hospitals/clinics. The interview findings gave in-depth views to the research findings which assisted to answer the sub-research question 1 (cf Table 5.1). The hospitals/clinics were purposively selected based on their geographical area being "rural" and the respondents by their profession which was relevant to answer the research question. In this instance two hospital administrators, two doctors, two nurses and two ward attendants were selected from each hospital/clinic (cf chapter 4). The results of the various questions and answers are summarized in Table 5.9.1. The key operational areas and questions are listed in the left column while the summarized responses with direct quotations from respondents are listed in the right column.

Key operational areas and interview questions		Summarized responses with direct quotations from rural hospitals/clinics
Q. 1. What benefits will you expect if the following e-health applications were installed in your hospital/clinic?		
	E-patient health record system	Save time in recording patient information, diagnosing and treatment of patients. It will protect the confidentiality of patient information. **Respondent 1**: "*Ok, I think we see that if e-patient health record system we will see that the initial time will be there consuming to use more time at the beginning, but subsequent time for referring, making diagnoses and safeguarding the patient confidentiality is guaranteed.*" **Respondent 2**: *"It is going to help a lot. It is going to benefit us a lot. Sometime take the file and record to file because there are so may files. It will save us time. it will be easy to take the patient and get life information"* **Respondent 3:** *"it will save time and time is money, this system of having material out of stark will be no more".*
	E-consultation system	Improve work efficiency because healthcare professionals can seek advice from colleagues for diagnoses and treatment of patients. **Respondent 1:** "*Again if you are not sure of*

		giving for example, a dose to a patient, you will be able to ask for help immediately, it will prevent medical hazards in a health situation". **Respondent 2**: *"It will be of help because initially doctors should refer to another hospital if there is a problem, doctor will waste time phoning to the referral hospital, but could not get"*.
	E-prescription system	Save time in dispensing medication and prevent errors. **Respondent 1**: "*Very much benefit if the patient walks straight to the dispensary and doctor puts the medicine on the system*" **Respondent 2**: "*It will benefit a lot. Yes it will save the time of the patient because he got the medicine quickly and go".* **Respondent 3**: "Legibility-correctness of presentation of dosage".
	E-referrals	Save time because doctors at the referred hospital will not re-write patient clinical history as it will already be on the system. It will assist to trace and follow up patient's progress from the referred hospital. **Respondent 1:** "Yes *it will save us time. Because the doctor at the other hospital will be ready, the doctor at other side will not start afresh to start with diagnosis*". **Respondent 2**: "*Sometimes you get problem with feedback when patient are referred from maybe Klerksdorp to our hospita*l". **Respondent 3:** "If *you have it, one patient at Tembi can be traced through out. You have one*

		patient one information whoever is taking the patient is able to see who was the previous to left".
	E-training	Improve skills of healthcare professionals which will further improve job performance if the e-training is combined with face to face training. **Respondent 1:*"****It will help us get more skills in computers and do our jobs alright"*. **Respondent 2: "***I think the normal one will be better because you can ask question face to face-I don't know but sometimes because of money it be, but maybe if there is somebody who is responsible, not necessary face to face, then he can train the others".* **Respondent 3**: *"It will take us a long time. Go for place for training therefore better e-training".*

Table 5.9.1: Responses to interview questions: rural hospitals/clinics

In addition to the first interview question which is summarized in Table 5.9.1, other questions were also asked during the group interview sessions. The summarized responses with some direct quotations are presented in Table 5.9.2. The key operational areas and questions are listed in the left column while the summarized responses with selected direct quotations from some of the respondents are presented in the right column.

Key operational areas and interview questions		**Summarized responses with direct quotations from rural hospitals/clinics**
Current hospital /clinic e-health problems		
Q.2	If any of the e-health application systems (e.g. e-patient health record, e-prescription-cf. Table 5.10.1) was implemented at your local	Improving the filing system and preventing loss of files. **Respondent 1:** "*It going to be of benefit, because some of the patient old files get lost and*

	hospital/clinic, what will be your personal expectations in terms of solving some of the current problems the hospital/clinic is faced with, or improving the quality of healthcare services provided? Name such a system and explain your expectations	*we use e-PHR, it will be better. Doctor will not know prevent present. Referral system help doctors".* Improve communication. **Respondent 2:** "*from my point of view if one system is put in place, it will minimize everything like-communicate early with other doctors. Over and above personal information, will be that the job that is done on phone will be minimize, again the to and from of the patients or everyone will be minimize. Again I think we solve any, problem at the end.* Reduce long queues at OPD and pharmacy. **Respondent 3:** *"Long queue will be shortened because time for retrieving the patient information will be short. Place of filing will be reduced".* Reduce cost **Respondent 4**: "*It will solve some of our problems because at time the material we are using e.g. case history sheet, patient forms etc, will save time and more money, because the stationary is being bought with money. Improve the working periods of our clients because this system may be more fast*".
Anticipated problems		
Q.3	What problems do you anticipate may arise from the implementation and use of such a system? Name the system and state the anticipated problem(s).	Inconsistent electricity supply: **Respondent 1:** *"Lack of electricity and Lack of computer. Lack of operator of the system. Only the individuals who have keywords are not there the system will stand. Only one can open".* Lack of computers and virus infections. **Respondent 2:** *"Viruses that the computer may have. More computers, few are going to cause*

		problem, and these problem may be from e-consultation system." Inability to re-call your prescription forms in case there is an error. **Respondent 3:** "*E-Prescription-When you prescribe and it goes to the dispensary, you may not be able to call it back, you have to spend time again to go and correct it again at the dispensary. Possibility to be slow and work cannot continue. Spelling becomes a problem as you become dependent on coded medicine put in the system. Issues of skills related the system may be slow to learn the system".*
Basic e-health technologies available		
Q.4	What basic technologies do you currently have in your hospital/clinic that support e-health application? Name any that you know of.	PAAB system **Respondent 1:** *"The only system that we have in the administration system is called PAAB system, that system does not help us 100% of the patient, it only helps us in the tracing of the information. But when the information is lost, that is where we experience a problem. But now the system only record the history background of the patient, not anything that has to do with the diagnose of the patient".*
Need for training		
Q.5	Will you like to have further training in computer usage to enhance your job performance?	Further training in computer usage is needed. **Respondent 1:** "*The training is needed for the settlement of our job. We need to use the basic computer literacy program".* **Respondent 2:** "*Even to the extent of when the system is slow, to know how to overcome the problem".*
Access e-health application outside work		

Q.6	Will you like to access e-health application outside your work environment?	Mixed reaction. Doctors indicated yes whilst nurses and other healthcare workers responded no. **Respondent 1:** "*It happened that you forgot to do something for the patient, so you need to access the website to correct what went wrong or exchange information".* **Respondent 2:** "*Closed, because of confidentiality, because my child knows computer and he can open to see other person's information".*
Suggestions and comments		
Q.7	Is there anything else you will like to suggest, recommend or comment on?	Suggestions and comments from respondents: **Respondent 1**: "*To my knowledge, this electronic H.R.S is very good though it will take the public hospital a lot of time to benefit, but I suggest it can be done, it will benefit*". **Respondent 2:** "*With this strategy I think if is implemented it will save time for the patient because the files are too many for a clerk to sort out for files every time".* **Respondent 3**: "*The system must be user friendly.-back-up of electricity. Linking all clinics and hospitals. Fair distribution of doctor across all levels. There should be signature so that if anything goes wrong we know who did what (electronic signature)".* **Respondent 4**: "*The research is needed for us, when everybody is on board, where a doctor can easily scroll through the system. Where there are challenges we should be able to face and work*".

Table 5.9.2: Responses to interview questions: rural hospitals/clinics

5.3.1.3.1 Summary of group interview responses

The group interviews gave an in-depth view on the research findings. The interview responses indicate respondents' views of e-health application systems and are as summarized as follows:

An e-patient health record system will:

- Save time in recording patient information, diagnosing and treatment of patients;
- Decrease time spent in searching for paperwork and patient record;
- Protect the confidentiality of patient information; and
- Help doctors, nurses and other healthcare professionals to access and capture real-time patient statistics.

An e-prescription system will:

- Save time for both patient and pharmacist when it comes to dispensing medicine; and
- Prevent errors in prescribing medication.

An e-referral system will:

- Save doctors' time at the referred hospital because doctors will not re-write patient clinical history as it is already in the system; and
- Assist in tracing and following up patients' progress from the referred hospital.

An e-consultation system will:

- Assist healthcare professionals to share professional ideas and advice

An e-training system will:

- Improve the ICT skills of healthcare professionals which will improve their job performance if the e-training is combined with face-to-face training.

In addition, the respondents indicated that if the e-health applications systems are installed in their hospitals/clinics, it will help solve some of their current needs such as:

- Improving their filing system to prevent the loss of files;
- Reducing long queues at OPD and pharmacy;
- Preventing patients from collecting medication from two or more hospitals/clinics within the same geographical area; and
- Improving communication.

However, the respondents indicated that the following problems may arise from or impact on the implementation of the e-health application systems in the rural hospitals/clinics:

- Inconsistent electricity supply;
- Lack of computers and virus infections;
- Inability to re-call prescription forms in case there is an error; and
- Lack of qualified personnel to capture the information onto the system.

The group interviews also revealed that there is a PAAB system in all the hospitals but not in the clinics. The PAAB system is used to support revenue collection and to keep patient demographic information but it is not used to capture patient clinical history or other records. In addition, the respondents suggested that the e-health applications if implemented would improve their work performance and assist them to deliver better healthcare services to their patients. The next section focuses on the questionnaire findings.

5.3.1.4 Questionnaire findings

To answer the first sub-research question (cf Table 5.1), the results from the questionnaire instrument which was administered to doctors, nurses and assistant nurses in the rural hospitals/clinics (*cf*. Appendix B) are summarized and presented in Table 5.10. The column on the left side of the table refers to the key operational areas and the questions that were asked. In the right side column are the summarized responses that were obtained from the respondents. The number of respondents was 42. The respondents were purposively selected based on their geographical area being "rural" and their profession, which were relevant to answer the research question. In this instance, two doctors, two nurses and two ward attendants were selected from each hospital/clinic.

Key operational areas and questions asked		Summarized responses from respondents of rural hospitals/clinics
General		
Q.1.2	Do you conduct your practice as a multidisciplinary clinical team?	Health professionals conduct their practice in a multidisciplinary group.
Q. 1.3	Do you need to share other patients' health records with other healthcare practitioners?	Yes, healthcare practitioners share patient files.
E-patient health record system		
Q. 2.1	What is the current system of creating patient health record?	Patient health records are created by hand (paper and file).
Q.2.2	What is the current system of maintaining patient health record?	By filling in new information by hand. Kept in a facility locker.
Q.2.3	Does each doctor create and maintain each patient's record or the records are centralized?	Patients' records (files) are centralized and kept in a locker.
Q.2.4	State the means of recording, e.g. hand-written, Dictaphone, transcription, word processor, etc)	Hand-written
Q.2.5	State staff responsible for recording	Clerks at the Out Patient Department (OPD) - when patients first come to the hospital/clinic. Doctors and nurses who the patients contact for consultation put information in the patients' file.
Q.2.6	State the standard format for collecting patient information (e.g. a form, minimum fields for clinical notes, etc).	Different types of forms, including a case history sheet are used where patients are verbally asked questions and the clerks write the information down which are kept in the patient file and stored in the record room.
Q.2.7	State the average time spent on the maintenance of patient health records per day.	An average time of 30-40 minutes.
Q.3.1	Where are the patients' health records kept? (e.g. registry,	Files are kept at the registry and later transferred to the records room.

	records room, etc).	
Q.3.2	What is the current procedure for the storage and retrieval of a patient health record? (e.g. means of storage - locked/unlocked filing cabinets, cupboards etc).	Put in a filing cabinet or cupboards locked and kept in a record room where the door is always kept locked.
Q.3.3	What is the standard format for storage? (e.g. alphabetically or date wise, number of copies, security, etc).	Stored alphabetically as well as dates and numbers
Q.3.4	Accessibility (staff with authorized access to patient records e.g. physicians and assistants such as nurses). Please, state.	Record office clerks, doctors and authorized nurses, who use patient files. The files are accessible only during working hours. In emergency situations it can be accessed during night and over the weekend.
Q.3.5	What is the average time for retrieving a patient's record?	An average of about 15-20 minutes.
Q.4	In your opinion does the current patient health record system provide a complete and accurate patient health record?	A higher percentage of respondents (N=42) said no citing that accessibility is difficult because there is no staff to do it. Accessibility on admission is irregular-sometimes there is no staff to retrieve the file on admission. Struggling to retrieve a file on follow ups. At times the file is missing: "sometimes patients are admitted and discharged without a file and staff struggle to make out the file on discharge".
Q.5	Is the format and quality of the patient health record satisfactory for effective sharing of patient information between healthcare professionals?	No - because of individuals' handwriting, this may be poor and difficult to read. Mistakes in the filing system. Loss of patient information. No confidentiality is ensured.
Q.6	Does the current patient health record system provide optimal	

	cost effectiveness and efficiency of healthcare service delivery in allowing:	
Q.6.1	Optimal/minimal time for creating and retrieving relevant patient health record? Yes/No Please give a reason for your choice.	No - because of the volume of paper and file used every month. No - because patients' files are sometimes misplaced or lost and you need to spend a lot of time to look for it.
Q.6.2	Minimal time for diagnosis and treatment? Yes / No Please give a reason for your choice	No - patient will be in the unit without a file for a long time without being admitted
Q.6.3	Confidentiality of patient health record? Yes/No Please give a reason for your choice	No - because there is no code for access everybody can get access to it
Q7	What are the main limitations/drawbacks of the current system of:	
Q.7.1	Creating patient health record?	Time consuming, correctness of information and lost files. Sometimes stationary is out of stock. Records are only accessible from 07hrs to 22hrs.
Q.7.2	Maintaining patient health record?	Small space to keep records; records are lost. Files sometimes get lost when used in wards and never come back to the storage room.
Q.7.3	Storing patient health record?	Unlocked cupboard poses security problem. Limited space to store files.
Q.7.4	Retrieving patient health record?	Difficult to find file after an extended period. Time consuming. Records staff are unavailable after hours to help retrieve patient file.
Determination of e-consultation, e-prescription and e-referrals		
Q.8	What is the current system of consultation between physicians and patients?	Face to face and sometimes electronic means.

Q.8.1	If electronic means, mark the medium/media (Mark more than one if applicable)	Telephones and e-mail.
Q.9	What is the current system of consultation between physicians and physicians:	
Q. 9.1	Within the hospital/clinic?	Face-to-face referral letters, electronic means and telephones
Q.9.1.1	If electronic means, mark the medium/ media (Mark more than one if applicable)	E-mail, telephones and cell phones.
Q.9.2	With other hospitals/clinics	Face-to-face, e-mails, referral letters and cell phones.
Q.9.2.1	If electronic means, mark the medium/media (Mark more than one if applicable)	e-mails and cell phones
Q.10	Does your hospital/clinic have telemedicine facility? Yes/No If yes, describe how it is used.	Telemedicine facility available only at Taung Hospital but not operational. No telemedicine facility in all the other rural hospitals/clinics.
Q.11	What method is used for referrals of patients to the pharmacy department for collection of medicine? (e.g. given paper prescription or electronic transfer of prescribed medicine). Please, indicate.	Patients are given paper prescription to the pharmacy.
Q.12	In your point of view, what are the advantages and disadvantages of the current system of referrals of patients to the pharmacy department for the collection of medicine in your hospital/clinic?	Advantage: Pharmacist explains medication dosage to patient face-to-face.
Determination of training opportunities		

Q13	How often do you use a personal computer? Please, mark with X.	About 60% indicates that they have never used the computer, while 20% indicated that they use it daily. The remaining 20 % use it weekly or monthly.
Q.13.1	For what purpose(s) do you use the computer? Please, specify	For Internet, compiling statistics, typing and capturing patient reports and information.
Q.14	How does your access or lack of access to a computer and Internet impact on your daily work? Please indicate	No direct impact on majority of work as most of the work is paper based. Those who capture patient information feel the lack of computer usage impacts on their daily work.
Q.15	How many hours do you spend on your computer per day? Indicate below.	Many say they have no time to spend on computers or Internet. Those who use it often spend an average of about 4 hours a day
Q. 16	How will you rate your knowledge of computer usage? Mark with X.	46% novice, 42% average and 12% experienced.
Q 16.1	Have you ever had any training or direct experience in using e-health record system? Yes/No If yes, please give details of the type of training received or your experience in using e-health record system	95% have no training while 5% have received training.
Q.17	Do you think you need training for the use of an e-health record system or any other system? Yes/No. If yes, indicate which system and how much time you will prefer to spend for this training?	98 % indicated that they will need training in the use of computers and e-health applications and they will like to spend time on any e-health application that is implemented.
Q.18	Do you have any other comments or recommendations? Please, indicate in the space below.	People will need training in the use of computers and e-health record system: "If the e-system can be in the place it will help the patient not to delay on their treatment", "If implemented now it will

		help in the diagnosing a patient without any delay”, “If all personnel can have an access for computer training, it will be much better and safe time”.

Table 5.10: Questionnaire responses: rural hospitals/clinics

5.3.1.4.1 Summary of questionnaire findings

This section presents a summary of the questionnaire findings as indicated by the responses for rural hospitals/clinics. The summary is presented according to the key headings as listed in Table 5.10, namely, general, e-patient health record, e-consultation, e-prescription, e-referrals, and e-training opportunities.

- **General**

According to the general information provided by respondents and summarized in Table 5.10, general practitioners (doctors) and other healthcare professionals in rural hospitals/clinics work in multidisciplinary teams and always share the patient information kept in the patients’ files.

- **E-patient health record system**

According to the responses indicated in Table 5.10, there is no e-patient health record system in all the rural hospitals/clinics. Patient records are hand-written on paper and hand-filed. The information created is used by doctors and other healthcare professionals in the hospitals/clinics. The files (which contain patients’ records) are kept in filing cabinets and locked in a record room .All the cabinets containing the files are centralized in a storage room. The files are arranged in alphabetical order. Therefore, retrieving and maintaining the patient file when the patient revisits the hospital/clinic makes it difficult and time consuming due to the large volumes of files in the storage room.

- **E-consultation, e-referrals and e-prescription**

The data presented in Table 5.10 indicates that the current system of consultation between healthcare professionals in rural hospitals/clinics are mainly through face-to-face consultation, referral letters, telephones and e-mails. The e-mails are often used by the physicians in the hospitals and not the healthcare professionals in the clinics because there is no Internet connection in these clinics. Doctors reduce face-to-face contacts by calling colleagues at other hospitals to seek advice. However, junior doctors, especially those placed at rural hospitals for the first time have fewer personal contacts at other hospitals; therefore, making telephone and e-mail contacts are uncomfortable. There are no e-referral and e-prescription systems in the rural hospitals/clinics. Patients are given a paper prescription to the pharmacy. When a case has to be referred to another department in the same hospital, this referral is done on paper and the patient goes to that department with a referral letter. When a serious but non-emergency case cannot be treated locally and has to be referred up the referral chain, the doctors typically give the patient a paper slip with a few notes. The receiving doctors find that when patients arrive with referral forms or letter, there is generally not enough information and the doctor must rebuild the clinical history by talking to the patient.

- **E-training opportunities**

The frequency of computer usage of the respondents was assessed to determine if e-training opportunities will be necessary to enhance the basic computer skills of the healthcare professionals. It was found that 60% have never used a computer or the Internet before, while 20% indicated that they use a computer or the Internet daily. The remaining 20% use it weekly or monthly. Figure 5.11 illustrates this.

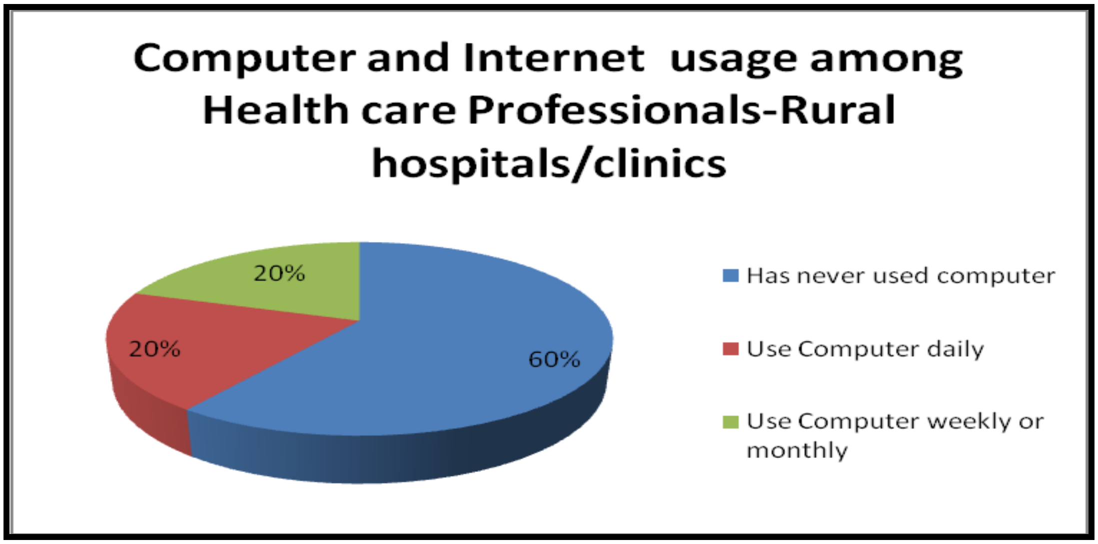


Figure 5.11: Computer and Internet usage among healthcare professionals

Figure 5.11 demonstrates that the majority of the healthcare professionals in rural hospitals/clinics are computer illiterate. When those with computer skills were asked to rate their knowledge in computer usage, 46% said they were novice, 42% were average and only 12% stated that they were experienced. This is further depicted in Figure 5.12 below.

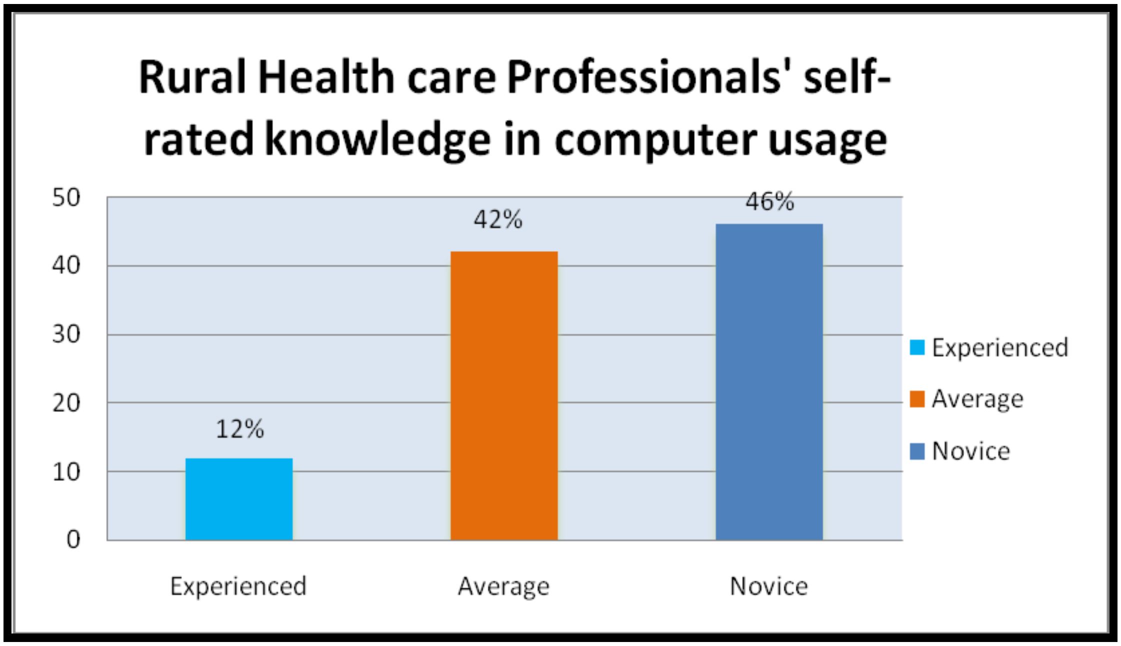


Figure 5.12: Rural healthcare professionals' Knowledge in computer usage

Furthermore, the healthcare professionals indicated that they have no experience in using e-health applications such as e-health patient record systems. Almost 95% have no training in e-health application usage and therefore, indicated their willingness to learn any e-health application which is put in place. However, the respondents were not positive to have the training entirely on the computer or through the web, but for it to be combined with face-to-face training.

The next section provides a summary and interpretation for sub-research question 1.

5.3.1.5 Interpretation for sub-research question 1

This section presents a thematic analysis across all the cases by considering the summarized responses from the interviews and the questionnaires for all the rural hospitals/clinics. Creswell (2007) refers to this form of analysis as cross-case analysis. Stake (1995) and Yin (2003) indicate that in cross-case analysis, the researcher investigates more than one case to examine themes across the various cases in order to discern themes that are common to all the various cases. In the analysis of the e-health readiness assessment results, the common themes found in all the rural hospitals/clinics through the interviews and the questionnaires which answer sub-research question 1 are stated as follows:

- **Shortage of healthcare professionals in rural hospitals/clinics**

The findings from the interviews and questionnaires indicate that there is a widespread shortage of doctors in the rural hospitals/clinics in the North West Province, which results in a heavy workload for doctors. This problem is not peculiar to only the rural hospitals/clinics in the North West Province, but to both developing and developed nations as well (Liu *et al*., 2001). In a developed country like Canada, rural and small town dwellers have half as many doctors (1 per 1000) as their urban counterparts, and on average, have to travel five times the distance (10 km) to access these healthcare services (Liu *et al*., 2001). Therefore, the shortage of doctors in rural hospitals/clinics causes an increased need for e-health solutions in the rural hospitals/clinics. This can assist nurses and other non-professional caregivers to consult with doctors in urban hospitals for professional advice at the point of care. This leads to the next topic which is ICT availability, accessibility and training.

- **ICT availability, accessibility and training**

The findings reveal that there are few computers in many of the rural hospitals/clinics. The average ratio of doctor to number of computers in the rural hospitals is 1:3 while the average ratio is 1:1 in rural clinics. However, this does not reflect the use of computers as evidenced from the e-health readiness assessment done in the various hospitals/clinics. It was noted that there was no computer in the consultation rooms of the doctors and therefore, the doctors do not use computers for their clinical duties. Nurses and assistant nurses do not use computers for their clinical work. Computers are rather used by hospital/clinic administrative staff for patients' demographic information and revenue collection. This indicates that even though there are computers in the hospitals and clinics, they are used for activities which are not directly related to clinical work like e-patient health record keeping, e-consultation, e-prescription or e-referrals.

This challenge is compounded by the lack of computer equipment such as printers, photocopiers, fax machines and desktop and laptop computers in the consulting rooms and wards. Similarly, telephone lines are frequently down which results in poor Internet connectivity. Again there is constant interruption of electricity supply in these rural hospitals/clinics. This hinders the hospitals/clinics from using the Internet for their daily work. There is also a lack of prompt technical IT support and lack of basic ICT skills and training for the healthcare professionals. These findings confirm the report from the ITU (2009) which points out that the penetration levels of Internet users in developing nations are low, about 12.8% of the population (*cf.* Figure 2.3) as compared to developed nations. These challenges are clear indicators of the context within which the e-health framework is to be established and therefore, must be taken into account during the development of the framework

On the question of computer literacy, it was found that a large percentage of the healthcare professionals do not have the basic skills in computer usage and, therefore, need training. The ITU (2009) states that computer literacy is important and users must be familiar not only with the use of computers and pertinent software products but also the benefits and potential uses of the Internet and the World Wide Web. Respondents indicated that when e-training is to be offered it must be combined with face-to face-training.

- **E-health solutions: availability and accessibility**

The e-health solutions discussed in this research study include e-patient health record systems, e-consultation systems, e-prescription systems, e-referral systems and e-training systems. The findings indicate that none of these systems is installed in any of the rural hospitals/clinics that were studied. However, there is a PAAB system in all the rural hospitals (but not the clinics) which is used to support revenue collection and the keeping of patient demographic information. However, it is not used for keeping the patient clinical history. Moreover, the PAAB system is a non-interactive website where its main function is to disseminate information, in this case revenue collection and patient demographic information to the North West Health Department.

Considering the functionality of the PAAB system and the non existence of any other e-health solution in all these rural hospitals/clinics, these rural hospitals/clinics can therefore, be placed at “presence level” on the E-Health and E-Care Maturity Model (*cf* Figure 3.15). The presence level on the E-Health and E-Care Maturity Model corresponds to level 0. According to the E-health and E-Care Maturity Model (Ilia, 2006), level 0 means that there are ICT facilities and Internet which are non-interactive sites but are used to disseminate information. However, the e-health requirements that are needed by the healthcare professionals in rural hospitals/clinics go beyond non-interactive sites such as the PAAB system; as indicated by the respondents in their responses to the interview questions (*cf* Table 5.10.2). Silber (2003) states that one of the most important benefits of e-health solutions is to support the delivery of healthcare services which can be tailored to the needs of individual patients. Therefore, improving the maturity level of e-health applications in hospitals in order to promote effectiveness and efficiency is of great importance to this research study.

- **E-health applications: acceptance and perceived usefulness**

The healthcare professionals who are the users of e-health applications indicated their acceptance and perceived usefulness of the e-health application by stating, amongst others, that if e-patient health record systems were installed in their hospitals/clinics it would save time for recording patient information, diagnosing patients and in the treatment of patients. They also stated that e-prescription would prevent errors in prescribing medication and reduce long queues at the OPD and pharmacy. Again the healthcare professionals indicated that e-consultation systems would assist healthcare professionals to share professional ideas and advice.

This finding is an indication of acceptance of the e-health framework that will be developed for the hospitals/clinics in the North West Province. This is essential as community acceptance and ownership of any IT application for any community is important. Mclver and ODennel (2005) argue that community acceptance is necessary for technology assessment as communities may provide input into the design process. This implies that the technology assessment processes need to establish and maintain community partnerships from the period of inception to completion in order to facilitate a user-centered approach (*cf*. Section 3.9). The next section of this chapter presents the research findings from the urban hospitals/clinics.

5.3.2 Research findings: urban hospitals/clinics

5.3.2.1 Introduction

The preceding sections focus on the research findings from the rural hospitals/clinics. This section which constitutes part two of the research findings, deals with findings from the urban hospitals/clinics. These urban hospitals/clinics are listed in Table 5.11. This is followed by the description of each hospital/clinic. When the researcher went to the field to gather data, it was found that some of the hospitals/clinics have new names which are indicated in Table 5.11

NO	HOSPITAL/CLINIC	NEW NAME	LOCATION
1	Rustenburg Hospital(G)	Job Simankana Tabane Hospital	Bojanala Region
2	Classic House Clinic(I)	—	Bojanala Region
3	Klerksdorp Hospital(H)	Klerksdorp/Tshepong Hospital Complex	Central Region
4	Empilisweni Clinic (J)	—	Central Region

Table 5.11: List of urban hospitals/clinics

Each of these hospitals/clinics is described according to the following headings:

- Background/history of the hospital/clinic;
- Hospital infrastructure;
- ICT access level including ICT availability, accessibility and usability; and
- E-health applications including availability, accessibility and usability.

5.3.2.2 Description of hospitals/clinics

The sequence of the description of these urban hospitals/clinics follows the order in which they appear in Table 5.11. In this section the responses from the questionnaire instrument handed to hospital administrators (*cf* Appendix A) together with photographs taken at the time the data was gathered are used to describe the urban hospitals/clinics.

5.3.2.2.1 Rustenburg Hospital (G)

Background/history of the hospital

Rustenburg Hospital is situated in the Bojanala Region in the North West Province. The name of the hospital has recently been changed to Job Simankana Tabane Hospital. It is a district hospital and serves a population of about 1.9 million in the Rustenburg District. The size of the hospital is about 2km^2. The number of out-patient clients the hospital serves per day is about 1287. Figure 5.13 presents a photograph of the Job Simankana Tabane Hospital in Rustenburg.

Figure 5.13 Job Simankana Tabane Hospital (Rustenburg Hospital)

Hospital infrastructure

The hospital has well-constructed buildings with a clean environment. The hospital has sixteen general consultation rooms with eighty seven general practitioners (doctors) and seven specialist doctors. The hospital has 380 beds in both male and female wards and 10 beds in the Intensive Care Unit (ICU). The doctors in this hospital conduct their practice as a team. The hospital offers a wide range of services such as oncology, social, psychological, counseling, X-ray, dietetics, pharmacy and speech therapy services.

ICT access level including ICT availability, accessibility and usability

The ICT access level in relation to its availability, accessibility and usability in the Job Simankana Tabane Hospital is summarized as follows: There are 22 laptop computers, 95 desktop computers, 90 printers, two fax machines and three photocopiers. It was noted that the ratio of doctors to the number of computers in this hospital is about 1:1. However, the use of computers is not in line with this ratio, as gathered from the evidence obtained from the e-health readiness assessment done at the hospital. There were no computers in the doctors' consultation rooms, which means that doctors do not use computers for carrying out their clinical duties. The computers in the hospital operate on windows XP. There is an Internet connection in the hospital but not all the healthcare professionals have access to it.

The main purpose of the Internet connection is to link the administrators to the North West Health Department where patient demographic information is transferred monthly to the Provincial Health Department data base through the PAAB system. Moreover, there is a tele-radiography system which links the hospital to Klerksdorp Hospital and Mmabatho Hospital. This tele-radiography system is used to send X-rays and other images through the Internet to the two hospitals (i.e. Klerksdorp and Mmabatho Hospital). However, the Internet connectivity is slow and often down in the afternoons. There are TV based conference facilities.

E-health solutions including availability, accessibility and usability

The Job Simankana Tabane Hospital does not have any e-health application software for e-patient health records, e-consultation, e- prescription, e-referrals nor e-training in place. However, there is a PAAB system which is used to support revenue collection and patient administration by capturing patient demographical information and transmitting this information to the provincial data base on a monthly basis. Moreover, the tele-radiography system helps the hospital to send images to Klerksdorp and

Mmabatho District Hospitals but this system is hardly used because of slow internet connections. The tele-radiograpy is only limited to three hospitals in the whole province. The following section presents information on Classic House Clinic.

5.3.2.2.2 Classic House Clinic (I)

Background/history of the clinic

The Classic House Clinic is situated in Rustenburg in the Bojanala Region of the North West Province. It serves about 3000 patients per month. The clinic treats minor cases and refers any major case to the Rustenburg Job Simankana Tabane Hospital. Figure 5.14 below shows a photograph of the Classic House Clinic.

Figure 5.14: Classic House Clinic

Hospital infrastructure

The clinic has a well-constructed building with four consulting rooms for general practitioners (doctors) and two specialist consulting rooms. There are two general practitioners (doctors) who visit the clinic to attend to patients The clinic offers the following services: minor ailments services, ante-natal care, voluntary counseling and HIV testing, chronic disease management, immunization and well-baby service, cervical smear (pap smear), prevention of mother to child transmission of HIV, anti-retroviral screening, TB and other communicable diseases management, mental health and reproductive health services.

ICT access level including ICT availability, accessibility and usability

This clinic has one laptop and two desktop computers, one photocopier, a printer, a fax machine and two telephones. The two desktop computers are used by the hospital administrators for administrative purposes. If these computers were to be used by doctors, the ratio of doctors to the number of computers could have been 1:1. However, it was noted that there was no computer in their consultation rooms. Therefore, it means that doctors do not use computers for their clinical duties. The computers in the clinic operate on Windows XP. There is a telephone line in this clinic. The clinic has Internet connection and the PAAB system which allows it to send patient demographic information to the North West Health Department on monthly basis. However, there is no TV-based conference facility nor digitalized X-ray equipment in the clinic.

E-health solutions including availability, accessibility and usability

There is no e-health application in this clinic, although, there is a PAAB system which is used to support revenue collection and to send patient demographic information to the Provincial Health Department on a monthly basis. There are telephone lines and Internet connectivity but most of the time these lines are down on average, about two to three times per week. The next section focuses on Klerksdorp Hospital.

5.3.2.2.3 Klerksdorp Hospital (H)

Background/history of the hospital

The hospital is situated in the Central Region of the North West Province. The hospital is administered together with another hospital called Tshepong Hospital which is about

5km from Klerksdorp Hospital .The two hospitals together have been named the Klerksdorp/Tshepong Hospital Complex and are referred to as the East Wing and West Wing Hospital respectively. These two hospitals are under one administrator. Moreover, these hospitals are referral hospitals and serve about 4000 patients per week. Figure 5.15 presents the Klerksdorp Hospital where the research was conducted.

Figure 5.15: Klerksdorp Hospital

Hospital infrastructure

The hospital has well constructed buildings and a clean environment. It has 20 general consultation rooms with 104 general practitioners (doctors) and 31 specialist doctors. The hospital has 237 beds in nine general wards in the hospital and 112 beds in special wards. Doctors in this hospital conduct their practice as a team. The hospital offers a wide range of services such as pediatric services, maternity, gynaecology, neonatal, urology and ophthalmology. In addition, the hospital offers specialized services like oncology, renal dialysis, TB, high infectious diseases, X-ray, dietetics, pharmacy and speech therapy services.

ICT access level including ICT availability, accessibility and usability

The ICT equipment in this hospital outnumbers any found in the other hospitals that were studied. The ICT access level in the hospital can be seen in Table 5.12. There are 17 laptop computers, 200 desktop computers, 113 printers, two fax machines, nine photocopiers and two ISDN telephone lines. The ratio of doctors to the number of computers is 1:2 in this hospital. However, it was noted that there were no computers in their consultation rooms. This implies that doctors do not use computers for their daily routine clinical duties. The computers are rather used by hospital administrative staff for patients' demographic information and revenue collection. The computers operate on Windows XP. The hospital has TV-based conference facilities and digitalized X-ray equipment linked to seven computers in the hospital.

E-health solutions including availability, accessibility and usability

The hospital has tele-radiography which allows the hospital to send images to either Mmabatho Hospital or Rustenburg Hospital through the Internet. The hospital has a PAAB system. The PAAB system is used for patient administration by capturing patient personal and geographical information and transmitting this information to the provincial data base on a monthly basis. However, there is no e-patient health record system, e-consultation, e-prescription, e-referral or e-training system in the hospital. The next section reports on Empilisweni Clinic.

5.3.2.2.4 Empillisweni Clinic (J)

Background/history of the clinic

The Empilisweni Clinic is situated in Klerksdorp in the Central Region of the North West Province. It serves about 2500 patients per month. The clinic treats minor cases and refers any major case to Klerksdorp/Tshepong Hospital Complex. Figure 5.16 shows a photograph of the clinic.

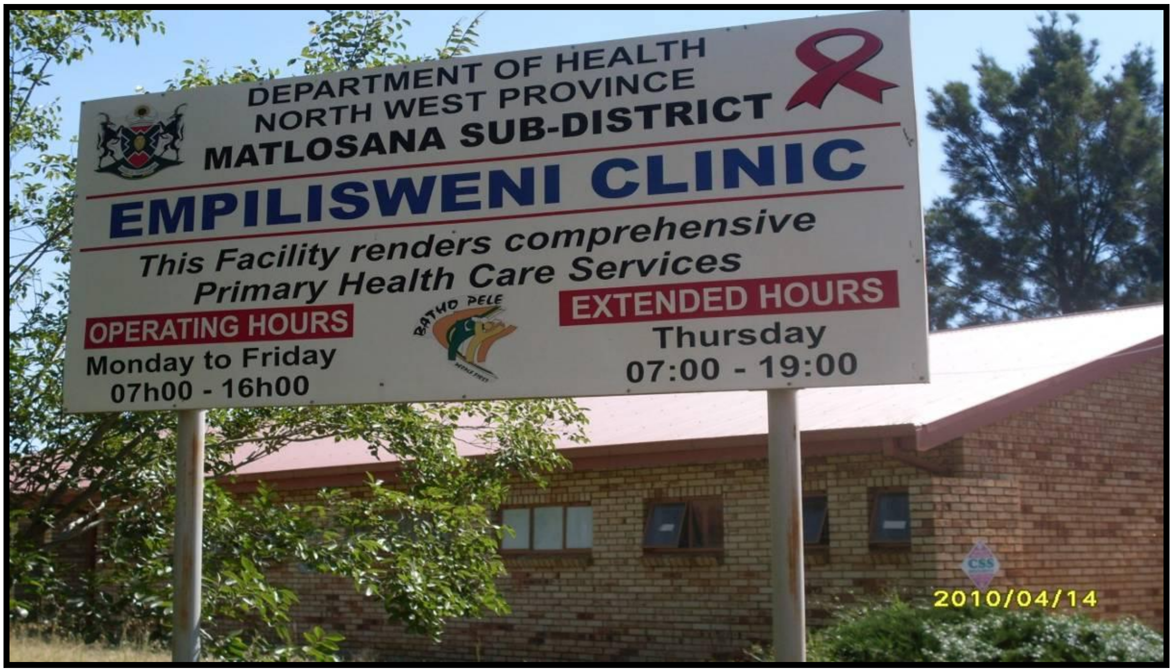


Figure 5.16: Empilisweni Clinic

Hospital infrastructure

The clinic has a well-constructed building with four consulting rooms. There is only one doctor who is assigned to the clinic. The other consulting rooms are used by sisters/nurses. The clinic offers a comprehensive primary healthcare program including, minor ailments services, ante-natal care, voluntary counseling and HIV testing, chronic disease management, immunizations and well-baby service, cervical smear (pap smear), prevention of mother to child HIV transmission, anti-retroviral screening, TB and other communicable diseases and mental and reproductive health services.

ICT access level including ICT availability, accessibility and usability

The clinic has one desktop computer, a photocopier, two telephones and an Internet connection. There is one printer and a fax machine. There is no laptop computer. The desktop computer operates on Windows XP. The ratio of doctor to the number of computers is 1:1, but the doctor does not use the computer for clinical purposes as evidenced from the e-health readiness assessment done in the clinic. It was noted that there was no computer in the consultation room. The desktop computer is used by the clinic administrator for administrative purposes. The desktop computer is linked to the Internet which allows the clinic to send patient demographic information to the North West Provincial Health Department on monthly basis. There are no TV-based conference facilities or digitalized X-ray equipment in the clinic.

E-health solutions including availability, accessibility and usability

There is no e-health application in this clinic. However, there are telephone lines and Internet connectivity but most of the time these lines are down for about two to three times per week. The next section gives a summary of the background/history of all the urban hospitals/clinics.

5.3.2.2.5 Summary of background/history of urban hospitals/clinics

The urban hospitals/clinics described have good building infrastructure and serve a high number of people in the communities in which they are located. Table 5.12 summarizes the ICT access level in relation to its availability, accessibility and usability in all the hospitals/clinics in the urban areas.

Hospitals		Rustenburg Hospital(G)		Classic House Clinic(I)		Klerksdorp Hospital(H)		Empilisweni Clinic (J)	
Indicators		Availability	Accessibility and Usability	Availability	Accessibility and Usability	Availability	Accessibility and Usability	Availability	Accessibility and Usability
Hardware	**1. Laptop computer(s)**	22 laptops but available to only administrators	Accessible to administrators but not frequently used.	1 laptop	For only one administrator	17 laptops but available to only administrator	Accessible to administrators but not frequently used.	None	None
	2. Desktop computer(s)	95 desktops	Located in the offices of the administrators.	2 desktops	Accessible	200 desktops	Located in the offices of the administrators.	1 desktop	Accessible to only one administrator
	3. Monitor(s)	95 monitors	Accessible to administrators	2 Monitors	Accessible	200 monitors	Accessible to administrators	1	Accessible
	4. Printer(s)	90 printers	Accessible	1 printer	Accessible	113 printers	Accessible	1 Printer	Accessible
	5. Document scanner/ fax	2	Accessible	1	Accessible	2	Accessible	1	Accessible
	6. Photocopier	3	Accessible	1	Accessible	9	Accessible	1	Accessible
	7. Telephone(s)	Available	Accessible and frequently used	Available	Accessible	Available with 2 ISDN lines	Accessible and frequently used	Available	Accessible
	8. TV based conferencing	1	Accessible used occasionally	None	None	1	Accessible used occasionally	None	None
	9. PC based conferencing	None	None	None	None	None	None	None	None
	10. Web cam connected	None	None	None	None	None	None	None	None
	11. Digitalized X-Ray Equipment	3 computers connected to digitalized X-ray equipment	Accessible to only X-ray department	None	None	7 computers connected to digitalized X-ray equipment	Accessible to only X-ray department	None	None
	12. High resolution digital cam monitored on a Microscope	None	None	None	None	None	None	None	None

Hospitals		Rustenburg Hospital(G		Classic House Clinic(I)		Klerksdorp Hospital(H)		Empilisweni Clinic (J)	
Indicators		Availability	Accessibility and Usability	Availability	Accessibility and Usability	Availability	Accessibility and Usability	Availability	Accessibility and Usability
Network	1. Internet access	Available	Accessible to only administrators	Available	Accessible to only administrators	Available	Accessible to only administrators	Available	Accessible to the only administrator who uses the PC
IT support Personnel	1. Provision of technical support	Available	Not always accessible	Available	Not always accessible	Available	Not always accessible	Available	Not always accessible
	2. Technical support personnel	Available	Not always accessible	Available	Not always accessible	Available	Not always accessible	Available	Not always accessible
Healthcare Professionals' IT experience	1. Frequency of using PC	Not often	Not often	Not often	Not often	Not often	Not often	Not often	Not often
	2.Frequency of using e-media	Seldom	None	None	None	Seldom	Not often	None	None
	3. Computer usage for E-Health	Tele-radiography and PAAB system	Accessible for sending images to Klerksdorp Hospital and Mmabatho Hospital. PAAB system-accessible only to OPD and accounts department	PAAB system	Accessible only to OPD and accounts department	Tele-radiography and PAAB system	Accessible for sending images to Job Simankana Tabane Hospital and Mmabatho Hospital. PAAB system-accessible only to OPD and accounts department	PAAB system	Accessible only to OPD and accounts department
	4. Training or direct experience in using e-health software	Not available and many staff members are computer illiterate	Not accessible	Not available and many staff members are computer illiterate	Not accessible	Not available and many staff members are computer illiterate	Not accessible	Not available and many staff members are computer illiterate	Not accessible

Table 5.12: Summary of ICT access level of urban hospitals/clinics

Table 5.12 reveals that both the urban hospitals and the urban clinics use the PAAB system. The hospitals, but not the clinics, have tele-radiography systems which enable them to send images such as X-rays to other hospitals. All the hospitals/clinics are faced with some challenges which are listed as follows:

- Lack of computer equipment such as desktop and laptop computers, printers, photocopiers and fax machines in consulting rooms and wards;
- Unreliable telephone services including frequent out of service telephone lines;
- Poor Internet connectivity;
- Lack of prompt technical IT support;
- Lack of basic ICT skills and training;
- Lack of e-health solutions like e-patient health records, e-consultation e-prescription and e-referrals; and
- A widespread shortage of doctors - (note that all the clinics do not have doctors – doctors from the hospitals visit the clinics at certain times).

Moreover, the clinics experience additional challenges such as:

- Heavy workload for doctors; and
- Constant interruption of electricity supply.

This means that both the hospitals and the clinics in the urban areas face a number of challenges, especially the clinics, in their pursuit of the implementation of e-health solutions as planned or proposed by the North West Department of Health. The following sections discuss the interview findings in the urban hospitals/clinics.

5.3.2.3 Group interview findings

This section presents the findings from the group interviews that were conducted in the urban hospitals/clinics. The participants (hospital administrators, doctors, nurses and ward attendants) who completed the questionnaires participated in the group interviews. The interview findings provide in-depth views to the research findings to answer sub-research question 1 (cf Section 5.2). Table 5.13.1 presents a summary of the responses from the respondents from the urban hospitals/clinics. The questions were aimed at establishing the acceptance level, perceived usefulness and the potential benefits that the hospitals/clinics would accrue if e-health applications are installed in these hospitals/clinics.

The responses to the various questions are summarized in Table 5.13.1. The key operational areas and the interview questions are listed in the left column, whilst the summarized responses with some direct quotations from respondents are recorded in the right column.

Key operational areas and interview questions		**Summarized responses with some direct quotations**
Q1. What benefits will you expect if the following e-health applications were installed in your hospital/clinic?		
	E-patient health record system	It will save time for recording patient information, diagnosing and treatment of patients. It will protect the confidentiality of patient information. **Respondent 1**: "*EPHR will save time because people will follow systematic way of recording and retrieving information will be much easier therefore saving time".* **Respondent 2**: *"Old patients who do not get their records after a long time, the EPHR will help to safe guard this information making retrieval of patient information quicker and time saving."* **Respondent 3:** *"As there are too many files stored, the EPHR will save time to retrieve a file instead of going through the whole bunch of files".*
	E-consultation system	It will improve work efficiency because colleagues can obtain quick advice from other colleagues during diagnoses and treatment of patients. **Respondent 1:** "*It will improve efficiency, doctors will be able to consult quicker for advice,*

		therefore saving time at job place". **Respondent 2**: *"Save time and money because doctors will not travel to other hospitals or departments in the same hospital to consult their supervisors for advice or directives"*.
	E-prescription system	It will save time in dispensing medication and prevent errors. **Respondent 1**: "*Before patients arrives at the pharmacy, the pharmacist has the information before the patient arrives so the pharmacy will have chance to pack treatment, in this instance it will save time"* **Respondent 2**: "*Save time by trying to read the difficult handwriting of doctors at the pharmacy".* **Respondent 3**: "*It will avoid lost of prescription notes given to patients to collect medicine from pharmacy*"
	E- referrals system	It will save time because doctors at the referred hospital will not re-write patient clinical history as it is already on the system. It will assist to trace and follow up patient progress from the referred hospital. **Respondent 1**: "*Before the patient arrives at the referred hospital, the doctor knows what type of patient is coming and prepare for his arrival*". **Respondent 2**: "*It will save time because the doctor at the referred hospital will not start afresh to start with diagnoses*." **Respondent 3:** "*It will help because you refer them on the way they get lost or they don't go. If it is done electronically then the referred hospital*

		will know that as such and surely a day we are expecting this person. They will do to follow up to find out if the person did not go".
	E-training system	It will improve our skills which will further improve our job performance if the e-training is combined with face-to-face training. **Respondent 1:**"It *will save time if done face-to-face at first and later use the e-training to support it or use the e-training for reference"*.

Table 5.13.1: Group interview findings: urban hospitals/clinics

Apart from question 1, other questions were asked during the group interview session. The summarized responses from the respondents with some direct quotations are presented in Table 5.13.2. The key operational areas and the questions are listed in the left column whilst the summarized responses with some direct quotations from respondents are presented in the right column.

Key operational areas and interview questions		**Summarized responses with some direct quotations**
Current hospital/clinic's e-health problems		
Q.2	If any of the above systems was implemented at your local hospital/clinic, what will be your personal expectations in terms of solving some of the current problems the hospital/clinic is faced with, or improving the quality of healthcare services provided? Name such a system and explain your expectations	**E-patient health record system** - Improve the filing system and prevent loss of files. **Respondent 1:** "*A lot of document will be kept safe and files can be retrieved after so many years 10 years back"* **E-prescription system -** Improve communication and help eliminate patients who collect medication from two or three hospitals/clinics at the same time **Respondent 2:** "*Those with fake ID's can be found. Can trace patient especially if the patient wants to move from one clinic to another clinic to collect medicines from all these clinics".* **E-patient health record system** and **E-**

		prescription system - Reduce long queues at OPD and pharmacy **Respondent 3:** *“Long queue will be shortened because time for retrieving the patient information will be short. Place of filing will be reduced”.* **(All categories/systems)** Reduce cost **Respondent 4:** “*It will cut down cost; money spent on stationery will be reduced*”.
Anticipated problems		
Q.3	What problems do you anticipate that may arise from the implementation and use of such a system? Name the system and state the anticipated problem.	**All systems** - **Inconsistent electricity supply and confidentiality of patient records** **Respondent 1*:*** *Lack of constant supply of electricity. Problem of confidentiality of information.* Lack of education and efficient human resource. **Respondent 2:** *“System being a liability because of low level of education of rural workers. Lack of efficient human resource. Slow internet speed”.* **All systems** - Financial constraints **Respondent 3:** *“Financial constraints with regard equipment”.*
Basic e-health technologies available		
Q.4	What basic technologies do you currently have in your hospital/clinic that support e-health application? Name any that you know of.	**PAAB system** **Respondent 1:** *“we have in the administration system is called PAAB system, that system does not help us 100% of the patient, it only help us in the tracing of the information. - But when the information is lost, that is where we experience a problem. - But now the system only record the history background of the patient, not anything that has to do with the diagnosis of the patient”.* **Tele-radiography** **Respondent 2:** *“We have tele-radiology, linked to only 3 regional hospitals*”.

Need for training		
Q5	Will you like to have further training in computer usage to enhance your job performance?	**Yes, we need further training**. **Respondent 1***: “We need training because we are not optimizing”.* **Respondent 2**: “Yes, all. *To be able to fix small problem when technicians are not here”.*
Access e-health application outside work		
Q.6	Will you like to access e-health application outside your work environment?	**The majority of respondents indicated that they will like to access e-health applications outside work.** **Respondent 1:** “*I will definitely want to know on daily basis how many patients came in- at which cost.”* **Respondent 2:** “*To check on my patients who fall out of that, or are there anyone who died a natural death and to pick up early warning*.*”*
Suggestions and comments		
Q.7	Is there anything else you will like to suggest, recommend or comment on?	**Suggestions and comments from respondents** 1. These are needed – powerful servers, more computers and better security and medical secretaries for doctors. 2. Pilot before implementation 3. It will save time and money **Respondent 1:** “*If we want to achieve this we need big servers*”. **Respondent 2:** “*We need more computers and security must be good”.* **Respondent 3:** “*Use big hospitals for your pilot implementation*” **Respondent 4:** “*It will save us a lot of money. -A lot of time will be saved*”. **Respondent 5:** “*There should be Medical secretary who will type what the doctor is diagnosing, so by the time the doctor finishes with all the examination information is on the system*”.

Table 5.13.2: Group Interview findings: urban hospitals/clinics

5.3.2.3.1 Summary of group interview findings

The group interviews elicited in-depth information from the respondents from urban hospitals/clinics. The responses indicate the respondents' belief that if these e-health applications or systems are installed in these hospitals/clinics:

An e-patient health record system will:

- Save time for recording patient information, diagnosing and in the treatment of patients;
- Improve communication and help eliminate patients who collect medication from multiple hospitals/clinics at the same time; and
- Protect the confidentiality of patient information.

An e-consultation system will:

- Improve work efficiency because colleagues can obtain quick advice from other colleagues during diagnoses and treatment of patients

An e-prescription system will:

- Save time for both the patient and pharmacist when it comes to dispensing medicine; and
- Prevent errors by pharmacists when dispensing prescribed medication.

An e-referral system will:

- Save the time of doctors at the referred hospital because they will not re-write patient clinical history as it will already be on the system; and
- Assist to trace and follow up patient's progress from the referred hospital.

An e-training system will:

- Improve the ICT skills of healthcare professionals; and

- Further improve job performance if the e-training is combined with face-to-face training.

In addition, the respondents indicated that if e-health applications are installed in their hospitals/clinics, they will help solve some of their current needs such as:

- Improve their filing system to prevent loss of old files;
- Reduce long queues at OPD and pharmacy;
- Improve communication;
- Reduce travelling cost;
- Save time for healthcare professionals who have to consult their supervisors for advice.

However, the respondents stated the following problems that may arise from or impact on the implementation of the e-health systems in urban hospitals/clinics:

- Inconsistent electricity supply; and
- Lack of computers and virus infections

The group interviews further reveal that the Klerksdorp Hospital and Rustenburg Hospital have tele-radiography where images like X-rays are sent electronically between these hospitals. Moreover, there is a PAAB system in all the hospitals/clinics and this PAAB system is used to support revenue collection and the keeping of patient demographic information but not clinical history.

Respondents further commented that the e-health applications, if implemented, will improve their work performance and assist them to deliver better healthcare services to their patients. In addition, the respondents suggested that medical secretaries will be able to assist the doctors to capture information related to the diagnosis directly on the e-patient health record. The next section elaborates on the questionnaire findings.

5.3.2.4 Questionnaire findings

This section discusses the findings of the questionnaires that were administered to the doctors, nurses and the ward assistants in the urban hospitals/clinics (*cf* Appendix B).

The questionnaire findings for the urban hospitals/clinics are summarized and presented in Table 5.14. The column on the left side represents the key operational areas and questions that were asked whilst the column on the right side presents the summarized responses that were obtained from the respondents.

Question 1.1 on the questionnaire seeks/requests information on the role of each of the participants in the hospital/clinic.

Key operational areas and questions asked		**Summarized responses from respondents**
General		
Q. 1.2	Do you conduct your practice as a multidisciplinary clinical team?	Healthcare professionals conduct their practice in a multi-disciplinary group
Q. 1.3	Do you need to share patients' health records with other healthcare practitioners?	Yes, healthcare professionals share patients' health records/files.
E-patient health record system		
Q. 2.1	What is the current system of creating patient health record?	1. Manual - hand-written using paper and pen and keeping them in files. 2. Electronic - using PAAB to capture patient demographics.
Q.2.2	What is the current system of maintaining patient health record?	By filling in new information by hand. Kept in a facility locker.
Q.2.3	Does each doctor create and maintain each patient's record or the records are centralized?	Patients' records are centralized.
Q.2.4	State the means of recording (e.g. hand-written, Dictaphone, transcription, word processor, etc).	Hand-written
Q.2.5	State staff responsible for recording patient health record	Clerks at the OPD when patients first come to the hospital, physicians and nurses.
Q.2.6	State the standard format for collecting patient information (e.g. a form, minimum fields for clinical notes, etc).	Format varies depending on the medical domain. In all domains forms are used. At OPD demographic information is captured. In the consulting rooms medical history is recorded.
Q.2.7	State the average time spent on the maintenance of patient health record per day.	An average time of 20-35 minutes.

Q.3.1	Where is the patients' health records kept? (e.g. registry, records room etc).	Records room and later transferred to archive room.
Q.3.2	What is the current procedure for the storage and retrieval of patient health record? e.g. means of storage - locked/unlocked filing cabinets, cupboards etc).	Unlocked cabinet but locked filing room.
Q.3.3	What is the standard format for storage? (e.g. alphabetically or date wise, number of copies, security, etc).	Date of birth and alphabetically.
Q.3.4	Accessibility (staff with authorized access to patient records e.g. physicians, and assistants such as nurses). Please, state.	Doctors, nurses, administrators and all other healthcare professionals.
Q.3.5	What is the average time for retrieving a patient's record?	An average of about 15 -20 minutes
Q.4	In your opinion, does the current patient health record system provide a complete and accurate patient health record?	No - due to constant loss of files; there is always duplication of files where information is fragmented in each duplicated file.
Q.5	Is the format and quality of patient health record satisfactory for effective sharing of patient information between healthcare professionals?	Yes - because there is a physician's document in the patient health record as well as the nurse's document. All information is included in the file.
Q.6	Does the current patient health record system provide optimal cost effectiveness and efficiency of healthcare service delivery in allowing:	
Q.6.1	Optimal/minimal time for creating and retrieving relevant patient health record? Yes/No. Please give a reason for your choice	No: 1. because of the volume of paper and files used every month. 2. Because patients' files are sometimes misplaced or lost and you need to spend a lot of time to look for them.
Q.6.2	Minimal time for diagnosis and	No, a patient will be in the unit without a file for a long

	treatment? Yes/No. Please give a reason for your choice.	time without being admitted.
Q.6.3	Confidentiality of patient health record? Yes/No. Please give a reason for your choice	No, because every healthcare worker can have access as files are always at patient's bedside and are kept in unlocked cabinets
Q7	What are the main limitations/drawbacks of the current system of:	
Q.7.1	Creating patient health record?	Spend too much time to create a patient file. Labor intensive.
Q.7.2	Maintaining patient health record?	Small space to keep records. Records are lost. When used in wards, sometimes files get lost and never come back to the storage room.
Q.7.3	Storing patient health record?	Not secured, Limited space because of old files. No confidentiality.
Q.7.4	Retrieving patient health record?	Always a problem and therefore delays in retrieving patient health record. A lot of time is needed to pull out a patient's file among many files.
Determination of e-consultation, e-prescription and e-referrals		
Q.8	What is the current system of consultation between physicians and patients?	Face-to-face.
Q.8.1	If electronic means, mark the medium/media (Mark more than one if applicable)	Telephone.
Q.9	What is the current system of consultation between physicians and physicians:	
Q. 9.1	Within the hospital/clinic?	Face-to-face, referral letters, electronic means and telephones.
Q.9.1.1	If electronic means, mark the medium/ media (Mark more than one if applicable).	E-mail, telephones, cell phones.
Q.9.2	With other hospitals/clinics.	Face-to-face, e-mails, referral letters, cell phones
Q.9.2.1	If electronic means, mark the medium/media (Mark more than one	e-mails

	if applicable).	
Q.10	Does your hospital/clinic have telemedicine facility? Yes/No. If yes, describe how it is used.	Tele-radiography in 3 main hospitals: Klerksdorp, Rustenburg and Mmabatho. Radiology- images are sent to distant office where specialist can assess and reprint them.
Q.11	What method is used for referrals of patients to the pharmacy department for collection of medicine? (e.g. given paper prescription or electronic transfer of prescribed medicine). Please, indicate.	Paper based prescription. Patients are given paper prescription to the pharmacy.
Q.12	In your point of view, what are the advantages and disadvantages of the current system of referrals of patients to the pharmacy department for the collection of medicine in your hospital?	Prescription forms are kept with the rest of the records Pharmacy can confirm the authenticity of the prescription. Illegible handwriting delays prescription.
Determination of training opportunities		
Q13	How often do you use a personal computer? Please, mark with X.	About 41% indicates that they have never used the computer, while 47% indicated that they use it daily. The remaining 12 % use it weekly or monthly.
Q.13.1	For what purpose(s) do you use the computer? Please, specify	Communication, presentations, e-mails, report writing
Q.14	How does your access or lack of access to a computer and Internet impact on your daily work? Please, indicate below	Limits communication with other healthcare professionals and head office. Those that capture patient information feel the lack of computer usage impacts on their daily work.
Q.15	How many hours do you spend on your computer per day? Indicate below.	Average of 2.5 hours for those who use computers.. Those who use it for capturing patient demographic information spend an average of 8 hours per day on it.
Q. 16	How will you rate your knowledge of computer usage? Mark with X.	29% novice; 59% average and 12% experienced.
Q 16.1	Have you ever had any training or direct experience in using e-health record system? Yes/No. If yes, please give details of the type of training received or your experience in using	98% have no training whilst 2% have received training.

	e-health record system.	
Q.17	Do you think you need training for the use of e-health record system or any other system? Yes/No. If yes, indicate which system and how much time you will prefer to spend for this training?	99 % indicated that they will need training in the use of computers and e-health applications and would like to spend 2 hours per day for 6 months on any e-health application that is implemented.
Q.18	Do you have any other comments or recommendations? Please, indicate in the space below.	Confidentiality and security of medical records are the main concern; safety would have to be very good. This is against hackers, etc.

Table 5.14: Questionnaire findings: urban hospitals/clinics

5.3.2.4.1 Summary of questionnaire findings

The summary of the responses obtained from the doctors, nurses and assistant nurses in the urban hospitals/clinics are indicated below.

- **General**

Doctors and other health professionals work in multidisciplinary teams in all the urban hospitals/clinics and always share the information which is kept in the file of the patient.

- **E-patient health record system**

There is no e-patient health record system in any of the urban hospitals or clinics. However, there is a PAAB system in all these urban hospitals/clinics which is used for capturing and transmitting patient demographic information to the Health Department of the North West Province. Moreover, two major hospitals (Klerksdorp Hospital and Rustenburg Hospital) have tele-radiography systems which are used to send images like X-ray images to other hospitals.

There is no e-patient health record system in any of these urban hospitals/clinics, therefore, patient information or records are written by hand using paper and file. The information created is used by doctors and other healthcare professionals to offer healthcare services to the patients. At the end of the working day, the patients' files which were created are stored in a filing cabinet and locked in a record room. All the cabinets containing patient files are centralized in a storage room. These files are arranged according to alphabetical order and the dates they were created to facilitate easy retrieval and maintenance when the patients revisit the hospital/clinic. However, it becomes difficult and time consuming to retrieve patient files due to the large volumes of current and old files stored in the records room.

- **E-consultation system**

The e-consultation referred to in this research study means e-consultation between doctor to doctor remote consultation, a nurse and a doctor consultation, and a doctor and a specialist consultation (*cf* Section 2.9.1). The current system of consultation between these healthcare professionals in the urban hospitals/clinics is mainly through face-to-face, consultation referral letters, telephones and e-mails. The e-mails which are used by the hospital administrators and doctors in the urban hospitals/clinics sometimes fail due to poor Internet connectivity.

- **E-referrals and e-prescription**

There are no e-referral or e-prescription systems in the urban hospitals/clinics. Referrals within the hospitals/clinics are done through the use of paper. When a patient is referred to another department within the same hospital/clinic, such as the pharmacy, the referring doctor/nurse gives the patient a prescription note to the pharmacy to collect his or her medication. Respondents indicated that sometimes the pharmacists find it difficult to read the handwriting of doctors and this can lead to serious consequences, i.e. dispensing wrong medication to patients. Patients also have to wait in long queues for pharmacists to prepare the medication for them.

Referrals where the patient has to go outside the hospital/clinic are paper-based. The clinics refer cases which they cannot handle to the hospitals which offer specialized treatment. The structure of the North West provincial health system follows the conventional three tier service delivery process found in many parts of the world.

- **E-training**
-

The frequency of computer and Internet usage by healthcare professionals in urban hospitals/clinics was assessed to determine if e-health training opportunities will be necessary to enhance the computer skills of the health professionals. It was found that 41% of the healthcare professionals have never used a computer or the Internet before, while 47% indicated that they use computers and the Internet daily. The remaining 12% use it weekly or monthly. The pie chart in Figure 5.17 explains further.

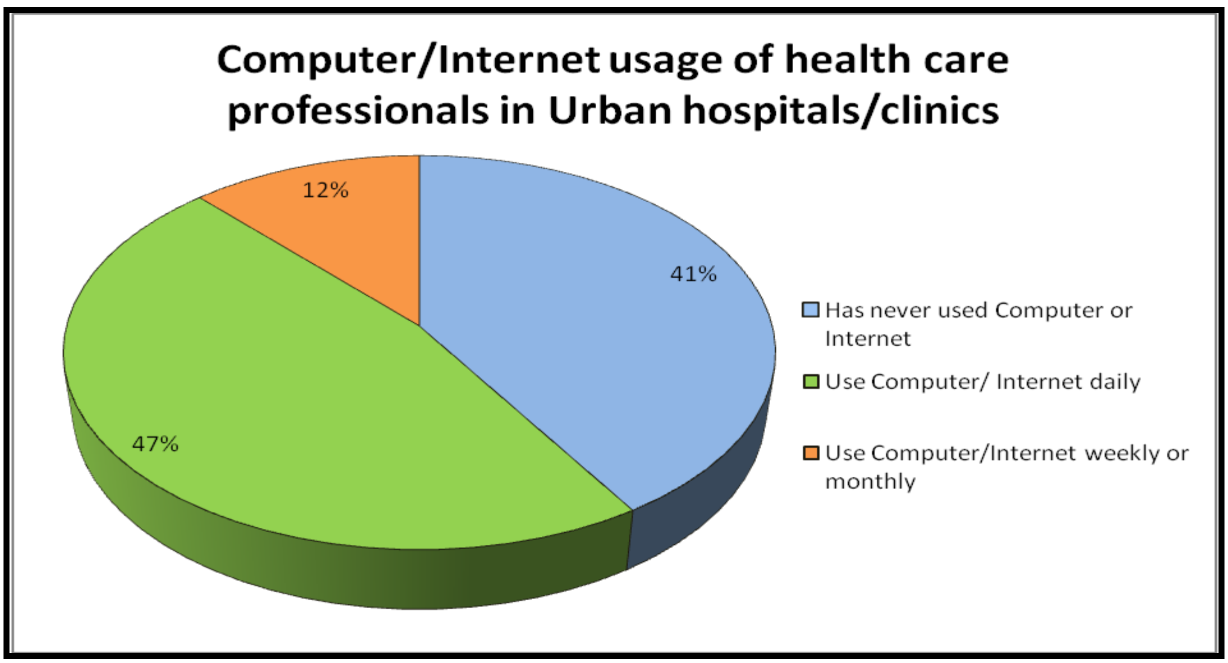


Figure 5.17: Computer/Internet usage: urban hospitals/clinics

The pie chart illustrated in Figure 5.17 indicates that 59% of the healthcare professionals in urban hospitals/clinics are computer literate. When those who are computer literate were asked to rate their knowledge in computer usage, 29% said they were novice, 59% indicated average whilst 12% stated that they were experienced. This is illustrated in Figure 5.18.

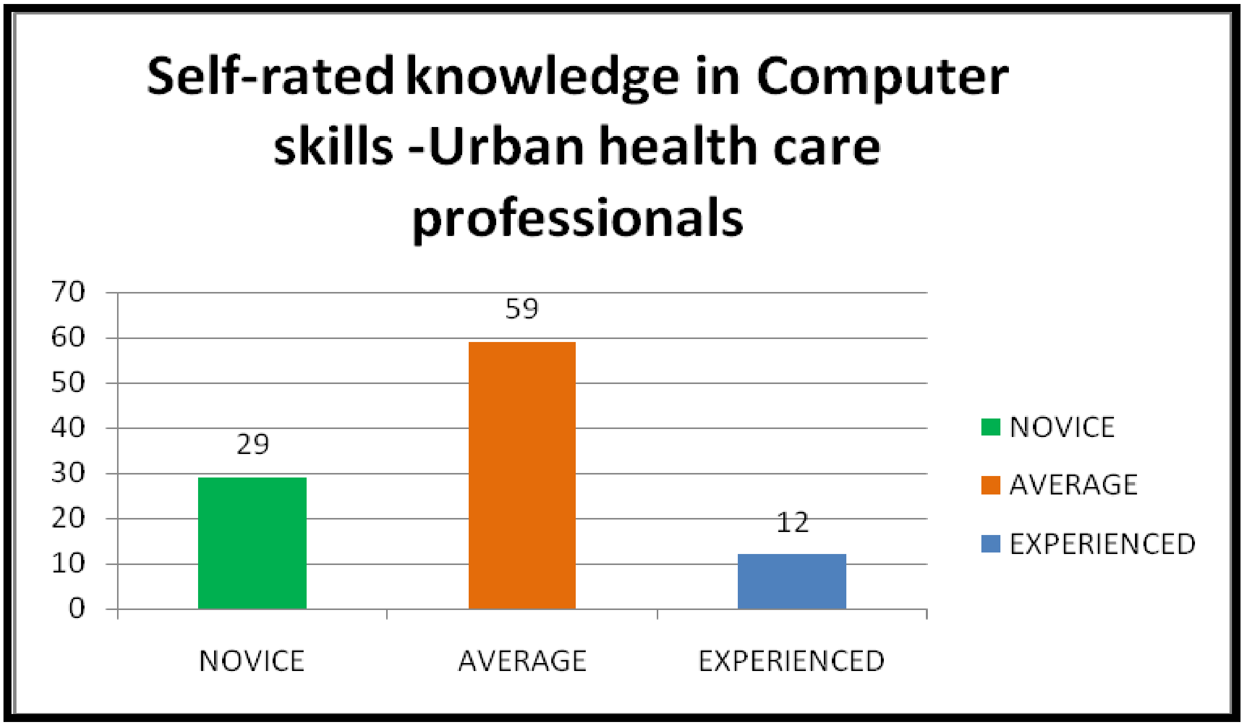


Figure 5.18: Knowledge level in computer skills: urban healthcare professionals

The healthcare professionals in the urban hospitals/clinics indicated that they have no experience in using e-health applications such as e-patient health record systems, e-consultation, e-referral and e-prescription systems. Furthermore, about 99% of the healthcare professionals stated that they have no training in e-health application usage and therefore, expressed their willingness to spend two hours per day to learn how to use e-health applications if any of these applications is installed in their hospitals/clinics. The next section focuses on the summary and interpretations of the findings from the urban hospitals/clinics to assist answering sub-research question 1.

5.3.2.5 Interpretation for sub-research question 1

This section presents a thematic analysis across the cases by considering the summarized responses from the interviews and questionnaires for all the urban hospitals/clinics. Similar to the cross-case analysis for the rural hospitals/clinics as reported in section 5.3.1.5, this section (5.3.2.5) provides a thematic analysis across cases by considering more than one case in order to examine themes common to all the cases. In the analysis of the e-health readiness assessment results, the common themes found in all the urban hospitals/clinics through the interviews and the questionnaires which answer sub-research question 1 are: shortage of healthcare professionals in urban clinics, ICT availability, accessibility and training, e-health solution availability and accessibility and e-health application acceptance and perceived usefulness. Each of these themes is discussed in detail.

- **Shortage of healthcare professionals in urban clinics**

The clinics in the urban areas do not have doctors because of the widespread shortage of doctors in general. The general approach to solving this problem is that one of the doctors from the hospitals is assigned to a clinic(s) where he /she visits on a regular basis or at scheduled times to attend to patients. This results in a heavy workload for these doctors.

- **ICT availability, accessibility and training**

The findings reveal that there are many computers in the hospitals in the urban areas but the clinics (in the same urban areas) have fewer computers. The ratio of doctors to the number of computers in the urban hospitals is 1:2 while clinics in the same urban areas have an average ratio of 1:1. However, this does not depict the real situation in the hospitals/clinics, as it was found that there were no computers in the consultation rooms in spite of the high number of computer to doctor ratio. This clearly indicates that doctors do not use computers for their daily routine clinical duties. The nurses and assistant nurses do not use computers for their clinical work. The computers are used by the hospitals/clinics' administrative staff for capturing patient demographic information and revenue collection. This implies that even though there are computers in the hospitals and clinics, they are used for activities which are not directly related to clinical work like e-patient health record keeping or e-consultation.

This creates a situation where there are no computers, printers, photocopiers and fax machines in the consulting rooms and wards in the hospitals/clinics and this will necessitate the purchase of new computers if e-health solutions are to be implemented in these hospitals/clinics. The telephone services are frequently out of order due to poor telephone lines. There is poor Internet connectivity, a lack of prompt technical IT support and lack of basic ICT skills among the healthcare professionals.

On the question of healthcare professionals who are computer literate, it was found that 59% (47% use computers and Internet daily and 12% who use them weekly) of the healthcare professionals in urban hospitals/clinics have basic computer skills (*cf* Figure 5.17). However, the respondents indicate that they need further training in computer usage (*cf* Table 5.13.2). This is in accordance with the report of the ITU (2009) which states that computer literacy is essential, and that users must not only be familiar with the use of computers and pertinent software products but also the benefits and potential usefulness of the Internet and the World Wide Web (*cf* Section 2.3.3).

- **E-health solutions: availability and accessibility**

The e-health applications discussed in this research study include e-patient health record systems, e-consultation, e-prescription, e-referral and e-training systems. The findings reveal that none of these systems is installed in any of the urban hospitals/clinics that were studied. However, there is a PAAB system in all the hospitals/clinics which is used to support revenue collection and keeping of patient demographic information (but not clinical history). It was indicated that Klerksdorp Hospital and Rustenburg Hospital have a tele-radiography system which operates in the North West Province.

- **E-health solutions: acceptance and perceived usefulness**

Lanseng and Andreassen (2007) note that when users are presented with a new technology, two notable factors influence their attitude towards using it. These are its perceived usefulness and its perceived ease of use. Davis (1989) defines perceived usefulness as the degree to which a person believes that using a particular system will enhance his or her job performance, whilst perceived ease of use refers to the degree to which the person believes that using the particular system will free him or her from effort (*cf* Section 3.8).

In this study, the healthcare professionals in the urban hospitals/clinics, who are the envisaged users of the e-health solutions, state that if e-health solutions are installed in their hospitals/clinics it will, among other things, improve their job performance and save time (*cf* Table 5.13.1-5.13.2 and Table 5.3.2.4.1). This demonstrates their acceptance and their perceived usefulness of e-health solutions.
The next section presents a comparative discussion of thematic commonalities between rural and urban hospitals/clinics.

5.4 Step 3: Comparative discussion and interpretation of rural and urban hospitals/clinics

This section compares the findings of rural and urban hospitals/clinics and proposes recommendations which serve as guiding principles in the development of the e-health framework. The comparative discussion is presented according to the following identified common themes:

- Availability of healthcare professionals in rural and urban hospitals/clinics;
- ICT availability and accessibility in rural and urban hospitals/clinics;
- E-health solutions, availability and accessibility in rural and urban hospitals/clinics; and
- E-health applications, acceptance and perceived usefulness in rural and urban hospitals/clinics.

5.4.1 Availability of healthcare professionals in rural and urban hospitals/clinics

There is a widespread shortage of doctors in rural hospitals/clinics as compared to urban hospitals. Again the clinics in the urban areas also experience a shortage of doctors similar to that found in the rural hospitals/clinics. This finding confirms the findings of the United Nations Framework Convention on Climate Change (UNFCCC, 2003) report which states that access to healthcare for South African citizens is clearly divided along class lines, as superior healthcare is available to urban residents (one physician per 1,200 people), while inferior services are available to rural people (one physician per 10,000).The urban residents' healthcare facilities include both private and state-owned healthcare institutions.

The World Bank (2008) report shows that rural and remote locations are plagued with problematic healthcare services because of distance, isolation, and dispersed populations. These common characteristics of 'rural' have led to difficulties in both recruiting and retaining qualified and skilled professionals in the healthcare field. The urban and more prosperous areas are disproportionately home to the skilled healthcare work force in most if not all countries in Sub-Saharan Africa. For example, urban Zambia has 20 times more doctors and over five times more nurses and midwives than the rural areas. In Malawi, despite 87 percent of its population living in areas considered rural, 96.6 percent of doctors are found in urban healthcare facilities. In Burkina Faso, there is one midwife for approximately 8,000 inhabitants in the richer zones, against one for nearly 430,000 inhabitants in the poorest zone. Many remote regions and districts do not have a single doctor, nurse or midwife to provide assistance to those that need it most (cf. Section 2.10).

The shortage of doctors in rural hospitals and clinics and urban clinics has to drive investment into e-health technologies in the context of an appropriate localized e-health framework, such as the framework proposed in this thesis, to enable healthcare workers such as nurses and midwifes to perform more advanced functions. Table 5.15 provides comparative data on the availability of doctors in the rural and the urban hospitals/clinics in the North West Province.

ITEM	RURAL		URBAN	
	HOSPITAL	CLINIC	HOSPITAL	CLINIC
Ave. size of hospital/clinic	0.85km^2	0.3km ^{2}	4km^2	0.35km^2
Ave. number of doctors per hospital/clinic	6	2	115	2
Ave. number of people served per hospital/clinic	110000	37000	1.1 million	36000
Ave. ratio of number of people served per doctor	1:18000	1:18500	1:9500	1:18000

Table 5.15: Average number of doctors per hospital/clinic in rural and urban areas

Table 5.15 provides a summary of the average number of doctors in the rural and urban hospitals/clinics that were investigated. The average size of the hospitals/clinics and the average number of people served in the rural and urban areas are indicated. An average ratio of 1 doctor to 18000 people for rural hospitals as compared to 1 doctor to 9000 people in urban hospitals is noted in Table 5.15. A rural clinic has a ratio of 1 doctor to 18500 people while an urban clinic has 1 doctor to 18000. The urban and rural hospitals/clinics are all state-owned healthcare institutions. Therefore, the ratios of doctors to the number of people both in the rural and urban hospitals/clinics are higher than those quoted by the UNFCCC (2003) report. The UNFCCC (2003) report focuses on both private and state-owned hospitals in South Africa while this thesis investigated only state-owned hospitals/clinics in the North West Province in South Africa. The next section focuses on ICT availability and accessibility.

5.4.2 ICT availability and accessibility in rural and urban hospitals/clinics

The findings reveal that the urban hospitals have more ICT equipment like printers, fax machines, telephones, scanners, and computers than the rural hospitals/clinics and the urban clinics (*cf* Table 5.8 and Table 5.12). Furthermore, the Internet connections are more reliable in terms of connectivity and speed in urban hospitals than rural hospitals. In rural hospitals, connectivity and speed of the Internet services are often affected by poor telephone lines and the interruption of electricity power supply. Internet connections in both urban and rural clinics are very slow and often down two to three times per week on the average and need upgrading. Table 5.16 provides a comparison of ICT availability and accessibility between rural and urban hospitals/clinics.

ITEM	RURAL		URBAN	
	HOSPITAL	CLINIC	HOSPITAL	CLINIC
Average (Av.) number of desktop computers per hospital/clinic	22	2	150	2
Av. number of laptop computers per hospital/clinic	7	3	20	1
Av. number of fax machines/scanners per hospital/clinic	2	1	2	1
Av. number of photocopiers per hospital/clinic	2	1	6	1
Av. number of printers per hospital/clinic	20	2	100	2

Table 5.16: Comparison of ICT availability and accessibility in rural and urban hospitals/clinics

It can be deduced from Table 5.16 that the average ratio of doctor to number of computers in rural hospitals is 1:3 while in urban hospitals it is about 1:2. The average ratio of doctor to computer in both rural and urban clinics is 1:1. As explained earlier, the evidence that was obtained from the e-health readiness assessment in the various hospitals/clinics show that the computers that are in the hospitals/clinics are not used by the healthcare professionals but by the administrative staff for clerical and other administrative purposes. This means that even though there are computers in the hospitals/clinics, they are used for activities which are not directly related to clinical work like e-patient health record keeping, e-consultation, e-prescription or e-referrals.

It is also revealed that more ICT equipment like printers, fax machines, telephones, scanners, and computers are needed in both the rural and the urban hospitals/clinics if e-health solutions are implemented. The computer skills of healthcare professionals in both the urban and the rural hospitals/clinics were assessed. The result is summarized in Figure 5.19.

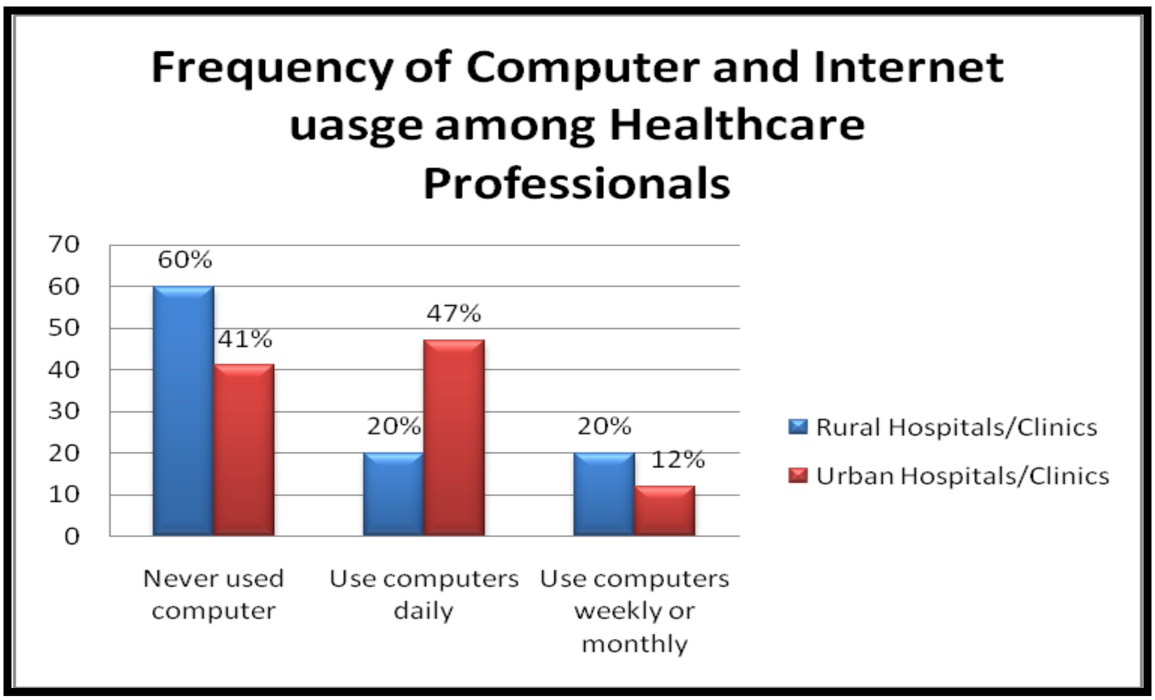


Figure 5.19: Computer and Internet usage among healthcare professionals in urban and rural hospitals/clinics

Figure 5.19 shows that there are many healthcare professionals in the rural hospitals/clinics who have never used computers (60%) when compared to the healthcare professionals in urban hospitals/clinics (41%). This implies that the percentage of healthcare professionals who use computers daily (to search for information but not for carrying out their clinical duties) is far higher in urban hospitals/clinics (47%) than those in the rural hospitals/clinics (20%). Furthermore, 20% of healthcare professionals in rural hospitals/clinics use computers weekly or on a monthly basis when compared to 12% in the urban hospitals/clinics.

These findings indicate that healthcare professionals in urban hospitals/clinics use computers more often than their counterparts in the rural hospitals/clinics. Some of the reasons for the low level of computer/Internet usage among the healthcare professionals in the rural hospitals/clinics may be due to the heavy workload for the doctors in the rural hospitals/clinics, a lack of computer equipment (such as desktop and laptop computers, printers, photocopiers) in the consulting rooms and wards, unreliable telephone services including frequent out of service telephone lines, poor Internet connectivity, lack of prompt technical IT support, and a lack of basic ICT skills and training (*cf* Table 5.12).

5.4.3 E-health solutions availability and accessibility in rural and urban hospitals/clinics

The following findings emerged when comparing the urban and the rural hospitals/clinics in terms of e-health solution availability and accessibility:

- There is no e-patient health record system, e-consultation system, e-prescription system, e-referral system and e-training system in both the urban and the rural hospitals/clinics in the North West Province;
- There are Internet facilities in both urban and rural hospitals but not in many of the clinics. However, Internet usage is limited to searching for information and sending e-mails;
- Both urban hospitals/clinics and the rural hospitals have PAAB systems; and
- Urban hospitals have tele-radiography facilities which are used for sending X-ray images between the Klerksdorp and Rustenburg Hospitals.

With the exception of the tele-radiography facility in the urban hospitals, the ICT systems are not integrated to be able to work together across organizational and departmental boundaries to use patient information. Based on these findings from the urban and the rural hospitals/clinics, the two sets of hospitals, (urban and rural) are represented on the E-health Maturity Curve as illustrated in Figure 5.20.

Source: Ilia (2006)

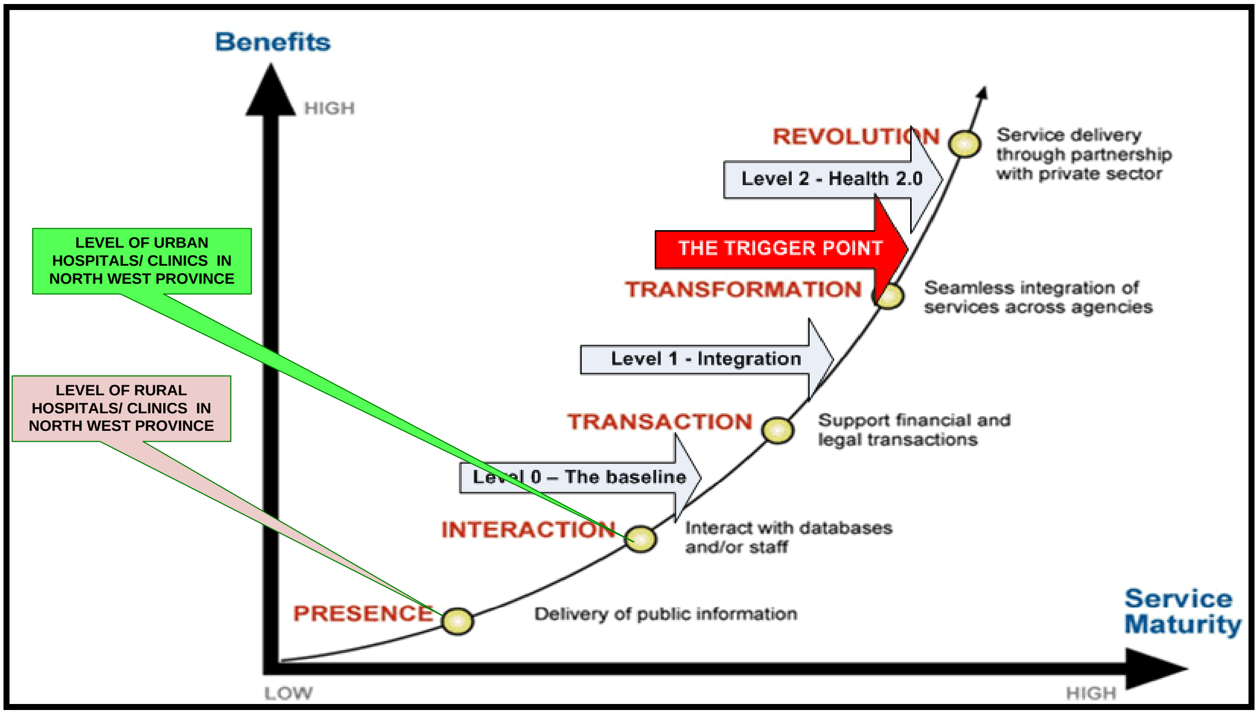


Figure 5.20: E-health Maturity Curve

Figure 5.20 illustrates that the maturity level of e-health applications in the rural hospitals/clinics in the North West Province is at the presence stage, which is classified as Level 0 (the baseline). At this stage of the E-health Maturity Curve, there is a non-interactive website where the main intent is to disseminate information. Thus, at this stage the e-health application (PAAB) that is in place in the rural hospitals, but not in the clinics, is used to receive and to send information (patient demographic information and revenue collection) to the North West Health Department. On the other hand, the maturity level of e-health applications in the urban hospitals/clinics in the North West Province is at the interaction stage of the E-health Maturity Curve, which is also at Level 0 (the baseline). The interaction phase offers services that are more advanced than the presence stage. At this stage, large volumes of available information enable the doctors, nurses and hospital administrators to search for relevant information, communicate with the North West Health Department and submit requirements. Moreover, there is horizontal communication through the use of e-mails among the healthcare professionals in the different hospitals. The two hospitals (Rustenburg and Klerksdorp) are able to send radiographic images of patients.

The rural and the urban hospitals/clinics in the North West Province are both at Level 0 (the baseline) of the E-health Maturity Curve. Therefore, the e-health framework that is developed in the next chapter will help bridge the gap between Level 0 (the baseline) and Level 2 (Healthcare 2.0) by ensuring that Level 1 (Integration) is effectively and efficiently achieved.

5.4.4 E-health application acceptance and perceived usefulness in rural and urban hospitals/clinics

The healthcare professionals in the rural and urban hospitals/clinics expressed their willingness and acceptance of e-health solutions if implemented in their hospitals/clinics. They stated that e-health solutions would improve their job performance and save time. This is confirmed by the positive attitude and the positive comments expressed by the respondents about how urgently they need the e-health solutions to ease their routine job activities (*cf* Table 5.10 and Table 5.14). This is in agreement with Ojo *et a*l. (2006) who indicate that acceptance and use readiness is the intention to accept and use e-health technologies and this is measured by the attitude towards using ICT for healthcare management.

5.5 Step 4: Recommendations

Based on the challenges and opportunities found in these rural and urban hospitals/clinics the following recommendations are made in the light of the e-health readiness structure: need-change readiness, engagement readiness, technological readiness, acceptance and use readiness, and learning readiness (*cf* Figure 3.17). These are explained below.

- **Need-change readiness**

Need-change arises when a community expresses dissatisfaction with the current situation and is willing to aggressively adopt a new practice to create the desired change (*cf* Figure 3.11). Need-change became evident when the research findings from the rural and urban hospitals/clinics revealed that there is a widespread shortage of doctors in these hospitals/clinics and as a result the delivery of healthcare services in these areas is affected. Respondents expressed their dissatisfaction with their current situation such as the long queues at the OPD and indicated how they felt that e-health solutions can help to alleviate or reduce such difficulties. Thus, e-health solutions are seen as a mediator between the shortage of doctors and the delivery of quality healthcare service. The staff who are less qualified than medical doctors can perform clinical activities in the absence of a doctor, but through the use of e-health applications. In such cases, professional advice can be obtained from a distant doctor or specialist doctor through the e-health solution and the relevant clinical activity can be executed.
Therefore, the first recommendation is:

The integration of applications: ICT systems within each hospital/clinic and across the hospitals/clinics in the North West Province should be integrated through the PEHF to:

1. Facilitate e-consultation using an integrated network of healthcare professionals to consult with peers for professional advice and information;
2. Provide integrated patient information at the point of care (Patient Healthcare Records);
3. Help hospitals/clinics' healthcare professionals to create, maintain and share patient healthcare records;
4. Assist in e-referrals where healthcare professionals will routinely use electronic means to transfer patient medical data to other departments within the hospitals/clinics and to other hospitals/clinics within the province; and

5. Promote e-prescription where the doctors and other healthcare professionals will transmit patient prescriptions electronically to pharmacies within the hospital/clinic.

- **Engagement readiness**

An attitude of engagement readiness was expressed when the doctors indicated that they perform their clinical practice in multidisciplinary group and share patient files (*cf* Table 5.10). This aspect is needed for the operation of the e-health solutions. Doctors need to share patient information in a co-operative manner. Therefore, the following recommendations are made:

1. Intergroup co-operation between doctors and other healthcare professionals;
2. Open communication and respect for one another; and
3. Willingness to make initial extra investment.

- **Technological readiness**

The findings indicate that the urban hospitals have more ICT equipment, such as computers and printers, than the rural hospitals. Internet connectivity and the speed of transmitting information were found to be more reliable in the urban hospitals than in the urban clinics and the rural hospitals/clinics. However, it was revealed that the use of the Internet in both the urban and the rural hospitals/clinics was limited to searching for information and sending e-mails and not to support e-health solutions.

In comparing the urban and the rural hospitals/clinics in terms of availability and accessibility of e-health solutions, it was revealed that there is no e-patient health record system, e-consultation system, e-prescription system, e-referral system nor e-training system in both the urban and rural hospitals/clinics. The findings also reveal that the urban hospitals/clinics and the rural hospitals (but not the clinics) have the PAAB system which is used to support revenue collection and to send patient demographic information to the North West Health Department. Despite the availability of the PAAB, the ICT systems and other ICT infrastructure are not integrated to be able to work together across organizational and departmental boundaries to allow the healthcare professionals to gain the benefits of e-health solutions. Therefore, the following recommendations are proposed:

1. Interoperability of systems: Bringing together diverse systems and data sources into a coherent, controlled environment;
2. Creating a network of healthcare delivery;
3. Incorporating existing e-health applications like PAAB and tele-radiography into one new e-health framework;
4. Increasing the number of computers in the hospitals/clinics, especially in the consulting rooms and wards;
5. Providing broadband, high speed Internet access to each hospital/clinic; and
6. Ensuring reliable and constant electricity supply to rural hospitals/clinics and possible backup electricity supply by generators.

- **Acceptance and use readiness**

With reference to Section 3.8, Lanseng and Andreassen (2007), explain in their TAM that when users are presented with a new technology, two notable factors influence their attitude towards using the application. These are its perceived usefulness and its perceived ease of use. Davis (1989) explains that perceived usefulness refers to the degree to which a person believes that using the particular system will enhance his job performance, while perceived ease of use refers to the degree to which a person believes that using a particular system would free him or her from effort (*cf* Figure: 3.10).

It became evident from the research findings that the respondents perceived that the implementation of e-health solution would enhance their job performance by improving upon challenges that include the loss of patient health records, the inability to trace patient files after many years, long queues of patients at OPD and pharmacy and errors in medication prescription. Therefore, the following recommendations are made:

1. Ensure that user interface facilitates a positive user experience;
2. Design simple and easy processes to facilitate e-consultation, e-patient record, e-prescription, e-referral and e-training systems; and
3. Provide incentives to motivate healthcare professionals' usage of e-health applications in the hospitals/clinics.

- **Learning readiness**

Learning readiness, according to Cronbach (1951), is the use of ICT in enhancing education for healthcare professionals (*cf* Table 3.2). E-training, which is a subset of e-learning, is the process of acquiring the knowledge and skills related to work requirements using computers or guided means (Sloman, 2002). The assessment of the computer skills of the healthcare professionals in the hospitals/clinics that were investigated showed that there are more (19%) healthcare professionals in the rural hospitals/clinics who have never used computers in their daily routine work than their counterparts in the urban hospitals/clinics (*cf* Figure 5.19).

This finding means that there is a need to train healthcare professionals in the usage of e-health solutions, and in computer skills. Furthermore, the healthcare professionals indicated their willingness to undergo training in the use of ICT facilities and e-health solutions if these are implemented (*cf* Table 5.13.2). Therefore, the following recommendations are proposed:

1. Incorporate e-training into the envisaged PEHF ;
2. Ensure that e-training content equips healthcare professionals with both basic computer skills and e-health application skills;
3. E-training should be pre-implementation and include the continuous training of healthcare professionals; and
4. The offering of the e-training should be incorporated with face-to-face training.

These recommendations provide input for the e-health framework that will be compiled to assist moving the hospitals/clinics in the North West Province from Level 0 to Level 2 on the E-health Maturity Curve (*cf* Figure 5.20).

5.5.1 Conclusion

This chapter analyzes the research findings based on Creswell's (2007) template for analyzing multiple or collective case studies. The chapter starts by placing the research question into context. In an attempt to contextualize the research question, the research respondents and the various research instruments were discussed.

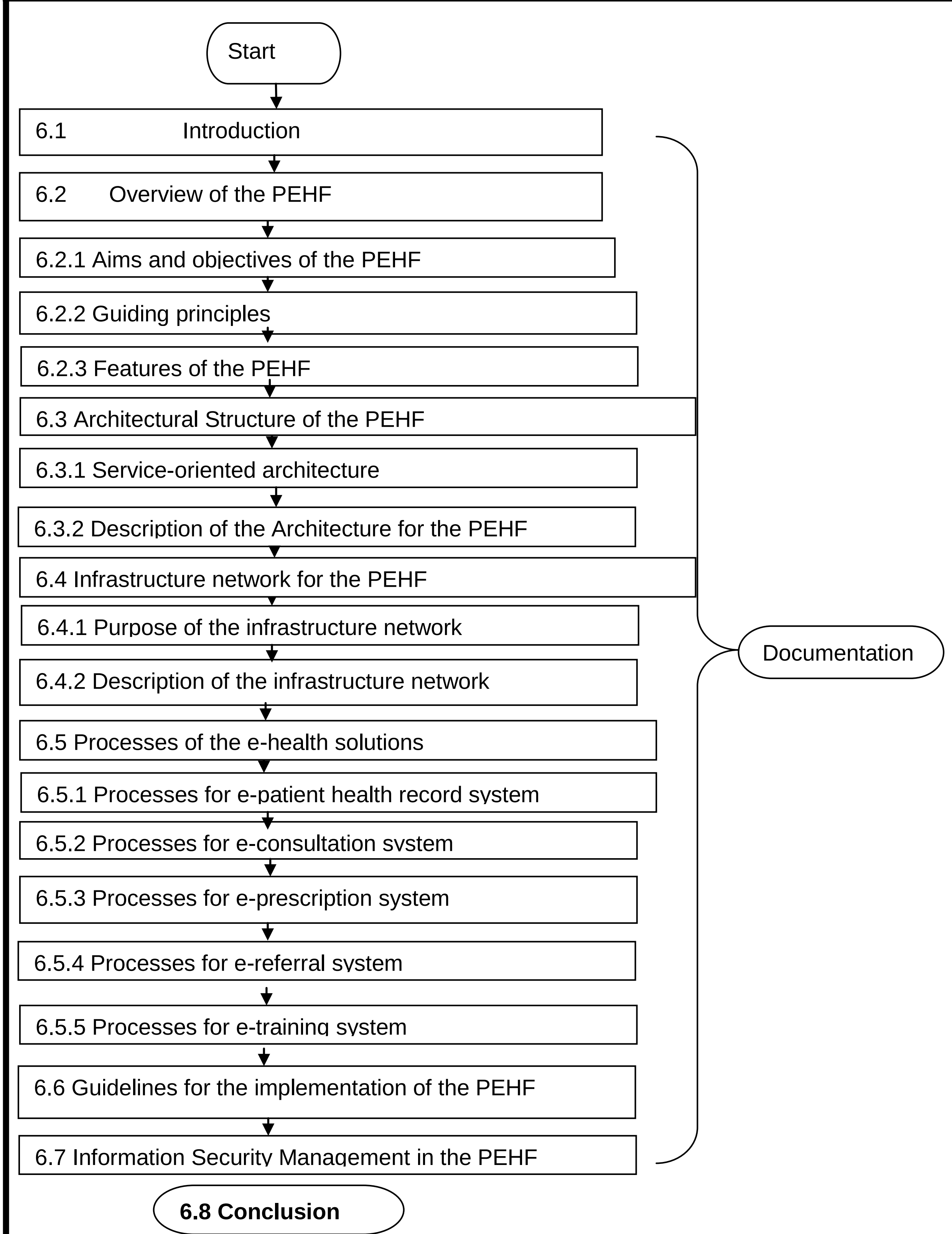
This is followed by step 2 of Creswell's (2007) template where rural and urban hospitals/clinics are fully described in terms of infrastructure, ICT availability and accessibility, and availability of e-health solutions. The findings from the rural hospitals/clinics include the following:
A widespread shortage of doctors in the hospitals/clinics, a lack of computer equipment (e.g. desktop and laptop computers, printers, photocopiers and fax machines) in consulting rooms and wards, an unreliable telephone services including frequent out of service telephone lines, poor Internet connectivity and above all a lack of e-health applications. These findings were the same for the urban hospitals/clinics except that there is more computer equipment in the urban hospitals, a slightly less shortage of doctors and better telephone services. Additionally, a tele-radiography system is available in the urban hospitals.

The cross-case analysis between the rural hospitals/clinics and the urban hospitals/clinics indicates that there is no e-health applications such as e-patient health record, e-consultation, e-referral, e-prescription and e-training systems in both the rural and the urban hospitals/clinics. However, there is a PAAB system in the urban hospitals/clinics and the rural hospitals.

In the comparative analysis and interpretation of results for the rural and urban hospitals/clinics using the E-health Maturity Curve (Ilia, 2006) it was found that rural hospitals/clinics are on the presence stage of the curve while urban hospitals/clinics are on the interaction stage. However, both stages are classified as Level 0. These findings, which led to the recommendations that are stated above, serve as the input in the compilation of the e-health framework for the North West Province.

Having identified the strengths and areas of improvement in these rural and urban hospitals/clinics that were investigated, the next chapter focuses on how the identified outcomes and the recommendations can be used to compile an e-health framework for use in public hospitals/clinics in the North West Province.

Chapter 6: Provincial E-health Framework



CHAPTER 6

PROVINCIAL E-HEALTH FRAMEWORK (PEHF)

6.1 Introduction

In chapter 5 the research findings and interpretations for sub-research question 1 are discussed. The findings reveal that there is a widespread shortage of doctors in rural hospitals/clinics as compared to urban hospitals. Additionally, it was found that the clinics in the urban areas experience a shortage of doctors like the rural hospitals/clinics. This implies that there is a disparity between urban hospitals and the rural hospitals/clinics and urban clinics in terms of quality healthcare delivery. Therefore, the implementation of e-health solutions can help alleviate or reduce such disparities by improving access to effective healthcare delivery.

Furthermore, the findings indicate that the urban hospitals have more ICT equipment, such as computers and printers, than the rural hospitals. Internet connectivity and the speed of transmitting information were found to be more reliable in the urban hospitals than the rural hospitals. However, it was revealed that the use of the Internet in the urban hospitals/clinics and the rural hospitals is limited to searching for information and sending e-mails, and not to support e-health solutions.

Moreover, the assessment of the computer skills of the healthcare professionals in the hospitals/clinics that were investigated revealed that there are many healthcare professionals in the rural hospitals/clinics who have never used computers in their daily routine work (*cf.* Figure 5.19). This finding means that there is a need to train healthcare professionals in the use of e-health solutions and in computer skills.

It also emerged from the findings that the healthcare professionals are willing and prepared to accept any e-health solutions that may be implemented in their hospitals/clinics. The healthcare professionals stated that e-health solutions will improve their job performance and save time. This is revealed by the positive attitude and comments that are made by the respondents about how urgently they need the e-health solutions to ease their routine job activities (cf Table 5.10). This is in agreement with the finding by Ojo et al (2006) which indicates that acceptance and use readiness is the intention to accept and use e-health technologies and this is measured by the attitude towards using ICT for healthcare management.

Another critical outcome that emerged from the findings is about e-health solutions. In comparing the urban and rural hospitals/clinics in terms of availability and accessibility of e-health solutions, it is revealed that there are no e-health applications in either. The findings reveal that the urban hospitals/clinics and the rural hospitals have the PAAB system which is used to support revenue collection and to generate patient demographic information. Additionally, it was found that the urban hospitals have tele-radiography facility which is used to send X-ray images between the two urban hospitals (Klerksdorp and Rustenburg Hospitals).

However, a major setback became evident, that despite the availability of the PAAB and tele-radiography facilities, these ICT systems and other ICT infrastructure in both the urban and rural hospitals/clinics are not integrated to be able to work together within and across these urban and rural hospitals/clinics to allow healthcare professionals to gain the benefits of e-health solutions and applications such as e-patient health record system, e-consultation system, e-prescription system, e-referral system and e-training system. These findings from both the rural and urban hospitals/clinics place them at the presence and interaction stages of the E-Health Maturity Curve respectively (cf Figure 5.20). Ilia (2006) reiterates that both the presence and the interaction stages are regarded as level “0” on the E-Health Maturity Curve. Therefore, it is imperative that a special e-health framework be compiled based on these findings to move the e-health application usage in these hospitals/clinics from level “0” to level “2” (healthcare 2.0) of the E-Health Maturity Curve by ensuring that Level “1”(integration) is effectively and efficiently achieved.

Furthermore, it is evident that most of the problems that exist in the hospitals/clinics such as insecure patient health records, loss of patient files, the inability to trace patient files after many years, the lack of consultation among doctors for professional advice, long queues of patients at OPD and pharmacy, errors in medication prescription and false usage of identity documents to collect medication from two or more hospitals at the same time (*cf* section 5.3.3), can be identified and solved if the usage of e-health solutions were at level "1"(integration) in these hospitals/clinics.

These findings precipitated some recommendations which are categorized according to the five main components of the overall e-health readiness assessment construct (cf Figure 3.17):

- Need-change readiness;
- Engagement Readiness
- Technological readiness;
- Acceptance and use readiness; and
- Learning readiness.

These recommendations are summarized in Table 6.1.

E-health readiness assessment structures	Associated Recommendation
Need-change readiness	Integration of applications: ICT systems within each hospital/clinic and across hospitals/clinics in the North West Province should be integrated through the PEHF to: 1. Facilitate e-consultation using an integrated network of healthcare professionals to consult with peers and specialists for professional advice and information; 2. Provide integrated patient information at the point of care (Patient Healthcare Record); 3. Help hospitals/clinics' healthcare

	professionals create, maintain and share patient healthcare records; 4. Assist in e-referrals where healthcare professionals will routinely use electronic means to transfer patient medical data to other departments within the hospitals/clinics and to other hospitals/clinics within the province; and 5. Promote e-prescription where doctors and other healthcare professionals will transmit patient prescriptions to pharmacies within the hospital/clinic
Engagement readiness	1. Intergroup corporation between doctors and other healthcare professionals. 2. Open communication and respect for one another. 3. Willingness to make initial extra investment
Technological readiness	Interoperability of systems to: 1. Bring together diverse systems and data sources into a coherent, controlled environment; 2. Create a network of healthcare delivery; 3. Incorporate existing e-health applications like PAAB and tele- radiography into one new e-health framework; 4. Increase the number of computers in the hospitals/clinics, especially in the consulting rooms and wards; 5. Provide broadband, high speed Internet access to each hospital/clinic; and Ensure reliable and constant electricity supply to rural hospitals/clinics and possible back-up electricity supply by generators.

Acceptance and use readiness	1. Ensure that user interfaces will facilitate a positive user experience. 2. Design simple and easy processes to facilitate e-consultation e-patient record, e-prescription, e-referral and e-training systems 3. Provide incentives to motivate healthcare professionals' usage of e-health applications in the hospitals/clinics.
Learning readiness	1. Incorporate e-training into the envisaged PEFH. 2. Ensure that e-training content equips healthcare professionals with both basic computer skills and e-health application skills. 3. E-training should be pre and continuous training of healthcare professionals. 4. The offering of the e-training should be incorporated with face-to-face training.

Table 6.1: E-health readiness assessment recommendations

The objective of this chapter is to use the research findings, the literature review in chapters 2 and 3, the document analysis (cf Section 6.1.2) and the e-health readiness assessment recommendations of Table 6.1 as input to create an e-health framework for the North West Province which is termed the Provincial E-health Framework-PEHF.

Tomhave (2006) states that "a framework is a fundamental construct that defines assumptions, concepts, values, and practices and that includes guidance for implementing itself". The PEHF proposed for the North West Province includes:

- Aims and objectives, guiding principles and desired characteristics;
- An architectural structure;
- An infrastructure network;
- Processes for the required e-health solution;
- Guidelines for implementation; and

- Notes on Information Security Management in the context of the proposed PEHF.

It should be noted that the implementation guidance proposed for the PEHF does not constitute the only option for its implementation. In this context, the e-health framework for the North West Province with its lack of ICT infrastructure will look different. This answers sub-research question 2:

> How can the identified outcomes of the e-health readiness assessment be used to compile an e-Health Framework for use in hospitals/clinics in the North West Province?

Apart from the literature study (cf Chapters 2 and 3), the e-health readiness assessment findings and the recommendations (cf. Chapter 5 and Table 6.1) and document analysis which informed the compilation of the PEHF, a review by experts (*cf* Appendix H) was solicited as an input to ensure the credibility and applicability of the PEHF. The literature study as reported in chapter 2, the document analysis and the expert review are discussed in the next section.

6.1.1 Literature study

Drury (2005) indicates that the e-health models and frameworks that have been developed in the UK, Canada and EU have emerged in a context of wealth where there are well-developed national and local ICT infrastructures already in place. On the other hand, the context in which e-health models and frameworks are developed in developing and underdeveloped countries in Africa (including South Africa) is not wealth but poverty. In this context, the e-health framework for the North West Province, with its lack of ICT infrastructure, will look different from those e-health frameworks that are seen in developed countries. However, the PEHF developed in this chapter is compiled with particular attention to the global health standards and health information guidelines (*cf* Section 2.4). Many e-health related models and frameworks are discussed in chapter 2, including those for e-health record systems (*cf* Section 2.7), e-consultation systems (*cf* Section 2.9.1), e-prescription system (*cf* Section 2.8) and e-referral systems (*cf* Sectio*n* 2.9.2). Each of these models or frameworks targets a specific e-health domain and does not provide a comprehensive e-health framework within which a total e-health solution for a healthcare institution can be accommodated. However, these systems are required in an integrated form to serve the people in the North West Province. Therefore, the PEHF is created based on SOA style which integrates services (*cf*. Table 2.3). The SOA provides an appropriate architectural style for the PEHF because it allows institutions (in this case the hospitals/clinics) the autonomy and flexibility to take control over their own IT environment while at the same time enabling inter-organizational business integration (*cf* Section 2.11.1 and Section 6.3).

6.1.2 Document analysis

Documents which were available to the public and did not compromise the confidentiality of patient information nor the classified information of the Health Department were scrutinized. Among the documents is the Draft e-health White Paper Discussion Document which is prepared by the National Health Department and is adopted by the North West Health Department. The document is available in the hospitals/clinics and has the following goals:

- To develop a comprehensive healthcare information system that will ensure effective and efficient delivery and management of healthcare;
- To improve access to healthcare for all and reduce inequity irrespective of distance and location;
- To ensure accessibility of healthcare information by citizens and healthcare professionals; and
- To focus on working in partnership with other stake holders to improve the quality of care at all levels of the healthcare system, especially preventive and promotive healthcare.

The document further indicates that to achieve these goals, the following is required:

- The development of a comprehensive and integrated healthcare information system;
- The development of healthcare information standards;

- Ensuring that all healthcare professionals have access to adequate ICT infrastructure;
- The development of a national telemedicine programme;
- The development and implementation of an integrated (national, provincial and local government) healthcare promotion strategy using ICT including;
    a. The development of ICT and HR strategies;
    b. The development of an e-health record strategy; and
    c. The promotion of research and development in e-health for the purposes of local innovation.

Furthermore, the documents reveal that six policy considerations have been identified and strategies have been proposed to address them. These are policies of security and confidentiality, increasing the efficiency and effectiveness of management and administration, access to ICT infrastructure, standards and interoperability, capacity building, funding and resources. This document informed the alignment of the objectives of the PEHF with the goals of the North West Health Department regarding e-health solution. The documents indicate the goals of providing a comprehensive healthcare information system that ensures effective and efficient delivery and management of healthcare, and this provides the guiding principles for the PEHF. Above all, the policies regarding security and confidentially outlined by the documents were scrutinized and adopted for the PEHF. The next section focuses on expert review.

6.1.3 Expert review

In addition to the literature study, it was important to solicit views of experts in the field of e-health and medicine about the applicability, usability and adaptability of the PEHF, including its infrastructure network and the proposed processes for the e-patient health record system, e-consultation system, e-prescription system, e-referral system and e-training system. The North West Health Department appointed a panel of three e-health experts who serve on the e-health board of the province. The panel included a doctor who is an e-health specialist, the director of IT services in the hospitals who is an e-health specialist and an administrator in the hospital who is also on the e-health board. The team assembled at Klerksdorp Hospital and invited the researcher for a panel discussion. The expert panel found the PEHF useful, appropriate, and applicable to the province. The expert panel further suggested that a mechanism to incorporate the existing data from paper files would be useful. It was proposed that scanners be used to scan existing paper records and provide this data to patients on memory sticks. This was seen as something that could be done concurrently while implementing the framework.

It is the opinion of the researcher that the scanned documents should be stored straight into a database, because supplying memory sticks would be an additional cost in terms of purchasing them and ensuring that the data is protected to ensure that privacy principles are upheld. It is also not inconceivable that some patients may sell the memory sticks, given the state of poverty, especially in rural areas (*cf* Section 2.10).

Below are some of the responses from the experts which add value to the research and the PEHF:

Respondent 1:

"*This is what we have been waiting for since all these years and we hope it will be implemented soon"*.

Respondent 2:

"*This framework, the infrastructure network is so clear and we can apply it".*

Respondent 3:

"Scan all the old paper files of patients for the last 5 years and save it on the memory stick for the patients so that when this system is ready we can easily upload this information":

Respondent 1:

"We will present this at our management planning meeting so that the North West Health Department can make some money ready for its implementation".

The acceptance letter from the North West Health Department is attached as appendix H.

The remaining section of this chapter is presented under the sub headings that are indicated in Figure 6.1. This section, according to the illustration in Figure 6.1, starts with the overview of the PEHF (Section 6.2) and is followed by the structure of the PEHF in Section 6.3. The infrastructure network relating to the PEHF is presented in Section 6.4. This is followed by the processes for an e-patient health record system, e-consultation system, e-prescription system, e-referral system and e-training system in Section 6.5. Section 6.6 provides the guidelines for using the PEHF and Section 6.7 elaborates on information security management in the context of the PEHF as indicated in Figure 6.1.

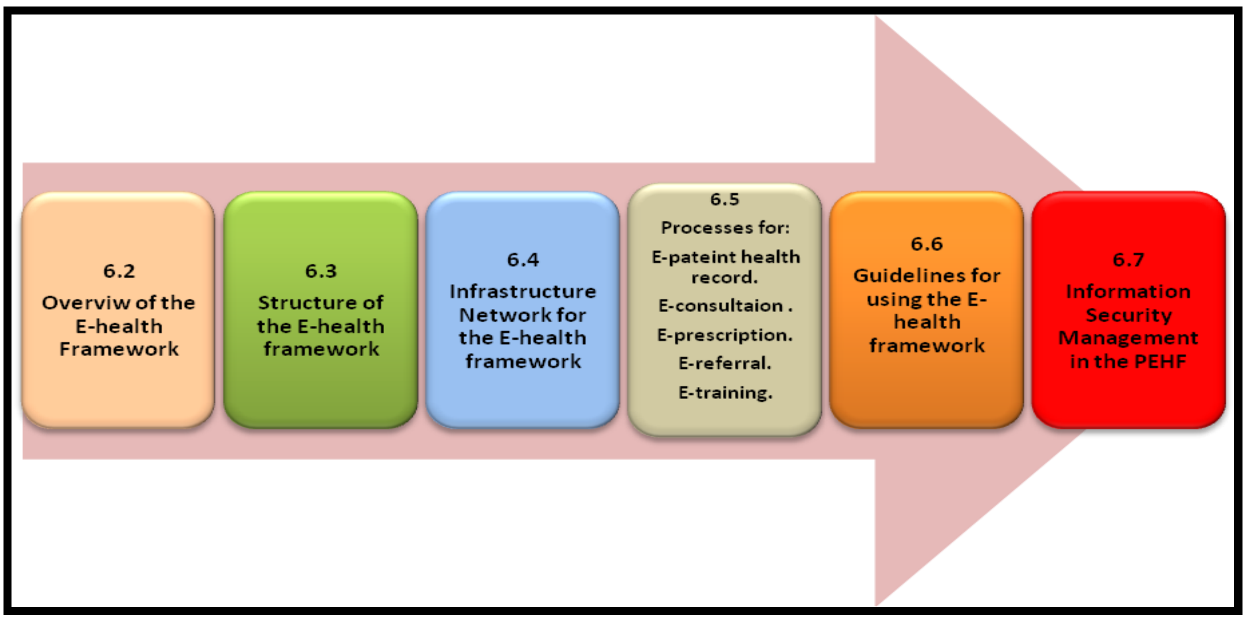


Figure 6.1: Outline of sub headings for Chapter 6

The next section focuses on the overview of the PEHF.

6.2 Overview of the Provincial E-health Framework (PEHF)

The compilation of the e-health framework was considered in the context of the healthcare needs of the hospitals/clinics, the capabilities of healthcare professionals and the available computing and communication infrastructure found during the e-readiness assessment conducted in the hospitals/clinics. Figure 6.2 provides an overview of how the PEHF is compiled.

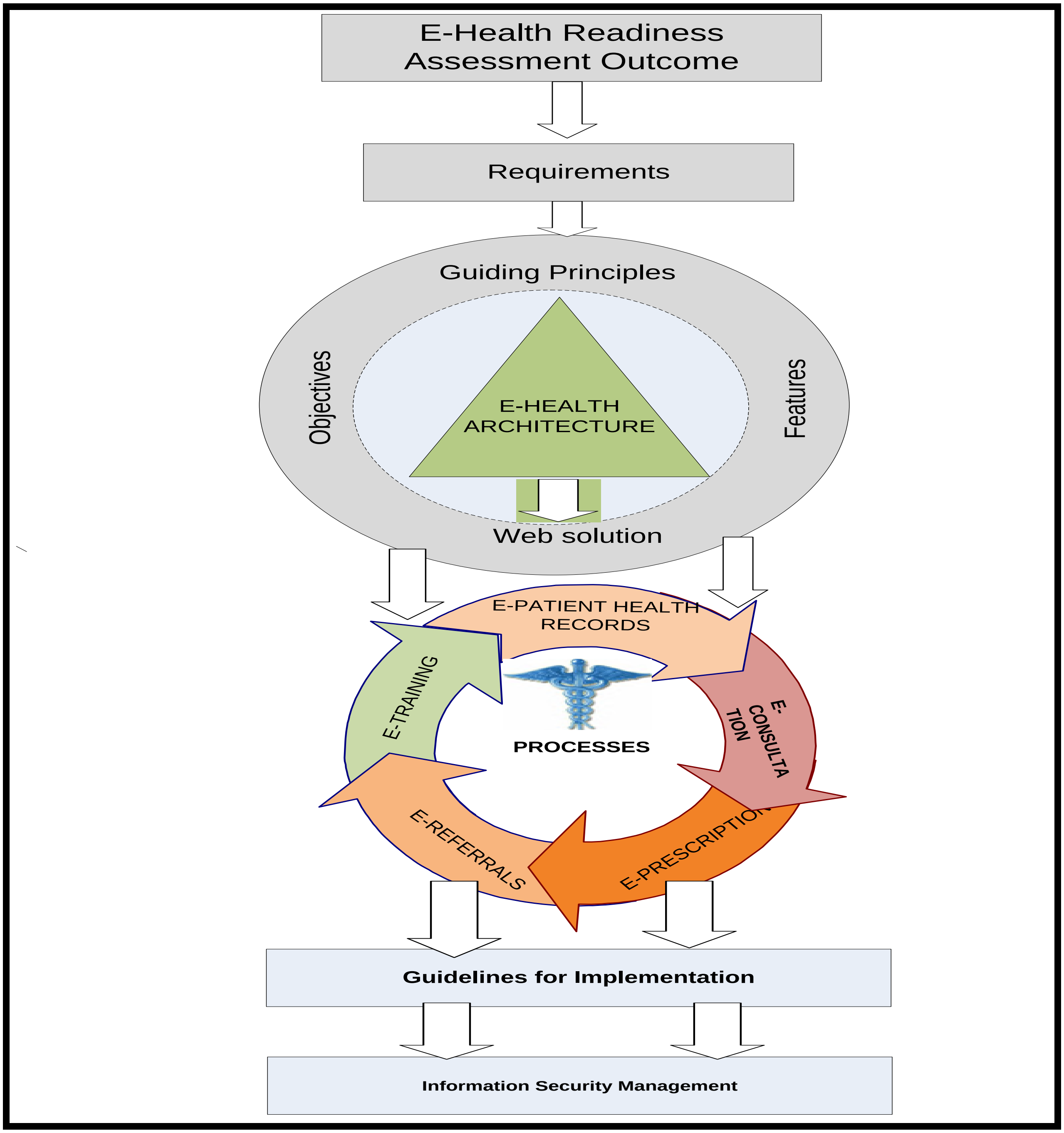


Figure 6.2: Stages leading to the development of the PEHF

Figure 6.2 maps out the various stages that lead to the compilation of the PEHF. The first item is the e-health assessment outcomes, together with the recommendations in

Table 6.1, the literature review in Chapters 2 and 3, and the document analysis findings, which informed the requirements for the compilation of the PEHF. These requirements led to the formulation of the objectives, the guiding principles and features for the PEHF. These serve as the basis for the development of an architecture and infrastructure network solution (web solution) for the relevant hospitals and clinics. It should be noted that the proposed infrastructure network solution integrates hospitals, clinics, applications, devices and work processes to improve knowledge sharing and efficient delivery of healthcare services. It became evident during the study that urban hospitals have more ICT equipment than urban clinic and rural hospitals/clinics in the North West Province (*cf* Section 5.4.2). Therefore, the infrastructure network must provide a solution for the hospitals/clinics in the rural and urban areas to share ICT facilities. The proposed solution bridges the ICT infrastructure disparities between rural and urban hospitals/clinics.

The PEHF also proposes e-health solution processes based on the developed infrastructure network. The processes address e-patient health record, e-consultation, e-prescription, e-referral and e-training solutions. The processes for these e-health solutions are emphasized because it emerged from the findings in chapter 5 that there are no such e-health solutions in the hospitals/clinics in the North West Province and therefore, any e-health framework for these hospitals/clinics should include them. Again before any of these e-health solutions can be fully designed into a system for use, both healthcare professionals and designers must know the processes that are involved in each e-health solution. Hence the processes for e-patient health record, e-consultation, e-prescription, e-referrals and e-training are expounded in Section 6.5.

The guidelines for the implementation of the PEHF are provided in section 6.6. These guidelines became necessary because of the shortage of skills and expertise in the field of e-health and the different levels of literacy of the stakeholders involved. The guidelines provide a broad operational approach to be followed to assist the implementation of the PEHF. In order to protect patients’ information from accidental disclosure to unauthorized persons and from alteration, destruction or loss, the PEHF provides Information Security Management which is presented in section 6.7. The next section elaborates on the aims and objectives of the PEHF.

6.2.1 Aims and objectives of the PEHF

The main aim of the PEHF is to integrate e-health services to improve healthcare delivery in the North West Province. This led to specific objectives to:

- Create a holistic PEHF that can be used at the national, provincial as well as the local levels in the healthcare environment;
- Connect systems and software networks that span across applications, devices, services and hospitals/clinics to help improve knowledge sharing and efficiency in the healthcare sector;
- Create a web-based service architecture solution which is linked to the PEHF;
- Create processes for e-patient health record, e-consultation, e-prescription, e-referral and e-training system; and
- Incorporate the existing PAAB system into the PEHF.

6.2.2 Guiding principles

In order to achieve these objectives the PEHF is guided by the following principles:

- Integration of services and ICT applications;
- Cross hospitals/clinics system interoperability;
- Integration of existing PAAB application; and
- The use of hubs to transform services to e-services.

6.2.3 Features of the PEHF

The purpose of this thesis is to compile an e-health framework that can assist healthcare professionals in the hospitals/clinics of the North West Province to deliver quality healthcare services to the people in the province. Based on the literature review in Chapters 2 and 3, the analysis of documents obtained from the hospitals/clinics and the findings of the e-health readiness assessment, together with the e-health readiness assessment recommendations elaborated in Table 6.1, the features of the PEHF should portray the characteristics indicated to make it relevant to the healthcare professionals in the rural and urban hospitals/clinics:

- Service oriented architecture and web service technology features;
- Flexible architectures which are distributed with centralized topographies (*cf* Figure 3.13);
- Features which show the use of hubs, adapters or routers and connectors;
- Synchronous and asynchronous operation features;
- Scalability features; and
- Authorization and authentication mechanisms.

The next section discusses an architectural structure for the PEHF.

6.3 Architectural structure of the Provincial E-health Framework (PEHF)

The design of the PEHF is based on SOA (*cf* Section 2.11). The choice of SOA to develop an architectural structure for the PEHF is discussed.

6.3.1 Service oriented architecture

Service oriented architecture (SOA) is an approach to designing a system that allows for loose coupling, interoperability, and standards-based computing (Papazoglou and Heuvel, 2007:389). The choice of SOA enables the provision of a comprehensive electronic healthcare framework to improve healthcare delivery in the North West Province. Erl (2005) notes that SOA can offer “real benefit potentials” that can change organizations for the better. Again SOA refers to the design of new applications that involve the incorporation of “services” from existing systems (Neubauer, 2007). It further allows organizations the autonomy and flexibility they need to take control of their own IT environments, while still enabling inter-organizational business. The SOA allows each hospital/clinic to operate independently within its own domain but when it collaborates with others in a larger setting, it does so through a number of defined services.

Therefore, the researcher has selected the SOA as appropriate for the development of the PEHF, because it respects the internal autonomy of each hospital or clinic in the North West Province.

The SOA method attempts to identify each of the participants in the PEHF and describe their roles and relationships to the rest of the system. The role and relationships of the participating hospitals/clinics imply a set of business services that each of them provides to the system as a whole. Each of the services requires a detailed definition of technical protocols, data and business rules, but these are not included in this architecture framework except for acknowledgement as a general guidance for the system as a whole. Once the services to be provided have been defined, it becomes simple to speculate about the kind of application each hospital/clinic or organization will need in order to provide those services. In this study the e-health applications needed in each hospital/clinic have been established through the e-health readiness assessment (*cf* Table 5.8 and Table 5.12). The proposed architecture incorporating these services or applications is subsequently discussed.

6.3.2 Description of the architecture for the PEHF

The description of the architecture for the PEHF is provided in Figure 6.3 and its components and their functionality are discussed.

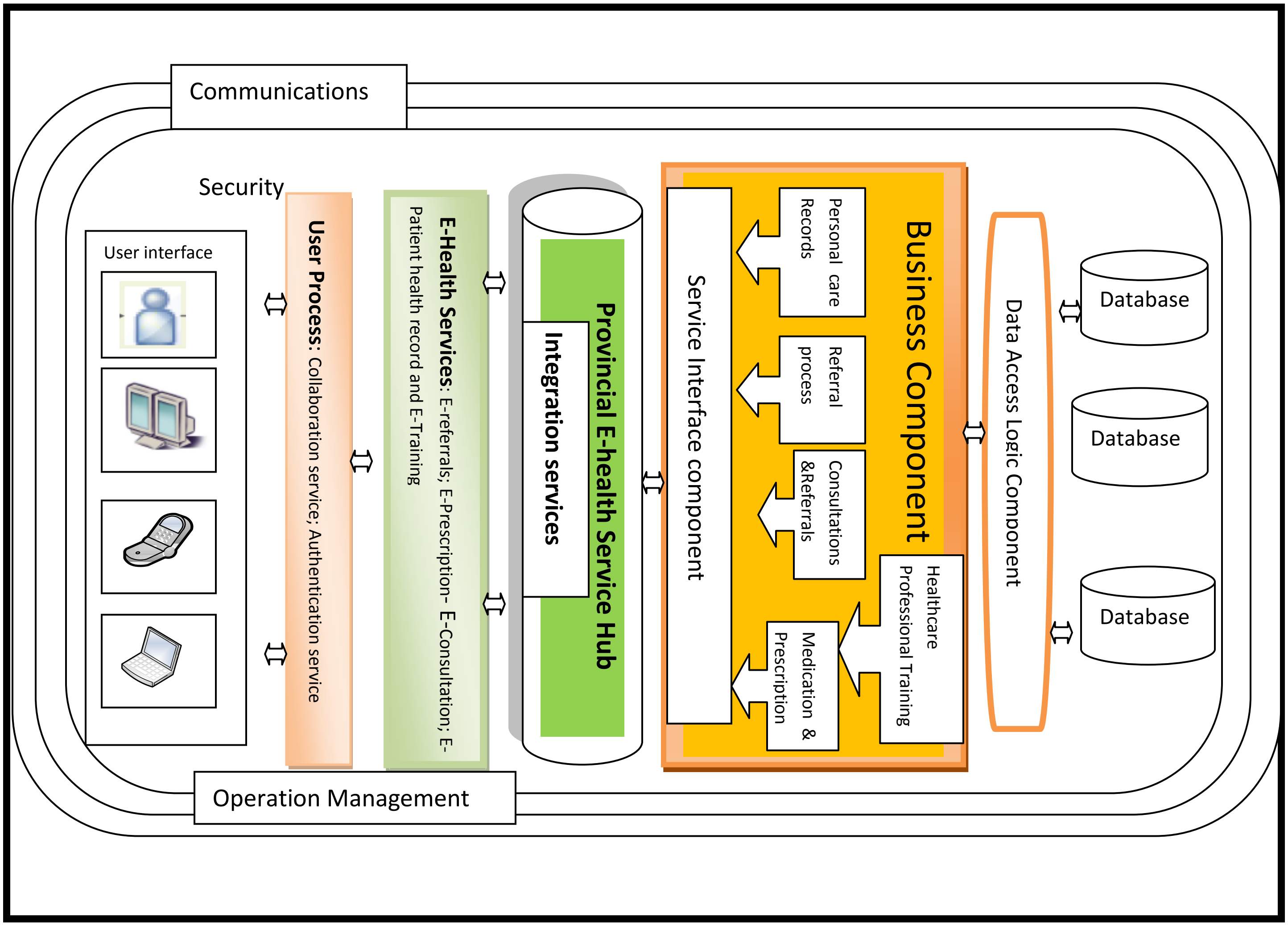


Figure 6.3: Architecture for the PEHF

Figure 6.3 illustrates the architecture for the PEHF. The architecture emphasizes the integration of services within local hospitals/clinics and avails these services to the web through a provincial e-health service hub. The various components of the architecture and their functionalities are discussed.

- **Database:** The database is a collection of data organized in a manner that allows access, retrieval and use of data. The stored data underpins a specific application and each application is run by specific software called application software that allows the users to create access and manage the database.

- **Data Access Logic Component:** This component as it appears in the PEHF, manages the reading and writing of data to the precise data store that underpins the application. The Data Access Logic Component becomes aware of where data is stored physically. It, therefore, provides the translation between the logical and physical views of the data. This mechanism enables data sharing between applications.

- **Business Component:** The business component performs business tasks, applies business rules, manages business data and exposes services for consumption by business process components.

- **Service Interface Component:** This component exposes the functionality of the business components (Business Logic) and the owned data of the business component (Business Entity) as a set of related services. This involves supporting the service contract that describes the functionality and the data available and the semantics, as well as the information about message formats, access and security restrictions and protocols used.

- **Provincial E-health Service Hub:** This is a uniform service integration architecture of infrastructure services that provides consistent support to business services across a defined ecosystem. The Provincial E-health Service Hub is implemented as a SOA architecture using a web service interface. The first set of tasks of the Provincial E-health Service Hub is to identify (authenticate) the user, and to show the service that the user may use and their status. Furthermore, the Hub must be able to route messages to the back-end services. The second function of the Provincial E-health Service Hub is to orchestrate the process that the user performs. This is extending the capabilities of the hub to expose functionality to the user.

- **Integration services:** Integration service is one of the functions the Provincial e-Health Service Hub provides. The hub provides a rich set of integration services which gives connectivity amongst all the participating healthcare systems and stakeholders. The integration services ensure interoperability between connected health systems and services, provide the required network and applicable protocols, message routing and process orchestration, and finally transaction management. These services are offered in a secure, reliable and highly available architecture environment.

- **E-health service:** This component incorporates the business services of the hospitals/clinics that have been transformed from physical and paper phase to the electronic phase through the service hub. In this study, the e-health services include e-patient health records, e-referrals, e-consultation, e-prescription and e-training services and systems. This represents the migration from the physical normal business and paper services of the hospitals/clinics to web services.

  E-patient health records constitute a set of e-health services for capturing and providing access to patient health information in both summary and detailed format. The patient health record is central to the other e-health solutions (e-referrals, e-prescription and e-consultation). Even though e-consultation in this research is electronic consultation among healthcare professionals, the subject of the consultation is the patient. Therefore, an e-patient health record system is central to the PEHF.

- **User process component:** This component controls the interaction of the user with the application and ensures that a flexible, yet predictable process is followed. It ensures collaboration services, authentication, authorization and privacy of service. The user process component manages the state of user transactions and handles issues such as cancellations and roll-back in the event of the abandonment of transactions.

- **User interface component:** It provides interaction between the user and the application. The user interface components handle the rendering of data for particular end user devices such as PDAs and mobile phones as well as computer devices such as PCs and terminal devices.

- **Security:** The implementation of e-health solutions in the context of the e-health framework must be done in a secure environment. This means that there should be reliable, secure user identification, authentication and authorization. The issue of security and confidentiality of patient information became evident during the fieldwork (cf Table 5.14) and therefore, it is important that such identification measures are put in place. One of the respondents stated that there should be signatures and passwords so that "if something goes wrong we know who did what" (*cf* Table 5.9.2). Again it was emphasized by the respondents that patient health information is a sensitive issue and must be password protected (cf Table 5.9.2).

- **Communication:** This is concerned with the interaction between components across the different layers. In the communication layer, an appropriate transport protocol, such as HTTP for Internet communication and TCP for intranet communication are considered for sending messages. All the components of the PEHF communicate through a shared network infrastructure using an agreed service protocol. An HL7 messaging standard has been adopted as the messaging standards for the healthcare sector in South Africa. However, there are plans to move to an XML based standards for messaging requirements. Therefore, the PEHF adopts these national messaging standards.

- **Operation Management:** It includes maintainability management, exception management, workflow management and service management. Maintainability management inserts mechanisms to update the application and its component periodically. Exception management executes a strategy for detecting and managing errors and exceptions. This prevents services from exposing information about its internal implementation when errors occur. Workflow management manages the flow of a complex process-oriented application in a predefined manner while service management facilitates minimum levels of standardization of approaches to support the delivery of information, computers and telecommunication services to healthcare professionals. The next section discusses the proposed infrastructure network for the PEHF.

6.4 Infrastructure network for the PEHF

This section proposes a web-based service architecture solution for the hospitals/clinics in the North West Province. As evidenced in the findings of the study, urban hospitals have more ICT equipment than the urban clinics and rural hospitals/clinics (*cf* 5.4.2). Therefore, the creation of the infrastructure network aims to provide a solution that allows the hospitals/clinics in the rural and urban areas to share ICT equipment facilities. The solution will bridge the ICT infrastructure disparities between rural and urban hospitals/clinics to promote equitable usage of ICT equipment.

6.4.1 Purpose of the infrastructure network

The purpose of the infrastructure network is to:

- Assist hospitals/clinics in a selected geographical area to share patient data and information through the integration of infrastructure;
- Store and distribute patient data and information across the infrastructure network using a hybrid distribution data model;
- Have a network infrastructure that is robust and delivers constant, 7/24 hours connectivity;
- Incorporate the existing PAAB system into the new infrastructure network; and
- Promote fault-tolerant computing across the network infrastructure system.

Having stated the purpose of the infrastructure network, the next section provides its description

6.4.2 Description of the infrastructure network

The infrastructure network, as indicated in section 6.2, integrates hospitals, clinics, applications, devices and work processes to improve knowledge sharing and the efficient delivery of health services. As indicated the infrastructure network presented in Figure 6.4 is developed based on the proposed architecture for the PEHF (cf Figure6.3), the literature study in chapter 2, the findings in chapter 5 and the recommendations in Table 6.1.

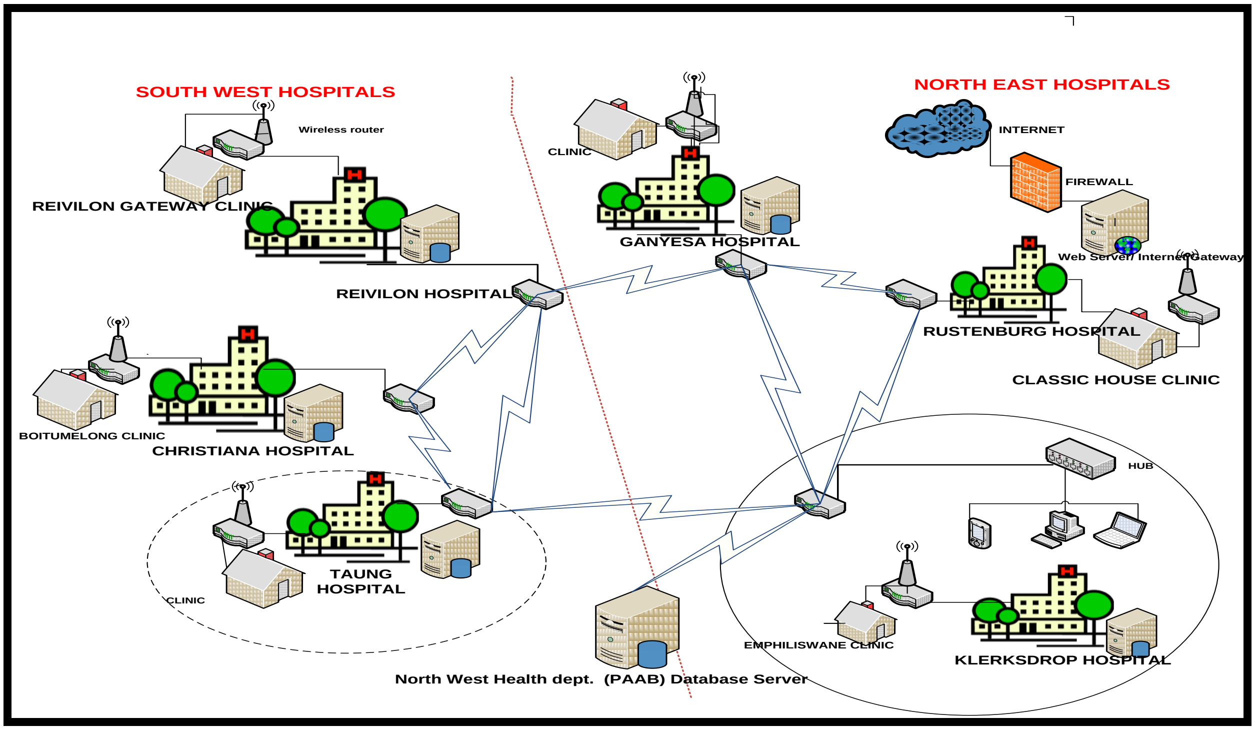


Figure 6.4 Infrastructure network for hospitals/clinics in the NWP

The description of the infrastructure network is done according to its purpose, as stated in section 6.4.1 and is expounded in the following paragraphs.

Assist hospitals/clinics in a selected geographical area share patient data and information through integration of infrastructure

The hospitals/clinics in the North West Province are grouped into two areas based on their geographical location. The geographical locations of these hospitals/clinics make distance between certain hospitals/clinics shorter and therefore, facilitate the clustering of these hospitals together as the South West Hospitals/clinics and the North East Hospitals/clinics.

Hospitals in the South West cluster have Taung Hospital at their centre. Therefore, the Taung Hospital becomes the centre of the infrastructure network layout for the South West cluster. Each database server in each hospital within the South West cluster will be linked to the database of Taung Hospital on the network. The clinics, which are gateway clinics to the hospitals, have their database servers linked to the nearest hospital database server. The networks of these clinics are linked to the network of the hospitals through wireless routers. Taung Hospital, which hosts, a central database for the hospitals/ clinics in the South West cluster is also linked to the Klerksdorp Provincial Hospital, which is a specialist hospital.

The hospitals in the North Eastern part of the province are also networked together, with Rustenburg Hospital being the host hospital with a central database for the surrounding hospitals/clinics. The network of the Rustenburg Hospital is linked to the database of the Klerksdorp Provincial Hospital as in the case of Taung Hospital. The Rustenburg Hospital is the Internet gateway for the infrastructure network .However, the network is designed in such a way that data can travel in any direction as illustrated in Figure 6.4.

Store and distribute patient data and information across the infrastructure network using a hybrid distribution data model

A hybrid distribution data model as applied in this infrastructure network is a combination of centralized and federated data distribution models. In a centralized distribution model, all the data is stored centrally and accessed by all stakeholders from a single source. Conversely, in a federated distributed model, data is not concentrated in a single store but remains spread across multiple subsystems. Data generated by each hospital is maintained by the hospital but replicated and stored centrally at both the selected host hospitals (Taung and Rustenburg Hospitals) for the South West and

North East hospitals respectively. Furthermore, the data stored at the host hospitals (Taung and Rustenburg Hospitals) is transmitted to the provincial database which is hosted at the Klerksdorp Hospital. A mechanism to obtain data from the participating hospitals must be put in place in the form of each participating hospital/clinic uploading the necessary data to the provincial e-health database during an off-peak period.

Have a network infrastructure that is robust and delivers continuous, 7/24 hours connectivity

Data can be updated asynchronously during an off-peak time from the participating hospitals/clinics to the provincial e-health database. This is to avoid data congestion and prevent slow transmission of data from one hospital to the other. Wireless routers with high speed transmission are used for all hospitals and clinics.

Promote fault-tolerant computing across the network infrastructure system

A fault-tolerant computer continues to operate when one of its components fails and ensures that no data is lost. A fault-tolerant computer has duplicated components and if one component fails the computer switches to the duplicated component. The design of the infrastructure network is such that data is duplicated in two other servers at any time excluding the local server. This allows other hospitals to switch on to the host server at Taung or Rustenburg Hospital in case of a system failure.

Incorporate the existing PAAB system into the new infrastructure network

The research findings from both the rural and the urban hospitals/clinics indicate that the PAAB system is used in all the hospitals/clinics (except the rural clinics). The PAAB system was developed as a solution to support revenue collection and patient administration. The proposed infrastructure network incorporates the PAAB system onto the network. The demographic information about the patients and revenue received are transmitted to the Provincial PAAB database via the Klerksdorp Provincial Hospital server. The next section explains the e-health applications adopted in the PEHF, in the form of discussing their envisaged operation.

6.5 Processes for e-health solutions

The processes for e-patient health record, e-consultation, e-prescription, e-referral and e-training systems are elaborated on in the following sub-sections.

6.5.1 Processes for e-patient health record system

An e-patient health record is central to the operation of the other e-health solutions. The types of data that can be stored in such a record include:

- Basic biographical data which gives patient identity and contact information;
- Core medical information like allergies, current problems, conditions and medication; and
- Cumulative medical history.

These data are generated by the various departments of a hospital and later stored in the central database server in each hospital. The data are further replicated and transferred to the selected host hospital servers. Figure 6.5 provides an example of how the data is generated and stored in a hospital.

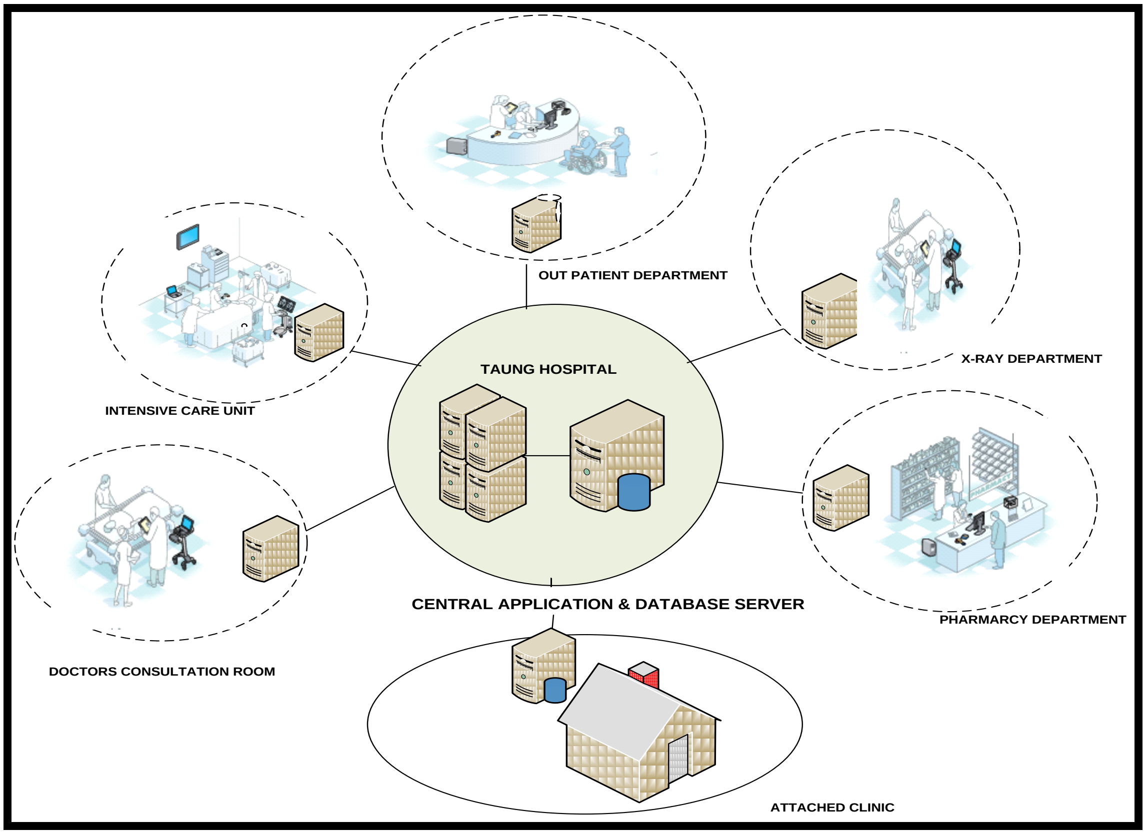


Figure 6.5: Linked departments in a hospital

Each department in the Taung Hospital, for example X-ray, pharmacy, intensive care unit, the consultation rooms and the OPD will have a computer which is linked to a central application server in the hospital. The central application server gathers all the data generated from each department and stores it in the central database server of the hospital. Gateway clinics which are attached to the nearest hospital will have their generated data replicated and transferred to the central database. This centralized data can facilitate the easy retrieval of patient information in the doctors' consulting rooms if a patient arrives without a paper-based history. It will decrease time spent on searching for paperwork. Furthermore, the data stored in the database at the host hospital (Taung Hospital) can be replicated and transferred to the provincial database server which is situated at Klerksdorp Hospital.

6.5.2 Processes for e-consultation system

The e-consultation system can help healthcare professionals share professional knowledge. The aim of the e-consultation is to improve patient healthcare by enhancing the skills and knowledge of local healthcare professionals by remote specialists. Remote e-consultation has a significant impact on rural hospitals/clinics due to the stated chronic shortage of doctors. Figure 6.6 illustrates an example of the process of e-consultation between Ganyesa and Klerksdorp Hospitals.

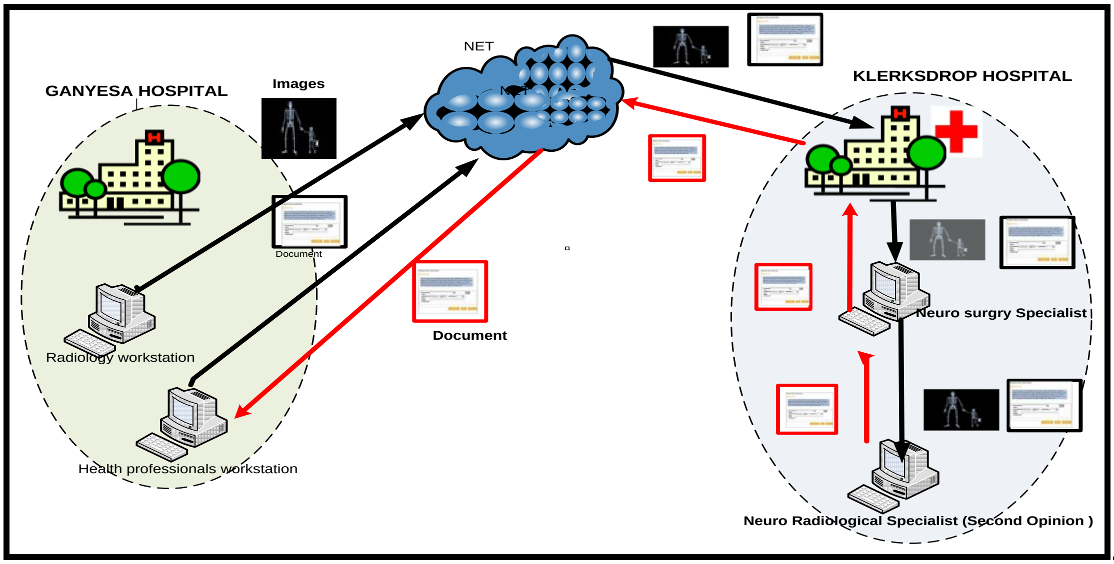


Figure 6.6: E-consultation among healthcare professionals

Figure 6.6 shows that a healthcare professional in a rural hospital (Ganyesa Hospital) needs the advice of a specialist on a radiology image taken at the hospital. The healthcare professional sends the image or document to the specialist at Klerksdorp Hospital via the database server. A neuro-surgery specialist examines it and forwards it to a neuro-radiology specialist for a second opinion. The neuro-radiology specialist gives his opinion to the neuro surgeon who sends a response to the doctor at radiology station at Ganyesa Hospital.

E-consultation is conceived as requiring synchronous communication in developed countries, but it is the opposite in developing regions like North West Province. Rural hospitals in the North West region are affected by severe economic and technical limitations on the availability of network infrastructure. The unreliability of bandwidth and the heavy workload of doctors will cause e-consultation in this region not to be supported by real-time media. Therefore, asynchronous communication is proposed as the context for the operation of the e-consultation system in the North West Province. With asynchronous consultation, information is stored in the hospital's database and forwarded at off-peak time. This allows the healthcare professionals to ask small, non-case specific questions which are important to the overall operation of the rural hospital/clinic. Such questions can include, what is the best method of pain relief in pediatric burns in hospitals with few drugs, or what brand, length and gauge of needle would be suitable for stereotactic core biopsy?

On the other hand, if the recommendations made in chapter 5 are viable to institute, then e-consultation between healthcare professionals can be synchronous. In this instance, communication can be supported by real-time media. It became evident from the research findings that the current system of consultation between healthcare professionals in the urban hospitals/clinics is mainly through face-to-face contact, referral letters, telephones and e-mails *(cf* Chapter 5, Section 5.3.2.4.1.). Therefore, e-consultation, whether synchronous or asynchronous will improve the current method of operation at the hospitals/clinics.

6.5.3 Processes for e-prescription system

E-prescribing means the transmission, using electronic media, of prescription or prescription-related information between a prescriber, dispenser, pharmacy benefit manager, or health plan, either directly or through an intermediary, including an e-prescribing network (*cf* Section 2.8). In this research, e-prescription means a computer-based electronic generation, transmission and filling of a prescription, taking the place of paper and faxed prescriptions (E-health Initiative, 2008). The e-prescription service is achieved through the use of a prescription management system. Figure 6.7 illustrates the process of e-prescription within Taung Hospital.

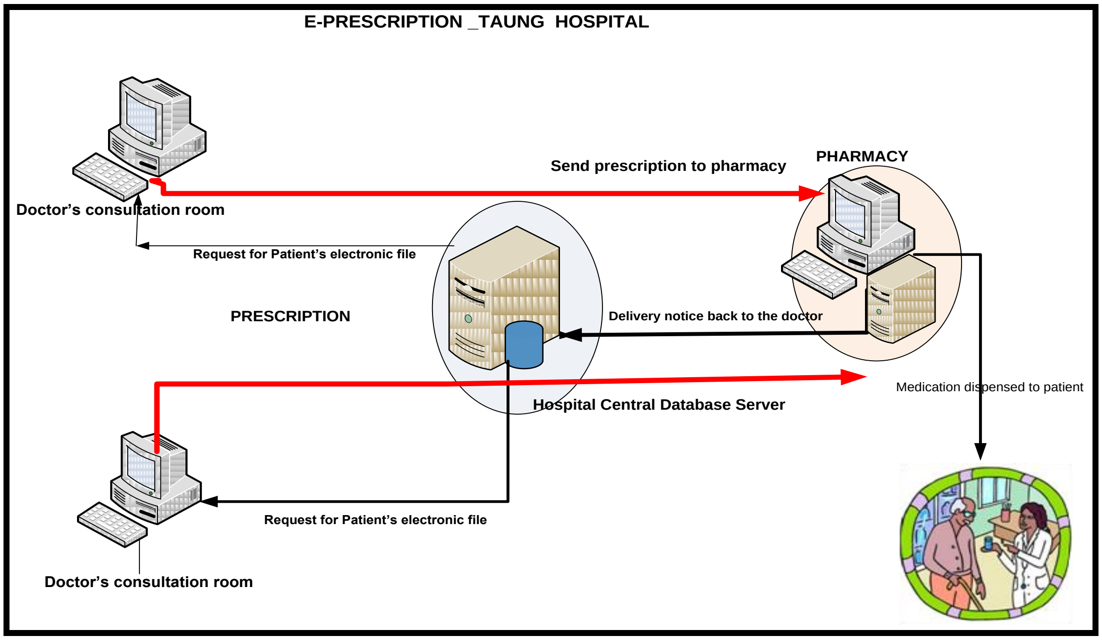


Figure 6.7: E-prescription process

When a patient consults a doctor in his consulting room within the hospital and the doctor sees the need for prescribed medication, the doctor requests the patient's information and current medication from the hospital's central database server. The key elements used to identify the patient on the system can include the patient's demographics or the patient's ID number. The doctor reviews the patient's current medication list and medication history, selects a drug and prescribes or adds a new medication. The doctor completes the prescription by signing the selected drug items electronically. He forwards it to the pharmacy department through the hospital's central database server. The pharmacist dispenses the medication to the patient and sends an alert to the doctor as a response to his message via the hospital's database server. The inclusion of an e-prescription solution was necessary because the findings indicate that the hospitals in both rural and urban areas need to reduce the long queues of patients at the pharmacy and need to prevent errors in dispensing medication (cf section 5.3.1.3.1).

6.5.4 Process for e-referrals system

The Australian Standard (2006) defines referral as the communication, with the intention of initiating care transfer, from the provider making the referral to the receiver. In this research study e-referral means transmitting electronic documents from doctor-to doctor, doctor-to-practitioners, and doctor-to-other departments within and outside the hospital through an e-referral management system (*cf* Section 2.9.2).

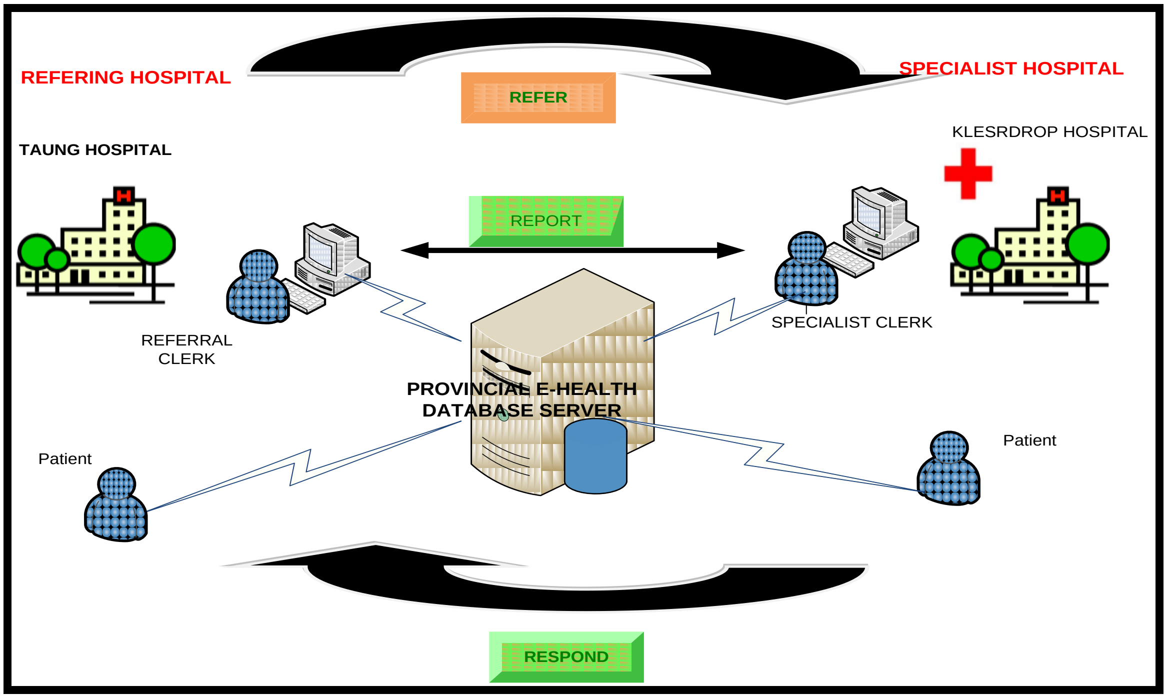


Figure 6.8: Example of e-referral process

According to the findings presented in chapter 5, there is an acute shortage of specialist doctors in the rural hospitals and clinics. Specialist doctors are concentrated in the urban hospitals like Klerksdorp Hospital and Rustenburg Hospital (cf Section 5.3.2.2.5). Therefore, most cases from rural hospitals that need specialist attention are referred to Klerksdorp or Rustenburg Hospital through the extensive use of paper-based work.

Figure 6.8 is an example of an e-referral process which is defined by the three “Rs”, Refer, Report, and Respond. The referral process starts when a patient visits a doctor at Taung Hospital and the patient needs a specialist referral. The doctor at Taung

Hospital requests for the e-patient health record of the patient through the hospital's central database. The doctor indicates his diagnosis and updates the patient record. The doctor alerts the referral clerk at Taung Hospital about the patient. The referral clerk at Taung Hospital uses the e-referral management system to initiate and manage the referral process. The referral clerk in Taung sends a summary of the patient's clinical history to the specialist clerk at Klerksdorp through the provincial e-health database. The specialist clerk at Klerksdorp Hospital receives the referral, communicates from the referral clerk and retrieves additional information about the patient from the Provincial E-Health database server. The specialist clerk reports back to the referral clerk acknowledging receipt of the referral message.

The patient sees the specialist who makes a diagnosis and captures his notes in the electronic patient health record system and submits them to the Provincial E-Health database server. The referral process is completed when the referring clerk of the referring hospital (Taung) accesses a referral report from the e-referral system and additional data from the Provincial E-Health database server indicating that the patient has been attended to at the Klerksdorp Hospital.

The referral process can take place in the same hospital, that is from one department to another department in the same hospital. In this instance, referrals are sent to the other department through the hospital database server. The receiving department provides the service to the patient and sends a response back to the referring department. It was evident from the research findings that patients who are referred with paper-based methods do not report back to the initiating hospital/clinic. This makes it difficult for the referred hospital/clinic to keep track of the progress of the patient (*cf* Section 5.3.1.3.1). Hence, the inclusion of e-referral in the PEHF.

6.5.5 Processes for e-training system

The assessment of the computer skills of the healthcare professionals in the hospitals/clinics that were investigated show that there are more healthcare professionals in the rural hospitals/clinics who have never used computers in their daily routine work, than their counterparts in the urban hospitals/clinics (cf. Figure 5.20). This finding means that there is a need to train healthcare professionals not only in the usage of e-health solutions, but also in basic computer literacy skills. Therefore, the main role of the e-training program is to provide e-training for effective use of e-health applications to improve healthcare delivery in the hospitals. The e-training program will assist doctors, nurses and other healthcare professionals to acquire basic computer skills and to master the use of the relevant e-health applications. Figure 6.8 depicts an example of an e-training process.

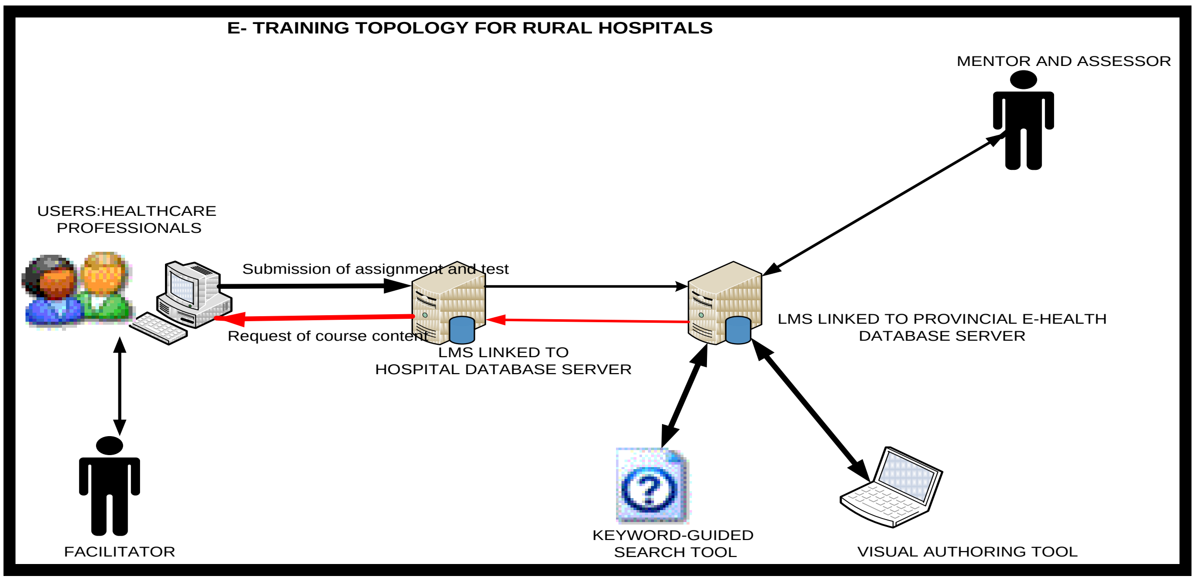


Figure 6.9: E-training processes

To initiate the training process, the healthcare professional uses the User Interface (UI) to register as a learner and to request to receive the course content which are divided into modules (basic computer skills, e-consultation lessons, e-prescription lessons, e-referral lessons and patient health record system lessons). As the user registers as a learner and selects a module, the Learning Management System (LMS) automatically assigns a mentor to the learner who guides and assesses their work. The learner requests the course material for the selected module. The learner completes the assignment on that module and forwards it to the mentor who will assess it and provide feedback to the learner. During the completion of assignments, the learner can consult with an appointed facilitator in the local hospital if assistance is needed.

The LMS delivers electronic content in the form of lessons about how to use the healthcare applications. The LMS is integrated as part of the e-health applications on the provincial and local hospital database servers. The LMS will support interactive learning but assignments will be submitted through the uploading of files. The LMS has collaborative features like discussion forums where learners will exchange ideas, post questions and offer answers which are relevant to the subject. There is a keyword search tool to assist learners to find supportive content to complete their assignments. Furthermore, there will be a visual authoring tool for experienced authors to create and update assignments, tests and other supporting materials which will be stored in both the hospital and provincial e-health database servers. However, healthcare professionals at the hospitals/clinics indicated that they need classroom-based training (face-to-face training), which should be followed up and supported by the continuous availability of an e-training system. The next section presents the guidelines for the operation of the e-health framework.

6.6 Guidelines for implementation

The PEHF can be used at provincial level or be applied at local hospital/clinic level. The framework can be used to improve upon existing e-health structures or to promote new e-health solutions for the health institution. However, the shortage of skills and expertise in the field of e-health and the different levels of literacy and diversity of the stakeholders involved are of concern. In view of this, a PEHF guideline for implementation was developed together with the processes for each e-health service to assist with its implementation. Furthermore, to make the implementation more tangible for the province and the hospitals/clinics, guidelines from Ilia (2006) were adapted.

There are four broad guidelines which need to be followed when applying the PEHF. Each guideline is discussed through a brief introduction, an explanation of its operational implications and a step by step approach

Guideline 1: Organizing requirements

In using the PEHF, health institutions must first formulate a structured set of requirements which constitute a list of needs. This includes the need to achieve a seamless migration from the current, usually fragmented system to an ideal future integrated environment.

Operational Implications

The formulated requirements for components of the framework could include:

- User interface, user process and business component requirements;
- Security requirements which are confidentiality and privacy of users. The security requirements must be in line with national legislation and professional practice;
- Communication related requirements which are messaging mechanisms and transactional control; and
- Capabilities such as scalability, performance, availability and reliability, which are governed by best practices.

Approach

The approaches to achieve the requirements are stated below:

Step 1: Clarify the needs in which you develop a list of known needs.

Step 2: Understand the required features and potential solutions in which you assess the facilities required.

Step 3: Understand the architectural requirements in which you compare and reconcile the required features and potential solutions with the PEHF.

Step 4: Document the requirements in the form of a “to be” statement.

Guideline 2: Defining the operational environment

This is to evaluate the hardware and software environment against the framework in the context of the expected business environment and the capability of available software.

Operational implications

- A stable infrastructure to ensure a robust and manageable e-health environment;
- Integration of systems running on different platforms to create an information sharing environment; and
- A practical identity management system to ease the burden of access and authentication.

Approach

Step 1: Understand the environment by collecting and organizing national, regional and local requirements.

Step 2: Define the initial technical architecture by listing the required technical features, scope and boundaries of the main technical areas.

Step 3: Develop a preferred technical architecture solution.

Step 4: Define the preferred operational environment by evaluating and performing a series of tests on a small scale to establish how the application would behave in that environment.

Guideline 3: Align the existing healthcare applications with the new e-health applications

This is achieved by aligning the existing healthcare applications which have been assessed and retained, with the new e-health framework.

Operational implications

The existing applications are designed to operate independently. Each application has its own unique user interface, in-built business process, business logic and proprietary database. It has been implemented to perform a specific job in a specific way. The existing applications are expected to work in a larger environment alongside other applications within a distributed processing environment. There are two degrees of integration, first enabling the application to interoperate with other applications and second, integrating the application functionally with others to use shared data.

Approach

Step 1: Understand the current and target capabilities of the application. This is done by assessing what the application currently does, how it does it and reviewing future development plans.

Step 2: Understand the interoperability capabilities of the application by assessing the structural capability of the application to interact with other applications.

Step 3: Re-engineer the application by mapping it onto the new application solution and define the revised application architecture.

Step 4: Define a preferred application solution by reviewing how the application might fit into a portfolio of complementary applications. Make adjustments and reconcile the new application with the others.

Guideline 4: Developing solution

When a request for proposal (RFP) is received, it is analyzed to clarify and categorize the requirements posed by the organization. This is compared with the PEHF, aligned with the application software and the preferred operational environment to identify gaps and overlaps which can provide a vehicle for the structured response to the RFP.

Operational implication

It implies deciding on the key technical architecture parameters by inspecting the likely e-health solution, the organization of data and a possible network solution.

Approach

Step 1: Understand the scope and boundaries in which to develop the content of requirements.

Step 2: Understand architectural features by analyzing requirements and comparing them with the PEHF to arrive at architectural specifications.

Step 3: Define the architecture by carrying out more detailed analysis to produce detailed architectural specifications.

Step 4: Develop a solution by selecting the preferred applications and operational environment and prepare a response to the RFP.

The next section focuses on information security management in the context of the PEHF.

6.7 Information Security Management in the PEHF

In order to use the PEHF and ensure its continued relevance given the shifting environment and the rapid development in the area of security governing e-health applications, the researcher recommends the use of the International Information Security Management Standard, the ISO 27799 (2008), in South Africa the SANS 27799, which is based on the ISO 27001 and ISO 27002 standards (*cf* Section 2.4.1 and Section 2.5). The ISO 27799 (2008) is a comprehensive guideline for both security and privacy. It has been adopted as a standard by the South Africa Department of Health.

The area of health information and how to protect its confidentiality, privacy and integrity while ensuring its availability for healthcare delivery is the issue addressed by ISO 27799 (2008). The standard, furthermore, specifies a set of controls for managing health information and provides health information security best practice guidelines. By implementing this standard, the hospitals/clinics and other custodians of the PEHF may be able to ensure and maintain its confidentiality, integrity, privacy and availability.

The next section discusses why the PEHF is valuable to the North West Province.

6.8 The value of the PEHF to the North West Province

The value of the PEHF to the North West Province lies in the fact that the PEHF integrates all the ICT infrastructure, resources and services to enable all the urban and rural hospitals/clinics to share such ICT infrastructure and services whilst, at the same time, allowing these hospitals/clinics the autonomy and flexibility they need to take control of their own IT environment. This is important as the findings reveal that there is a widespread shortage of doctors in rural hospitals/clinics when compared to urban hospitals.

Furthermore, the findings indicate that the urban hospitals have more ICT equipment than the rural hospitals/clinics (*cf* Sections 5.3.1.5 and 5.3.2.5). By integrating the ICT infrastructure, resources and services, the PEHF assists to bridge the digital divide between the urban and the rural hospitals/clinics in the North West Province. Moreover, it became evident that some of the problems experienced in the hospitals/clinics such as insecure patient health records, loss of patient files, the inability to trace patient files after many years, lack of consultation among doctors for professional advice, the long queues of patients at OPD and pharmacy and the false use of identity documents to collect medication from two or more hospitals at the same time (cf section 5.3.2.1) can be addressed by the PEHF. By integrating ICT applications within and across the hospitals/clinics, the PEHF is poised to facilitate e-consultation among healthcare professionals, provide integrated patient information at the point of care, assist in e-referrals and promote e-prescription. This will improve productivity and the efficiency of healthcare delivery in these rural and urban hospitals/clinics.

Thirdly, as the PEHF integrates hospitals/clinics' applications, services and processes, it improves knowledge sharing among healthcare professionals and enhances service know-how of the healthcare professionals, and thus, improves the delivery of healthcare services in the North West Province. It emerged from the findings that there is Internet facility in both the urban and rural hospitals but this is limited to searching information and sending e-mails (Sections 5.3.1.5; 5.3.2.5).

It was found that both the urban and rural hospitals have PAAB systems but they are used to support revenue collection and keeping patient demographic information (Sections 5.3.1.5; 5.3.2.5). It is clear from this discussion that these ICT systems in the hospitals/clinics are not integrated to work together across organizational and departmental boundaries to use information that has been provided by the patients (*cf* Section 5.4.3). With the PEHF, all these ICT resources are brought together to enhance availability and the proper usage of patient information which leads to a better delivery of healthcare services.

The PEHF incorporates an e-training component for healthcare professionals in the NWP. Therefore, the PEHF ensures that the healthcare professionals are equipped with both basic computer skills and e-health application skills to empower them to work efficiently in the electronic space. Figure 6.10 summarizes the value of the PEHF to the North West Province.

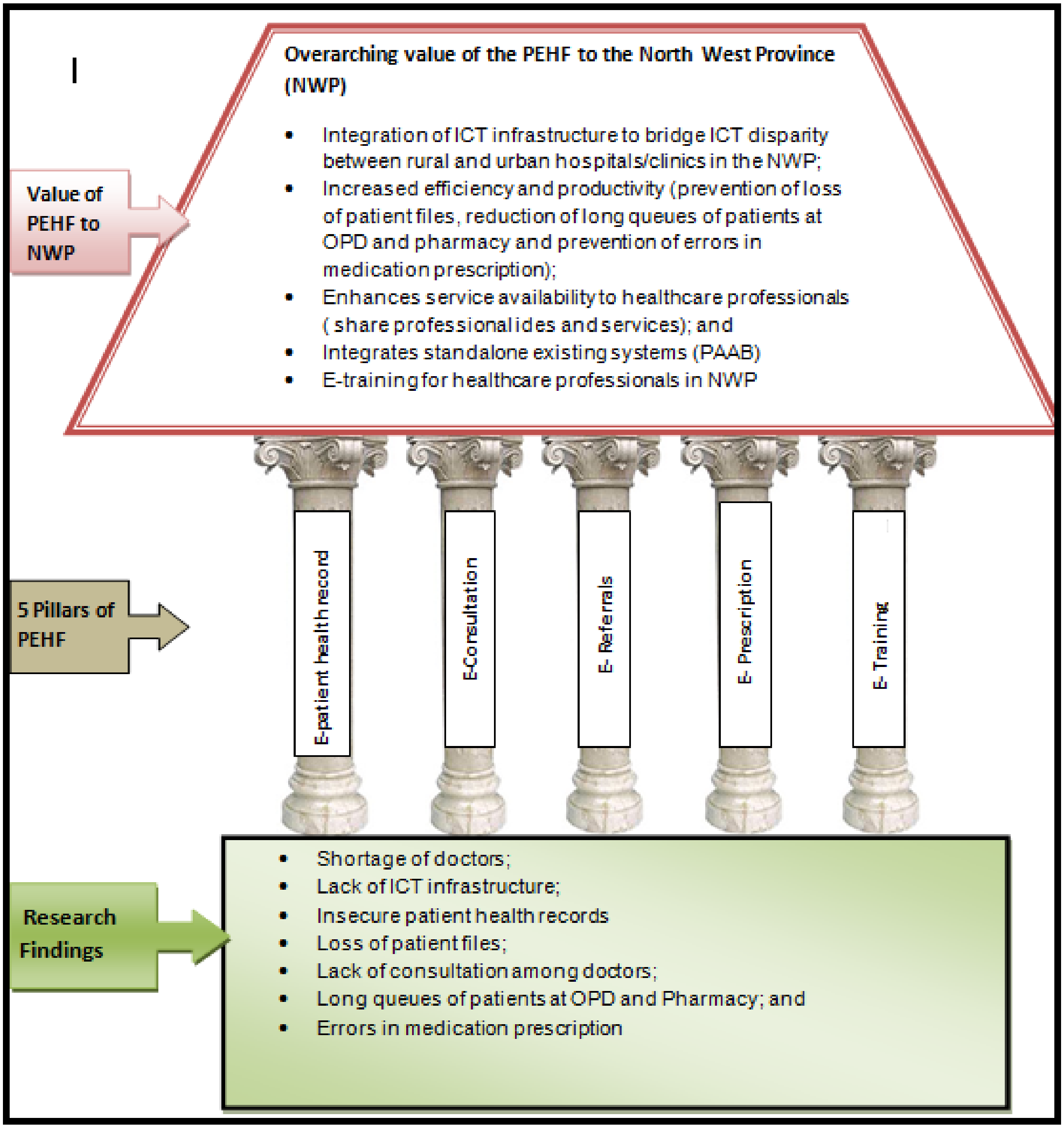


Figure 6.10: Value of PEHF to North West Province

The value of the PEHF is supported by the five pillars of the PEHF (e-patient health record, e-consultation, e-referrals, e-prescription and e-training) and the foundational components being the research findings.

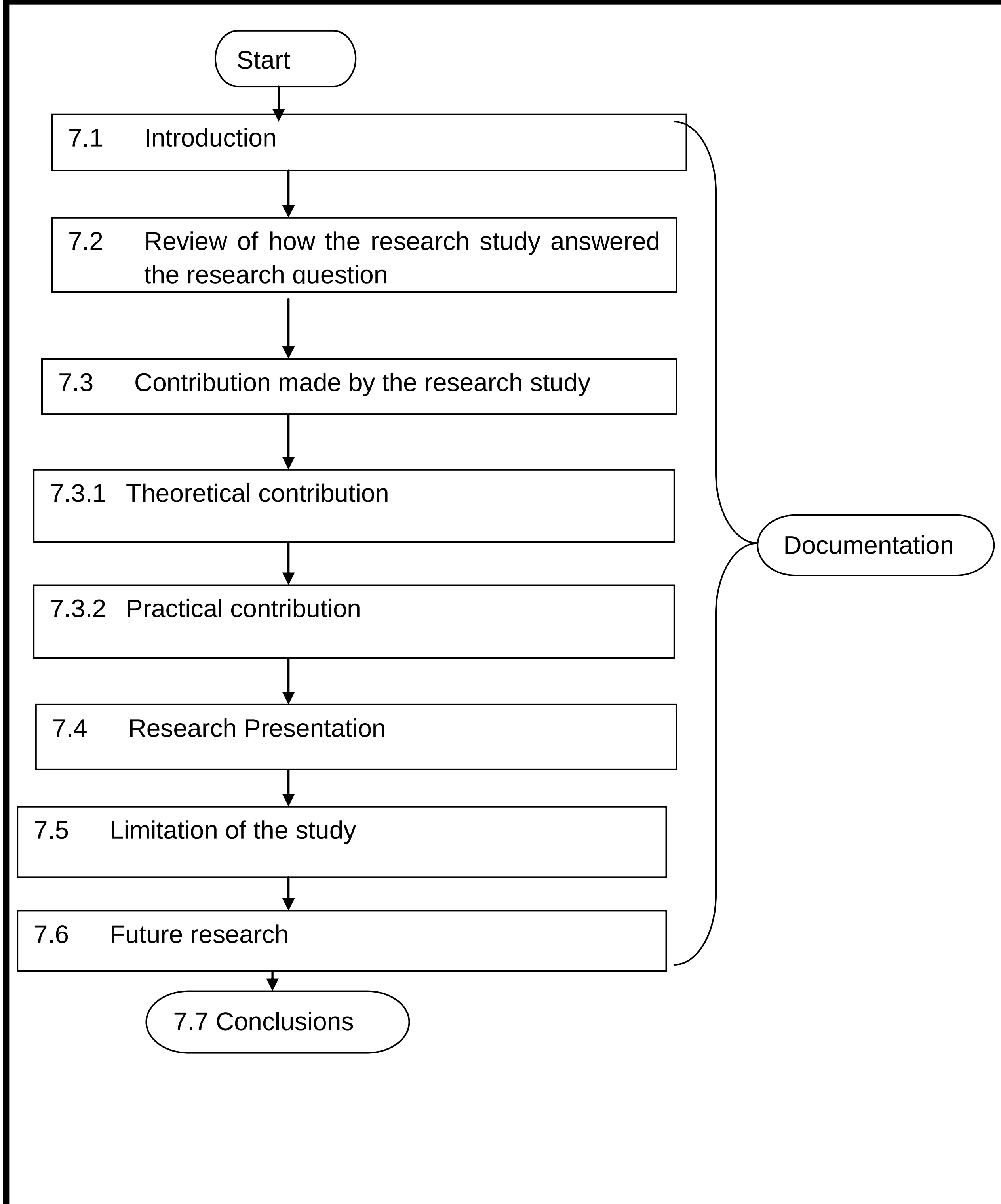
6.9 Conclusion

This chapter answers sub-research question 2, namely:
How can the identified outcomes of the e-health readiness assessment be used to compile an e-Health Framework for use in hospitals/clinics in the North West Province?

The chapter starts with an overview of the e-health framework and states the aims and objectives, the guiding principles and the capabilities or features which can make the framework relevant to the people in the North West Province.

In addition, the chapter highlights the approach which underpins the compilation of the PEHF. The SOA is adopted because it gives autonomy to the participating hospitals/clinics while integrating services across the hospitals and clinics. Furthermore, the description of the framework and its various components are stated.
An infrastructure network which serves as a network solution for the integration of services is presented in the chapter. Hospitals/clinics are clustered into South West and North East hospitals/clinics to facilitate the easy transmission of data and information across the hospitals/clinics. The chapter further explains the operational processes that are based on the PEHF for e-patient health record, e-consultation, e-prescription e-referral and e-training systems. Guidelines for the implementation of the PEHF and the administration of security measures which are needed are provided in the chapter. Finally, the chapter discusses why the PEHF is valuable to the North West Province. The next chapter reflects on and concludes this research.

Chapter 7: Summary, Reflection and Conclusion



CHAPTER 7

SUMMARY, REFLECTION AND CONCLUSION

7.1 Introduction

This chapter reflects on case study research grounded in the interpretivist epistemological assumptions which led to the design of the PEHF for the North West Province. The chapter highlights the significance and contribution this research study makes to the body of knowledge.

According to Fade (2005), reflection involves describing, analyzing and evaluating thoughts, assumptions, beliefs, theories and actions. Fade (2005) further indicates that reflection is a thought process which involves:

- Looking back at events and asking questions - retrospective;
- Looking forward and asking questions - prospective;
- Self-assessment of practice/competence in a given situation; and
- Looking for learning points within the scenario or situation which is under reflection.

Retrospectively or looking back at events, this research study was, in the first place motivated by the researcher's interest in healthcare delivery in rural areas based on his personal experience in working in rural areas in the North West Province for many years. This intrinsic motivation of the researcher was reinforced by scientific articles elaborating on challenges in healthcare provisioning in rural areas (Ojo *et al*., 2006) and a white paper on health transformation in South Africa which was published in 2006.

The afore-mentioned white paper on the transformation of the public healthcare systems revealed that the majority of the South African population has inadequate access to basic healthcare services and that the greater percentage of this population lives in rural communities. Rasmeni (2007:3) further notes that a vast majority of South Africans, particularly those in the rural provinces like the North West, receive their medication from government-run hospitals/clinics. Therefore, the North West Health Department has invested substantially in the district and provincial health services, health facilities management and healthcare support services. However, despite this investment in the healthcare system and the stated objective of the North West Health Department to reduce inequalities in healthcare services through overcoming the inadequacies of hospitals/clinics (DoH, 2006), many of the rural people who live in the North West do not receive quality healthcare services.

These identified challenges provoked the researcher to consider whether there is no special way by which specific e-health solutions could be provided to help alleviate this problem. This led to the idea of a locally relevant PEHF that can aid the delivery of efficient and effective healthcare services to the people in the North West Province. Interestingly, this notion is echoed by other scholars when they reiterate that e-health has the great potential to support systems within the healthcare sector to address pressing challenges facing healthcare systems in developing countries (Ojo *et al,* 2006).Therefore, the main purpose of this research study was to compile an e-health framework which could be used to improve healthcare delivery in the North West Province. However, it was important to ensure that the framework should cater for all the essential areas of e-health (e-patient record system, e-consultation system, e-prescription system, e-referral system and e-training system) that are needed in a rural area like the North West Province.

This precipitated the main research question of this research study:

How can an E-Health Framework with the objective of improving the delivery of electronic healthcare services to the people in the North West Province be compiled?

The research question was broken down into two sub-research questions which guided the entire research process until the PEHF was compiled.

The researcher reiterates, having stated the events leading to the research question, that the essential elements for the PEHF need to be clearly understood by the healthcare professionals who use it, for it to be useful.

It should be noted that the researcher is aware of the ample evidence which suggests that a researcher's motivation and preconceptions shape all research processes (Deetz, 1996). However, the researcher's motivation prior to this study was used actively and creatively in the research process to compile the PEHF. This is supported by Eakin and Mykhalovskiy (2003), who assert that a researcher's subjectivity is something used actively and creatively through an interpretive research process rather than it being a problem for the researcher to be biased.

The remaining sections of this chapter revisit how the research study has successfully provided answers to the research questions and the contribution it makes to the body of knowledge. Furthermore, section 7.4 l reflects on how the research has been presented in the research study. This is followed by the limitation of the study, future research directions and finally, the conclusion of this chapter.

7.2 Review of how the research study answered the research question

From the literature review in chapters 2 and 3 as well as the personal experience of the researcher, the research study was carried out in two phases to answer the two sub-research questions (*cf* 1.2.1). Ten selected hospitals and clinics are categorized as urban and rural, and an e-health readiness assessment conducted. The outcomes of the e-health readiness assessment together with the literature review led to the answering of the research question and the compilation of the PEHF. Various methods and techniques were applied to solicit answers to the main research question and its research-sub questions. In reviewing this research study to assess how it has answered the research question, the researcher adopts:

1. Klein and Myers (1999) seven principles for evaluating interpretive field studies in information system; and

2. The researcher poses six pertinent questions.

These are expounded in Table 7.1.

Source: Klein and Myers (1999)

Fundamental principles for conducting and evaluating interpretive studies	Evaluation questions	How and where applied in this study
1. The fundamental principle of the hermeneutic circle	Does the data analysis consider the independent meaning of parts and whole of human understanding?	Situations in hospitals were analyzed in parts and whole using Creswell’s (2007:75) within-case, cross-case and holistic-case analysis template. Applied in data analysis in chapter 5
2. The principle of contextualization	Does the research study provide historical background so that the intended audience can see the current situation?	Section 5.2 highlights the background history of the multiple case studies (hospitals/clinics) which led to the positioning of the research question
3. The principle of interaction between the researchers and the subjects	Is the researcher’s role in the research indicated?	The role of the researcher is positioned as observer/participant. This is reflected when the researcher, during his field visits to the hospitals/clinics observed the physical conditions of the hospitals/clinics and interacted with doctors, nurses and hospital administrators through group interviews
4. The principle of abstraction and generalization	Was the research outcome generalized to other context?	No generalization, the details revealed by data were content specific based.
5. The principle of dialogical reasoning	Was the interpretation of the data related to literature?	Yes, interpretation of data in chapter 5 was done in light of literature in chapters 2 and 3.
6. The principle of multiple interpretations Multiple witness accounts even if all tell it as they saw it.	Were different interpretations and ideologies taken into account for the compilation of the results?	Yes, expert review was sought from the North West Health Department officials and other

		groups (doctors, nurses and hospital administrators)
7. The principle of suspicion Requires sensitivity to possible "biases" and systematic "distortions" in the narratives collected from the participants.	Was data collection done in such a way to avoid biases?	Yes, data collected from participants was done anonymously. Multiple source for data collection were employed and multiple measures for data collection were employed (interviews, questionnaires and document analysis)

Table 7.1: Evaluation of research study

In addition to Klein and Myers' (1999) seven principles for evaluating interpretive field studies in information system, the researcher poses these six pertinent questions to expound on the evaluation of this research study:

1. Were the methods chosen appropriate to answer the research question?
2. Why was a case study a relevant approach to the research but not any other approach?
3. Is the unit of analysis and site most appropriate to the research study?
4. Does the collected data capture the contextual complexity and converge to support the research findings?
5. Do the research findings lead to the compilation of the e-health framework?
6. Does the research address problems that are of concern to the healthcare professionals?

The next section provides evidence that clarifies each question. This is done in ascending order starting with question 1.

1. **Were the methods chosen appropriate to answer the research question**?

Qualitative methods grounded in interpretive assumptions were used in this research study. A qualitative research design was selected as appropriate for this study because the researcher assessed and described the e-health readiness of rural and urban hospitals/clinics in the North West Province and the social impact of ICT usage in these hospitals/clinics. The assessment of the e-health readiness was meant to explore and understand the social or human problems. Therefore, a qualitative design was appropriate for this research. Alternative design choices like quantitative could have been used, but could not have assessed the human feelings and perspectives attached to the research. Quantitative design, according to Creswell (2009), depends on variables which can be measured by using numbers and statistical procedures.

The researcher is aware of the debate and different perspectives about the importance of validity and reliability as criteria for evaluating qualitative research. It is pointed out that without validity and reliability, qualitative research risks being seen as nonscientific and lacking rigor (Morse, Barrett, Mayan, Olson and Spiers, 2002). Their argument is compelling and suggests that reliability and validity should not be evaluated at the end of the research, but should be goals that shape the entire research process, influencing the study design, data collection and analysis choice. However, there is a second perspective that views the criteria of validity and reliability as inappropriate for qualitative research and argues for the development of alternative criteria for assessing qualitative research (Sandelowski and Barroso, 2002). Their position is commonly based on the premise that the theoretical and methodological beliefs informing quantitative research are not the same as the methodological and theoretical beliefs informing qualitative research and are therefore, inappropriate (Sandelowski and Barroso, 2002).

Cohen and Crabtree (2008) argue for a third perspective by indicating that the field of qualitative research is broad and diverse, without lending itself to evaluation by one set of criteria. Instead, researchers need to recognize each study as unique in its theoretical positioning and approach, and that different evaluation criteria are needed. A full comprehension of the scientific quality of qualitative research requires a deep understanding of the theoretical foundation and the science of the approach. Thus, evaluating the scientific rigor of qualitative research requires learning, understanding, and using appropriate evaluation criteria (Johnson, Long and White, 2001; Rolfe, 2006;

Sparkes, 2001). In this research, the researcher aligned the study to the third perspective and, therefore, used triangulation methods and expert opinions to maintain credibility, relevance, dependability and confirmability (*cf* Section 4.8) of the PEHF to make the qualitative research reliable and valid.

2. Why was a case study a relevant approach to the research but not any other approach?

The e-health environment and its application in rural and urban areas in developing nations, is regarded as an important area of research in the IT field because the feedback from the users and their experiences are valuable to ensure the sustainability of use of new e-health systems. For this reason a case study is appropriate since research based on experiences and feedback is important. The research involved the assessment of different hospitals and clinics in their natural setting to obtain detail about the needs of these health institutions, therefore, a case study approach is appropriate. This is supported by Yin (2003) who refers to a case study as an empirical inquiry that investigates a contemporary phenomenon within its real- life context, especially when the boundaries between the phenomenon and the context are not clearly evident. Creswell (2007:73) expounds on this and explains that a case study research is a qualitative approach in which the investigator explores a bounded system (case) over time through detailed, in-depth data collection involving multiple sources of information. There are other approaches like ethnography, grounded theory and phenomenological approaches, but none of these could, according to the researcher, have answered the research question more appropriately than the case study approach supported by a system approach.

3. Is the unit of analysis and site most appropriate to the research study?

This is a case study on e-health readiness assessment and how the outcomes led to the compilation of a framework for rural and urban hospitals/clinics in the North West Province. The units of analysis were healthcare professionals (20 hospital administrators, 20 doctors, 20 nurses and 20 assistant nurses) at selected hospitals/clinics in the North West Province – this is a multiple case study. The healthcare professionals were interviewed, given questionnaires to complete and were observed at different sites in the North West Province over a period of twelve months. Since the case study used healthcare professionals as the units of analysis, then in essence, the research could have been conducted in any province. However, the aim was primarily to compile an e-health framework for the North West Health Department, therefore, the North West Province was selected as the research base. This province also provided ethical clearance and support to conduct the study. The diverse healthcare professional population of the North West Health Department is similar to that of the other provinces in South Africa. The context and the characteristics of the provinces in South Africa are similar throughout the country. Therefore, the researcher reiterates that the units of analysis and the site chosen for the study was appropriate and if this study is replicated in the other provinces, the same PEHF may be compiled. This implies that the PEHF can be adopted by the other provinces.

4. Does the collected data capture the contextual complexity and converge to support the research findings?

As indicated in chapter 1, the main aim of the study is to conduct an e-health readiness assessment in selected hospitals/clinics in the North West Province and to use the outcomes to compile an e-health framework which encompassed e-patient health record, e-consultation, e-prescription, e-referral and e-training systems. To this end, data was collected from six rural hospitals/clinics and four urban hospitals/clinics. It was interesting to note that some nurses in two rural clinics were reluctant to complete the questionnaires stating that they were afraid to lose their jobs. This was resolved when their district manager contacted them, explained the nature of the research to them and assured them about how the research maintains participants' confidentiality and anonymity. The nurses accepted the explanations and completed the questionnaire.

Data from the hospitals/clinics were collected using six sources, viz., group interviews, questionnaires, observation, expert reviews, document analysis and photographs. The use of six sources reveals the complexities that differentiate between the rural and urban hospitals/clinics. The rationale was to expose the different needs of the hospitals/clinics and the different views and experiences of healthcare professionals in the interpretation of e-health solutions so that possible contradictions and similarities in the data could surface and be used in the compilation of the PEHF. Finally, the data collected using these six sources converged to support the research findings which further aided the compilation of the PEHF. The PEHF was also validated by requesting experts to review its usefulness and applicability for the North West Health Department. This was necessary to ensure that the framework can add value to delivery of healthcare services in this province. The mere development of the framework without validation would have been a futile exercise.

5. Do the research findings lead to the compilation of the e-health framework?

A detailed account of the research findings is presented in chapter 5. Within the findings of the study, it was evident that there are no e-health solutions such as e-patient health record, e-consultation, e-prescription, e-referral or e-training systems in both the rural and the urban hospitals/clinics. The lack of these e-health solutions has led to numerous challenges such as insecure patient health records, loss of patient files, the inability to trace patient files after many years, lack of consultation among doctors for professional advice, long queues of patients at OPD and the pharmacy department, errors in medication prescription and the false usage of identity documents to collect the same medication from two or more hospitals. The findings further indicate that had e-health solutions been implemented, some of these challenges could have been identified and resolved.

Data obtained from these findings together with the literature review informed the compilation of the PEHF. Additionally, a series of reviews of the PEHF took place during its compilation, and thus, it evolved over time until the final product emerged as a successful framework to assist the North West hospitals/clinics in their efforts to deliver better healthcare services to the people in the province.

The PEHF also provides an infrastructure network for equitable distribution and usage of ICT infrastructure between rural and urban hospitals/clinics. This was motivated by the findings which emerged from the study. Furthermore, the processes provided for each e-health solution were based on the findings from chapter 5. The findings informed the use of the SOA for the design of the e-health framework. The SOA approach allows each participating hospital/clinic to keep its autonomy to maintain its own IT environment, yet still remains part of the integrated network.

In summary, the research findings led not only to the creation of the PEHF, but also to the infrastructure network solution and the processes for the e-health services.

6. **Does the research address problems that are of concern to the healthcare professionals?**

The research findings revealed the problems and concerns of healthcare professionals in relation to the delivery of healthcare services in the North West Province. As a result, the PEHF was compiled. The PEHF was well accepted by a panel of e-health experts who were appointed by the North West Health Department as a major step toward transforming healthcare delivery in the province. Some comments made by the experts are indicated in section 6.1.3. Additionally, a letter of the acceptance (from the panel of experts) for the PEHF to confirm its usefulness is attached as appendix H. However, its implementation goes beyond the scope of this thesis due to its financial implications. This prompted the formation of the guidelines for its implementation together with processes for each e-health service. The next section discusses the contribution that is made by this research.

7.3 Contribution made by the research study

Opponents of qualitative research have criticized it as lacking scientific rigor and that it does not address generalizability. As a proponent of qualitative research, the researcher has used the preceding sections to illustrate how the methodological approach used in the research study has answered the research questions. The main research question was divided into two and different techniques were used to solicit answers to them. The solicited answers converged to answer the main research question. In the following section and the subsequent ones, the researcher indicates how this research has contributed to the existing knowledge (cf section7.3.1) and practice (cf. section 7.3.2) in health informatics.

7.3.1 Theoretical contribution

Locke and Golden-Biddle(1997) state that “an idea becomes a contribution, when it is constructed as important by the members of a scholarly community, relative to the accepted knowledge constituted by the field’s written work”.

Barrett and Walsham (2004) discuss making contributions from interpretive case studies. Drawing from IS research literature, they examine and outline the processes of constructing and using contributions. Barrett and Walsham (2004) distinguish between the *how*, *what* and *when* of the contribution, and base their arguments on the work of previous research (Locke and Golden-Biddle, 1997; Latour, 1987; Walsham, 1995). The *how* of the contribution focuses on how contributions are constructed and three broad strategic concepts are offered to achieve this, based on the work of Locke and Golden-Biddle (1997), and Latour (1987). The *what* of the contribution deals with the content of the contribution, and here their focus is on the work of Walsham (1995). The *when* of a contribution addresses the aspect which Latour (1987) states that a contribution constructed by an author is a claim to knowledge whose fate is always in the hands of later authors.

In evaluating the contribution of this research, the researcher focuses on the *how* and *what* of the contribution that the researcher claims is made by the research, and specifically uses the concepts derived from the work of Locke and Golden-Biddle (1997) and Walsham (1995). Locke and Golden-Biddle (1997) identify two processes of constructing contributions. These are structuring inter-textual coherence and problematizing context. Constructing inter-textual coherence refers to the need for texts to establish contribution by representing and organizing existing knowledge to configure a context for contribution that reflects the consensus of previous work. The researcher has used chapters 2 and 3 to organize the existing knowledge to inform the context and problematization of this research. The current literature on e-health and e-health readiness assessment frameworks in terms of developing and developed countries are argued in Chapters 2 and 3 with in-text references to enable other researchers to relate to them.

The second process involves problematizing the same literature that provides locations and the *raison d.etre* for the present efforts (Locke and Golden-Biddle, 1997). Locke and Golden-Biddle (1997) identify three ways of problematizing context for the construction of a contribution by the present work, by focusing on the incompleteness, inadequacy, and incommensurability of the existing literature. Incompleteness occurs when it is claimed that the literature is not complete, and that the present work will aim at future development of the literature. Inadequacy is when it is claimed that the existing literature does not sufficiently incorporate different views and perspectives about a phenomenon, and that the present work will address this aspect. Incommensurability is when it is claimed that the literature overlooks different and relevant perspectives and makes inaccurate claims. In this research study, the phenomenon of e-health frameworks for hospitals/clinics in existing literature is incomplete and incommensurable. Inadequacy was claimed when the review of the literature on e-health frameworks revealed that most of the e-health frameworks have evolved in developed countries in the context of wealth where there are well developed national and local ICT infrastructures already in place, but this is not so in developing countries. Currently, the researcher affirms that there is little or no literature on e-health frameworks of relevance for developing countries, especially in the rural areas of Africa, including South Africa and even more so in the North West Province. Therefore, further development and incorporation of knowledge from this research into the existing body of knowledge is considered necessary.

Incompleteness was claimed because there was no literature which confirms a single e-health framework which incorporates e-health records, e-consultation, e-prescription, e-referrals and e-training systems into a single framework for the African developing country context. Therefore, this research study adds to the existing body of e-health knowledge in literature on e-health frameworks for Africa using the SOA .At this point, the researcher reiterates that the SOA is not a framework on its own but an architectural style that can guide the development of a framework either in the context of wealth or poverty. In this research study, the SOA is used to guide the development of the PEHF in the context of developing countries where ICT infrastructure is lacking. The theoretical contribution which this research study makes to the body of existing knowledge has been argued, and the next section argues about the practical contribution of this research study.

7.3.2 Practical contribution

The research study provided the surrounding contextual environment and essential components that were critical for the compilation of the PEHF. The various complexities that differentiate the context of rural hospitals/clinics from urban hospitals/clinics were considered, including the circumstances that differentiate developing nations from developed nations before the PEHF was compiled. Its practical contribution is to foster e-health solutions to rural and urban hospitals/clinics. The PEHF aids the adoption of e-patient health record systems, e-consultation systems, e-prescription systems and e-referral systems, and provides ways to overcome the challenges that are related to e-health service processes for healthcare professionals in the hospitals/clinics. In addition, the research study helps to ensure the successful implementation of the PEHF through the implementation guidelines that are provided in the study.

Another practical contribution of the study is the ICT infrastructure network architecture solution to assist cluster hospitals/clinics to use common ICT infrastructure, while allowing the participating hospitals/clinics to maintain their autonomy. This promotes the effective reuse of resources, rather than their duplication, hence bridging the rural and urban equity divide in the healthcare sector. Furthermore, processes were provided for e-health services to assist the stakeholders in the implementation and sustainability of the PEHF.

Finally, the PEHF, which was based on the needs of the North West Health Department, has aspects like business components, integrated e-health services and processes which can be of great benefit to the province.

7.4 Research presentation

This section aims to help the reader to recapitulate the essence of each chapter as presented in the thesis. This is done in ascending order starting with the first chapter.
Chapter 1 introduces the research study by articulating the challenges in healthcare services in the North West Province. The researcher argues for the need and relevance of the research study by formulating the research problem and the research question. The relevance of the research is founded on the expectation that the research study contributes towards the compilation of an e-health framework, (encompassing e-patient health record system, e-consultation, e-prescription, e-referral and e-training systems) to assist the healthcare professionals to deliver quality healthcare services to the people in the North West Province.

The essence of chapters 2 and 3 is to present the theoretical backbone of the research study. Chapter 2 lays out the foundation of the study by carefully reviewing existing literature and previous studies to inform how e-health models and frameworks can benefit the hospitals/clinics. The chapter further emphasizes the different architectural styles of which enterprise SOA was selected. Chapter 3 reviews the relevant literature on e-health readiness assessment models and frameworks which could be applied. Reviewing the literature and other studies enabled the researcher to identify a gap in the study of e-health where the concept of using a single consolidated e-health framework approach to improve healthcare delivery has received little or no attention in developing countries. Chapter 4 discusses the various methodological approaches adopted to carry out the research study. The researcher justifies the approach and the methodology chosen for this research in this chapter. Chapter 5 presents a discussion and interpretation of the findings from the case study. The discussion and interpretation are done comparatively between rural and urban hospitals/clinics. The outcome of the findings, together with the literature review, informs the development of the PEHF which is presented in chapter 6. Chapter 7 constitutes the final chapter, which reflects on and concludes the research study.

Moreover, the researcher further reflects on these chapters and poses this question:

Has this research study been written in a style that can be understood by healthcare professionals and academics?

The research which focuses on developing an e-health framework through an electronic healthcare readiness assessment is written in a language and style meant to be understood by both healthcare professionals and academics. In writing up the research, the researcher presents the reader with an account of the research. First, the research problem and the challenges are described in chapter 1 and the choice of a case study is motivated. This is followed by an outline of the research questions and objectives which drive the rest of the research study. To make the research study easier to read, the researcher provides an outline in terms of a table of contents, and lists of tables and figures to guide the reader on what to expect in each chapter. Each chapter, thereafter, begins with a short introduction to signal its contents to the reader. At the end, each chapter is concluded with a concise summary of the presentation followed by an indication of what the next chapter is about. The next section presents the limitations of the study.

7.5 Limitations of the research study

The first limitation exhibited by this research study is the specific location chosen for this study. Only one province was selected which could constitute a major limitation in terms of generalization of the research findings. However, the North West Province which was chosen as the research base comprises both rural and urban areas which typify other provinces in South Africa. Moreover, the research study targeted participants who are healthcare professionals (doctors, nurses, assistant nurses and hospital administrators) and these healthcare professionals are found in all the other provinces in South Africa. The context of the rural and urban areas in North West Province is not different from that of other provinces in South Africa. Apart from this, the research study sought to obtain a detailed perspective of e-health solution needed to assist the delivery of quality healthcare services. It would have been problematic to perform such a detailed study in two or more provinces. Despite the fact that one province was used in this research study, the results obtained from this area can be replicated and applied to the other provinces in South Africa and other developing countries in the world.

The second limitation of this research is that the e-health readiness assessment did not cover all the dimensions of e-health readiness. For example, the e-health readiness pertaining to health financial and administrative systems was omitted. This was excluded to ensure the viability of the scope of this research. The third limitation of this research study is that the compiled framework has not been tested in an actual operational environment to ensure its workability and to identify areas of improvement and what the actual value is that it adds to e-health solutions in rural and urban hospitals/clinics. This is due to the financial implications associated with its implementation. However, a panel of experts on e-health appointed by the North West Health Department validated the applicability of the PEHF and certified that the PEHF is well designed as a tool to alleviate the challenges associated with healthcare delivery in the province. The panel undertook to present the PEHF to the executive board of the North West Health Department for its early implementation. Attached as appendix H is the letter from the e-health experts appointed by the North West Health Department.

7.6 Further research

The outcomes of the e-health readiness assessment were recorded based on what the researcher naturally experienced and saw at the time of the investigation. The results led to the compilation of the PEHF. Arguably, the researcher could have missed elements and cues that can further promote e-health solutions in these hospitals/clinics. It is, therefore, suggested by the researcher that such elements that may lead to further research can be identified. Such areas of research can include the design of user interfaces for both rural and urban hospitals/clinics in the context of the PEHF.

Another area of concern which the researcher did not address in detail because it falls outside the scope of this research but needs further investigation, is the issue of security and privacy of patient health information. This can be researched to determine how best the e-health technologies can be secured to protect patient health information which is a sensitive issue.

Furthermore, the e-prescription system indicated in this research as part of the PEHF can further be researched with regard to the “Intelligent Chronic Medication Administration Systems (CMAS) that can be used for administering medication such as ARVs and TB medication in rural hospitals/clinics. Again, it is important to note that for health technologies to be effectively used in hospitals/clinics, incentives for the healthcare professionals should be investigated. The researcher, therefore, recommends that further research be carried out on how incentives can be used to enhance healthcare professionals’ use, of ICT and e-health applications in hospitals/clinics to promote the delivery of quality healthcare services through e-health solutions. Finally, the testing of the framework in an operational environment is recommended as part of future research.

7.7 Conclusion

This chapter provides a reflection on the whole research study by first looking at the background events and motivation which prompted the study. The research question and the objectives of the research are reflected upon. The contributions made by the study which are both theoretical and practical, are reviewed. The research presentation, limitations and future research topics are also discussed.

The researcher undertook this research study to compile a framework which could assist hospitals/clinics in rural and urban areas to deliver quality healthcare services. The compilation of the e-health framework, the PEHF, came about through the outcome of an e-health readiness assessment conducted in selected rural and urban hospitals/clinics. The resultant recommendations and the literature review informed its development. These outcomes indicated many challenges, which included a shortage of doctors and a lack of e-health solutions (e-patient health record system, e-consultation system, e-prescription system, e-referral system and e-training system) which hamper effective delivery of healthcare services. It was important to use these outcomes from the research findings to develop the PEHF. Hence, the PEHF, which can be used to ensure the adoption of e-health solutions in rural and urban hospitals/clinics was developed. The PEHF includes the ICT infrastructure network architecture solution which clustered the hospitals/clinics to use common ICT infrastructure rather than duplicating these resources. As the ownership of the PEHF involves many stakeholders, implementation guidelines are provided to ensure its proper implementation and sustainability.

The PEHF, which is a major step towards e-health solutions in rural and urban hospitals/clinics, was well accepted by e-health experts from the North West Health Department, who pledged to advocate for its earlier implementation. Therefore, the product of this research needs not be confined to the North West Province but can be implemented in other provinces and countries, especially developing countries, with similar healthcare challenges.

In conclusion, this research study has been a learning expedition towards an e-health environment, a new dimension of solving many of the challenges confronting rural and urban hospitals /clinics in delivering quality healthcare services. Finally, the learning and writing up of this research has been an invaluable experience for me. My sincere hope is that the readers will also experience this sense of discovery that for me characterizes this research.

REFERENCES

AAS, I.H.M. 2001. A qualitative study of the organizational consequences of telemedicine. *Journal of Telemedicine and Telecare*, 7 (1):18-26.

ADAY, L. A., QUILL, B. E. AND REYES-GIBBY, C.C. 2001. Equity in rural health and health care. In Sana Loue ena Quill, B.E. eds. *Handbook of Rural Health*. New York: Kluwer Academic-Penum Publichers.45–72.

ADIGUN, M.O., OJO, S.O., EMUOYIBOFARHE, O.J AND DEHINBO, E. 2006. *E-healthcare Management: A Partner and collaboration model in developing countries*. Proceedings of the 1st All African Conference on Technology Diffusion. Johannesburg, June, 2006.

ADLER, K.G. 2009. *E-Prescribing:* Why the Fuss? *Family Practice Management*, 16(1):22-27. [Online] Available: www.medscape.com. [Accessed: 12/12/2009].

ALEXANDER, H. 2007. Health-service evaluations: Should we expect the results to change practice? *Evaluation*, *9*(4): 405-414.

ALLAN, J. AND ENGLEBRIGHT, J. 2000. Patient-Centered Documentation: An Effective and Efficient Use of Clinical Information Systems, *Journal of Nursing Administration*. 30(2):90-95. [Online] Available: http://www.jonajournal.com/pt/re/jona/abstract. [Accessed: 16/3/2009].

ALTRICHTER, H., FELDMAN, A., POSCH, P. AND SOMEKH, B. 2008. *Teachers investigate their work (2nd Ed.):* An introduction to action research across the professions. London: Routledge, 147.

AMATAYAKUL, M. 2007. *Managing Information Privacy and Security in Healthcare*: Setting Standards in Healthcare Information. Healthcare Information and Management

Systems Society (HIMSS). [Online] Available: www.himss.org/ASP. [Accessed: 10/11/2010].

AMERICA TELEMEDICINE ASSOCIATION (ATA). 2006. *Telemedicine, Telehealth, and health Information Technology*. [Online] Available: www.americantelemed.org. [Accessed: 28/3/2009].

AMMENWERTH, E., BRENDER, J., NYKANEN, P., PROKOSCH, H.U., RIGBY, M. AND TALMON, J. 2004. *Visions and strategies to improve evaluation of health information systems:* Reflections and lessons based on the HIS-EVAL workshop in Innsbruck. Int J Med Inf., 73(6):479-491.

AMMENWERTH, E., EICHSTADTER, R., HAUX, R., POHL, U., REBEL, S. AND ZIEGLER, S. 2001. *A randomized evaluation of a computer-based nursing documentation system*. Methods Inf Med, 40: 61–68.

APPLEBY, C. 2000. *Healthcare.com.Trustee*. 53(1): 18-22.

ARMENAKIS, A.A., HARRIS, S.G. AND MOSSHOLDER, K.W. 1993. Creating readiness for organizational change. *Human Relations*, 46 (6): 681-703.

ARMSTRONG, J.E. AND HARMAN, W.W. 1980. *Strategies for Conducting Technology Assessments*. Boulder, Colorado: Westview Press.

ARTHUR, C AND HUNTLEY, M.D. 2007. *Electronic Prescribing: Criteria for Evaluating Handheld Prescribing Systems and an evaluation of New, Handheld, wireless Wide Area Network (WWAN) Prescribing System*, Dermatology Online Journal; 7(1). [Online] Available: www.medscape.com. [Accessed: 12/12/2009].

ARZT, N.H. 2007. *Evolution of Public Health Information Systems: Enterprise–wide Approaches*. A consulting Paper for the State of Utah Department of Health. [Online] Available: www.hln.com. [Accessed: 7/08/2009].

AUSTIN, C. AND BOXERMAN, S. (2003). *Information systems for healthcare management* (6th Ed.). Chicago: Health Administration Press.

AUSTRALIAN INSTITUTE OF HEALTH AND WELFARE. 2005. *Rural, regional, and remote health*: Indicators of health. [Online] Available: http://www.aihw.gov.au/publications/index.cfm/title/10123. [Accessed: 28/3/2009].

AUSTRALIAN STANDARD (AS).2006. *Implementation of Health Level Seven (HL7*) Version 2.4, Referral, discharge and health record summary, 16/06/2006. Standards Australia, Available: http://www.standards.org.au. [Accessed: 10/12/2009].

BABBIE, E. 2006. *The basics of s ocial research*. Belmont, California: Thomson Wadsworth.

BABBIE, E. AND MOUTON, J. 2002. *The Practice of Social Research*. Oxford: Oxford University Press.

BAKKER, A.R. 2007. The need to know the history of the use of digital patient data, in particular the EHR. *International Journal of Medical Informatics*, 76(5-6):438-441.

BALL, M.J AND LILLIS, J 2001. E-Health : Transforming the Physician/Patient relationship. Int. Journal of Medical Informatics. Vol.61(1).

BANVILLE, C. AND LANDRY, M. 1989. Can the field of MIS be disciplined? *Communications of the Association for Computing Machinery*, 32(1):48-60.

BARDRAM, J.E., BOSSEN, C. AND THOMSEN, A. 2005. *Designing for Transformations in Collaboration.* A Study of the Deployment of Homecare Technology Proc. GROUP; ACM, 294-303.

BARRETT, M. AND WALSHAM, G. 2004. Making contributions from interpretive case studies: Examining processes of construction and use. In Kaplan, B., Truex, D., Wastell, D., Wood-Harper, T. and De Gross, J. (eds). *Information systems research: Relevant theory and informed practice*. Boston, MA: Kluwer Academic Publishers: 293-312.

BARRY, U. AND WINN, J. 2000. The Health Care Profit Pool: Who Stands to Gain and Lose in the Digital Economy? *Health Forum Journal*. 42: 46-50.

BASHSUR, R.L. 1997. Critical issues in telemedicine. *Telemedicine Journal* 3:113-126.

BASKERVILLE, R. AND LEE, A.S. 2003. Generalizing generalizability in IS research. *Information Systems Research,* 14(3):221-243.

BASKERVILLE, R. AND MEYERS, M.D. 2004. Special Issue on Action Research in Information Systems: Making IS Research Relevant to Practice - Foreword. MIS Quarterly, 28 (3), 329-335.

BATES, D.W., CULLEN, D.J.AND LAIRD, N. 2003. ADE Prevention Study Group. Incidence of adverse drug events and potential adverse drug events: Implications for prevention. *JAMA*, 274:29-34.

BECKHARD, R. AND HARRIS, R. 1977. *Organizational transitions: Managing complex change*. Reading, MA: Addison-Wesley.

BENBASAT, I. GOLDSTEIN, D. K. AND MEAD, M. 1987. The Case Research Strategy in Studies of Information Systems. MIS Quarterly, 11 (3), 369-386.

BERNSTEIN K., BRUUN-RASMUSSEN, M., VINGTOFT, S., ANDERSEN, S.K. AND NØHR, C. 2005. Modeling and implementing electronic health records in Denmark. *International Journal of Medical Informatics*, 74 (4):213-220.

BERRY, L.L. AND BENDAPUDI, N. 2003. Clueing in customers. *Harvard Business Review*, 81(2):100-6.

BERRY, L.L., PARKER, D., COILE, R.C. Jr, HAMILTON, D. K., O'NEIL, D.D. AND SADLER, B.L. 2004. Can better buildings improve care and increase your financial returns? *Frontiers of Health Service Management*, 21(1):3-24.

BIEMANS, M., SWAAK, J., HETTINGA, M. AND SCHUURMAN, J.G.,2005. *Involvement Matters*: The Proper Involvement of Users and Behavioral Theories in the ACM, 304-312.

BLEICHER, J. (1980). Contemporary Hermeneutics: Hermeneutics as Method, Philosophy and Critique (Routledge and Kegan Paul, London).

BOGDAN, R.C. AND BIKLEN, S.K. 2006. *Qualitative research in education: An introduction to theory and methods.* Allyn and Bacon. [Online] Available: www.zamfohr.org/approach.doc. [Accessed: 12/2/2010].

BOLAND, R. 1985 .*Phenomenology:* A Preferred Approach to Research in Information Systems. In: Research Methods in Information Systems. E. Mumford, R.A. Hirschheim, G. Fitzgerald, and T. WoodHarper (eds.), North Holland, Amsterdam, 193201.

BOLAND, R.J. (1991) .The in-formation of information systems, in Critical Issues in Information Systems Research, Boland, R.J. and Hirschheim, R.A. (eds) oohn Wiley, Chichester) pp. 362-79.

BOLLMAN, R.D., AND BIGGS, B. 1992. *Rural and small town Canada*: An overview. In: R.D. Bollman, (Ed.). Rural and Small Town Canada. Toronto, Ontario: Thompson Education Publishing, Inc., 1–43.

BOTSWANA GOVERNMENT. 2003. *Status of the National Response to the UNGASS:* Declaration of Commitment on HIV/AIDS. National Aids Coordinating Agency, Gaborone.

BOZIC, K.J., PIERCE, R.G AND HERMON, J.H. 2004. Health Care Technology Assessment. Basic Principles and Clinical Appliance. *The Journal of Bone and Joint Surgery,* 86, 130.

BRANT, S., GARRIS, M., OKEKE, E. AND ROSENFELD, J. 2006. *Access to Care in Rural China: A Policy Discussion*. The Gerald R. Ford School of Public Policy, University of Michigan. [Online] Available: www.umich.edu. [Accessed: 10/11/2009].

BRENDER, J. 1999. *Methodology for constructive assessment of IT-based systems-in an organizational context.* Int: J Med. Inform, 56:67-86.

BRENDER, J. 2006. *Evaluation Methods for Health Informatics.* London, UK: Elsevier Inc.

BRIDGES.ORG. 2005. E-*Readiness assessment tools comparison*. [Online] Available: www.bridges.org. [Accessed: 2/01/2009].

BRITISH COLUMBIA E-HEALTH STEERING COMMITTEE, (BC). 2000. *E-health Conceptual system.* [Online] Available: www.gov.bc.ca. [Accessed: 15/02/2010].

BROWN, K. 2004. Technology Building Interaction. *Tech Trends*, 48(5): 34-36.

BROWN, K. 2008. Developing countries must plan road map for e-health. Conference Interview by Africa. Bellagio, Italy. [Online] www.allfrica.com. [Accessed: 20/10/2010].

BUCKLY, J. 2003. E-service quality and the public sector. *Managing Service Quality*, 13(6):453-62.

BURBECK, S. 2000. *The Tao of E-business Service*. IBM Corporation. [Online] Available: www.ibm.com/software. [Accessed: 20/2/2010].

BURNS, N. AND GROVE, S.K. 2003. *Understanding Nursing Research.* (3rd Ed.). United States of America: W. B. Saunders Company.

BURRELL, G. AND MORGAN, G. 1979. *Sociological paradigms and organizational analysis: Elements of the sociology of corporate life.* London: Heinemann.

CAMPBELL, J.D., HARRIS, K.D. AND HODGE, R. 2001. *Introducing telemedicine technology to rural physicians and settings*. J Fam Pract, 50:419-24. Canada Health Infoway. [Online] Available: www.infoway-inforoute.ca/home.php?lang=en. [Accessed: 1/05/2009].

CANARIE. 2002. *Final report. Framework for rural and remote readiness in Telehealth*. Written by the alliance of building Capacity. [Online] Available: http://www.fp.ucalgary.ca. [Accessed: 10/2/2008].

CARR, W., AND KEMMIS, S.1986 *Becoming Critical: Education, Knowledge and Action Research,* Falmer Press, London, 1986.

CASEY, M.M., THIEDE, C.K. AND KLINGNER, J.M. 2001. *Are rural residents less likely to obtain recommended preventive healthcare services? Am J Prev Med.*, 21(3):182-188.

CASHEN, M., DYKES, P. AND GERBER, B. 2004. eHealth technology and Internet resources*:* Barriers for vulnerable populations. *The Journal of Cardiovascular Nursing*, 19(3): 209-217.

CAVAYE, A.L.M. (1996). Case study research: a multi-faceted research approach for IS. Information Systems Journal, 6, 227-242.

CENTER FOR THE ADVANCEMENT OF COMMUNITY-BASED PUBLIC HEALTH (CACBPH). 2000. Outcomes used for traditional research design in which expert researchers are used. [Online] Available: www.cdc.gov/eval/HPP_Article.pdf. [Accessed: 20/10/2010].

CHILUNDO, B. AND AANESTAD, M. 2004. Negotiating multiple rationalities in the process of integrating the information systems of disease-specific health programmes. *Electronic Journal of Information Systems in Developing Countries* 20 (2): 1-28.

CHIN, T. 2005. *Untapped power:* A physician's handheld. *American Medical News*, 48(2): 25-26.

COHEN, D.J. AND CRABTREE, B.F. 2008. Evaluative Criteria for Qualitative Research in Health Care: Controversies and Recommendations. *Annals of Family Medicine* (6):331-339, Available: www.annfammed.org. [Accessed: 10/08/2010]

COHEN, L. AND MANION, L. 2000. *Research methods in education* .(5th Ed.)*.* London: Routledge, 254.

COIERA, E. AND CLARKE, R. 2004. e-Consent: The design and implementation of consumer consent mechanisms in an electronic environment. *J. Am. Med. Inform. Assoc.*, 11 (2):129–140.

CORMACK, D. 2002. *The Research Process in Nursing. (4th* Ed.). Oxford: Blackwell Science Ltd.

CRESWELL, J. W. 2007. *Qualitative Inquiry and Research Design. Choosing among five approaches. (*2nd Ed.). London: SAGE Publications.

CRESWELL, J. W. 2009. *Research Design. Qualitative, Quantitative and Mixed Methods Approaches. (*3rd Ed.). London: SAGE Publications.

CRONBACH, L. J. 1951. *Coefficient alpha and the internal structure of tests*. Psychometrika, 16: 297-334.

DARBY, M.R. AND KARNI, E. 1973. Free competition and the optimal amount of fraud. *Journal of Law and Economics*, 16: 67-88.

DARKE, P., SHANKS, G. AND BROADBENT, M. 1998. Successfully completing case study research: combining rigor, relevance and pragmatism. Information Systems Journal, 8, 273-289.

DATES, K. 2008. *Administrative Supplement for Telehealth/Telemedicine*. National center on Minority Health Disparities (NCMHD). [Online] Available: http://www.ncmhd.nih.gov. [Accessed: 9/06/2009].

DAVIDSON, J.L., SMITH, A.E., AMOUSSOUS, G.L. AND STEINBERG, S.J. 2009. A framework using service oriented architecture in a community information and referral system*. Journal of Computing Sciences in Colleges* .Vol. 24 (4):252-258.

DAVIS, F.D. 1989. P*erceived* usefulness, perceived ease of user acceptance of information technology.*MIS Quarterly,* 319-340.

DE VILLIERS, M. R. 2005. *Three approaches as pillars for interpretive information systems research: development research, action research and grounded theory*. Proceedings of the 2005 Annual Research Conference of the South African Institute of Computer Scientists and Information Technologists on IT research in developing countries. White River, South Africa, 142–151.

DEETZ, S. 1996. *Differences in approaches to organizational science:* Rethinking Burell and Morgan and their legacy. *Organ Sci*.; 7(2):191-207.

DELUCA, J. AND ENMARK, R. 2000. *E*-health: The changing model of healthcare. *Frontiers of Health Services Management*, 17(1): 3-15.

DEMIRIS, G., OLIVER, D.R.P., POROCK, D. AND COURTNEY, K. 2004. *Home telehealth: The Missouri telehospice project: Background and next steps.* Home Health Care Technology Report, 1(49): 55-7.

DENARO, G., PEZZ´E, M., TOSI, D. AND SCHILLING, D. 2006. *Towards self-adaptive Service-oriented architectures in TAV-WEB '06:* Proceedings of the 2006 Workshop on Testing, analysis, and verification of web services and applications. New York, NY, USA: ACM Press, 10–16.

DENSCOMBE, M. 2001. *The Good Research Guide for small-scale social research projects.* Buckingham: Open University Press.

DENZIN, N. 2006. *Sociological Methods:* A Sourcebook. Aldine Transaction. [Online] Available:http://www.amazon.com/Handbook-Qualitative-Research-Norman-Denzin/dp/0761915125. [Accessed: 20/4/2010].

DEPARTMENT OF HEALTH (DoH). 2005. *Document and Reports.* North West Department of Health. [Online], Available: http://www.nwhealth.gov.za/nwhealth_web/doc_reports.php. [Accessed: 16/3/2008].

DEPARTMENT OF HUMAN SERVICES (DHS). 2006. *E-referral Architecture Framework*. Ocean Informatics, 19-20. [Online] Available: http://www.dhs.vic.gov.au/health/communityhealth/downloads/pch_report. [Accessed: 21/10/209].

DESMEULES, M., PONG, R., LAGACÉ, C., HENG, D., MANUEL, D., PITBLADO, R. AND BOLLMAN, J. 2006. *How healthy are Rural Canadians?* An Assessment of their Health Status and Health Determinants. Ottawa, Ontario: Canadian Institute for Health Information.

DICKINSON, G., FISCHETTI, L. AND HEARD, S. 2004. *HL EHR System Functional Model*: Draft Standard for Trial Use. [Online] Available: www.hl7.org/ehr/downloads/index_2004.asp. (Accessed: 10/8/2008].

DONABEDIAN, A. 1982. *An exploration of structure, process and outcome as approaches to quality assessment*. Quality Assessment of Medical Care, Bleicher Verlag, Gerlingen.

DRABORG, E., GYRD-HANSEN, D., POULSEN, B.P. AND HORDER, M. 2005. *International comparison of the definition and the practical application of health technology assessment*. International Journal of Technology Assessment in Healthcare 21(1):89-95.

DRAFT NATIONAL HEALTH BILL. 2007. *Review of health information systems (HIS) in selected countries.*South Africa HIS maps essentials health-related Information discussion. [Online] Available: www.hrhresourceceter.org. [Accessed: 9/06/2009].

DRURY, P. 2005. *E-health: A Model for developing countries. E-Health International Journal,* 2(2) [Online], Available: www.ehealthinternational.net. [Accessed: 20/3/2008].

DUBÉ, L. AND PARÉ, G. 1999. Rigor in Information Systems Positivist Case Research: Current Practices, Trends, and Recommendation. MIS Quarterly, 27 (4), 597-635.

DUTTA-BERGMAN, M. 2004. The impact of completeness and Web use motivation on the credibility of e-health information. *Journal of Communication*, 54(2): 253-269.

EAKIN, J.M. AND MYKHALOVSKIY, E. 2003*. Reframing the evaluation of qualitative health research*: Reflections on a review of appraisal guidelines in the health sciences. *J Eval. Clin Pract*., 9(2):187-194.

ECONOMIC RESEARCH SERVICE. 1998. Rural Median Household Income Increases: Rural Conditions and Trends. Socioeconomic Conditions Issue, 8: 28-30.

EFFERTZ, G. 2004. *Using a Business case for Telehealth*: A model for persuading Decision Makers. Telehealth Practice Report, 9(1), 2: 9-10.

E-HEALTH INITIATIVE AND CENTER FOR IMPROVING MEDICATION MANAGEMENT. 2008. *Electronic Prescribing: Becoming Mainstream Practice*. A collaborative Report From The e-Health Initiative and The Center for Improving Medication Management. [Online] Available: www.ehealthinitiative.org. [Accessed: 12/05/2009].

E-HEALTH INITIATIVE, 2008. Improving Our Nations Health and Healthcare Through Information Technology. An Executive Summary Drawn From eHealth Initiative Blueprint: Building Consensus for Common Action, eHealth Initiative Consensus Policy. [Online]. Available: www.ehealthinitiative.org. [Accessed: 15/01/2009]

EISENHARDT, K.M. 1989. Building theories from case study research. *Academy of Management Review*, 14(4):532-550.

EISENHARDT, K.M. 1991. Building theories from case study research. The Academy of Management Review, 14, 532-550.

ELECTRONIC PRIVACY INFORMATION CENTER (EPIC) AND PRIVACY INTERNATIONAL. 2002. Privacy and Human Rights Report: *An International Survey of Privacy Laws and Developments. United States of America,* [online] Available: http://www.privacyinternational.org. [Accessed: 10/10/2010].

Erl, T. 2005. *Service–oriented Architectures*: *Concepts, Technology and Design*. Indiana, USA: Prentice Hall.

EUROPEAN REGIONAL INFORMATION SOCIETY (ERISA). 2004. *A Guide to eHealth Applications for Regions*. IANIS. [Online] Available: www.ianis.net. [Accessed: 10/5/2009]

EYSENBACH, G. 2001. What is e-Health? *Journal of Medical Internet Research*, 3(2):20.

FADE, S. 2005. *Learning and Assessing through Reflection. [Online] Available:* http://www.practicebasedlearning.org/resources/materials/docs/RoyalBromptonV3.pdf [Accessed: 10/10/2010].

FINK, A. 2005. *Conducting Research Literature Reviews: From the Internet to Paper* (2nd ed.). Thousand Oaks, California: Sage Publications.

FITZGERALD, B. AND HOWCROFT, D. 1998. Competing dichotomies in IS research and possible strategies for resolution. *Proceedings of the Nineteenth International Conference on Information Systems*, Helsinki, 13-16 December 1998. Atlanta, GA: Association for Information Systems: 155-164.

FITZGERALD, B. AND HOWCROFT, D. 1998. Towards dissolution of the IS research debate: from polarization to polarity. Journal of Information Technology, 13 (4), 313-326.

FLYVBJERG, B. 2006. Five misunderstandings about case study research *Qualitative Inquiry*, 12(2):219-245.

FORSYTHE, D. 1999. "It"s just a matter of common sense": Ethnography as invisible work. *Computer Supported Cooperative Work,* 8(1-2):127-145.

FRASER, R. 2006. ISO 27799: *Security management in health using ISO/IEC 17799. CIHI Partnership Conference.* International Convener of the ISO health informatics security working group (TC215 WG4). [Online] Available: http://sl.infoway-inforoute.ca/downloads/Ross_Fraser_-_ISO_27799.pdf. [Accessed: 10/10/20210].

GADAMER, H-G.1976.*Philosophical Hermeneutics.* Berkeley, CA. University of California Press.

GAGNON, M.P. AND SCOTT, R.E. 2005. Striving for evidence in e-health evaluation*:* lessons from health technology assessment *Journal of Telemedicine and Telecare* 11(2): 34-36.

GALPOTTAGE, P.A.B. AND NORRIS, A.C. 2005. Patient consent principles and guidelines for e-consent: A New Zealand perspective. *Health Inform. J*., 11 (1): 5–18.

GARLAN, D. AND SHAW, M. 1994. *An Introduction to Software Architecture*. [Online] Available: http://www.cs.cmu.edu/afs/cs/project/able/ftp/intro_softarch/intro_softarch.pdf [Accessed: 11/10/2010].

GERBERICH, S.G., GIBSON, R.W., FRENCH, L.R., LEE, T.Y., CARR, W.P., KOCHEVAR, L. AND RENIER, C.M. 1998. Machinery-related injuries: Regional Rural Injury Study-I (RRIS-I). *Accident Analysis and Prevention*, 30:793-804.

GOFF, L. 1992. *Patchwork of laws slows EC data flow*. *Computerworld*, 26(15):80.

GOLDEN-BIDDLE, K. AND LOCKE, K. 1993. Appealing work: An investigation of how ethnographic texts convince. *Organization Science*, 4(4):55-616.

GOOD, A.J., O'CONNOR, K.A. AND LUCE, E.F. 2004. *Making long distance relationships work.* Meridian: 7 (2). [Online] Available: www.ncsu.edu/meridian. [Accessed: 15/3/2008].

GOODMAN, C.S. 1998. Health technology assessment methods, framework and role in policy making. *Am. J. Manag. Care*. 4, SP: 200-14.

GOODMAN, C.S. 2004. *Introduction to health Technology Assessment*. Med Biolog Eng. Comput. HTA 101. [Online] Available: www.nlm.nih.gov/nichsr/hta101/ta101_c1.html. [Accessed: 15/3/2008].

GORDON, D. AND GEIGER, G. 1999. Strategic management of an electronic patient record project using the balanced scorecard. *J Healthc Inf. Manag.,* 13:113-23.

GRONROOS, C. 1990. *Service Management and Marketing*: Managing the Moments of Truth in Service Competition. Lexington, MA: Lexington Books.

GUMMESSON, E. 1991. Qualitative Methods in Management Research. London.Sage Publications.

GUPTA, U. 1992. Global networks: promises and challenges. *Information Systems Management*, 9(4):28–32.

HAAG, S. AND CUMMINGS, M. 2008. *Management Information Systems for the Information Age.78* McGraw-Hills. [Online]Available: www.mhhe.com. [Accessed: 16/9/2009].

HARPER, R.H.R. 2000. The organisation in ethnography: A discussion of ethnographic fieldwork programs in computer supported cooperative work. *Computer Supported Cooperative Work*, 9(2):239–264.

HARRISON, P.J. AND LEE, A. 2006. The Role of E-Health in the Changing Health care Environment. *Nursing Economics*, Pitman, 24:6-283.

HASELTH, G. AND RYSER, L. 2006. Trends in service delivery: Examples from rural and small town Canada, 1998 to 2005. *Journal of Rural and Community Development*, 1: 69-90.

HEALTH LEVEL 7(HL7). 2004. *Electronic health record functional model and standard*. Available: www.hl7.org/ehr/. [Accessed: 6/6/2008].

HEALTH TECHNOLOGY ASSESSMENT INFORMATION. 2003. *Definition of HTA* [Online] Available: http://www.htai.org. [Accessed: 13/3/2008].

HEALTH TELEMATIC WORKING GROUP. 2003. *High Level Committee on Health:* Final Report. European Commission health and Consumer Protection, Directorate-General. [Online] Available: http://ec.europa.eu. [Accessed: 8/6/2009].

HEALTHCARE ADVISORY BOARD REPORT. 2002. Use of hospital websites to engender community loyalty. January 2000. *International Journal of Electronic Healthcare*, 2(1):50-65.

HEALTH-EU. 2008. *The Public Health of the European Union*. [Online] Available: http://europa.eu/health-eu. [Accessed: 10/12/2008].

HERSH, W.R., HICKAM, D.H., SEVERANCE, S.M., DANA, T.L., KRAGES, K.P. AND HELFAND, M. 2006. Diagnosis, Access and Outcomes: Update of a Systematic Review of Telemedicine Services. J. Telemed. Telecare,12(S2): 3-31.

HIRSCHHEIM, R. 1992. *Information Systems Epistemology: An Historical Perspective. In:* Information Systems Research: *Issues, Methods and Practical Guidelines,* R. Galliers (Ed.). Oxford: Blackwell Scientific Publications: 28-60.

HIRSCHHEIM, R. AND KLEIN, H.K. 1989. Four paradigms of information systems *Communications of the Association for Computing Machinery*, 32(10):1199-1216.

HL7 EHR. 2008. *Coming to terms*. Scoping Interoperability for Health care. Interoperability Work Group. [Online] Available: www.hln.com/assets/pdf. [Accessed: 19/5/2010].

HOLLE, R. AND ZAHLMAN, G. 1999. *Evaluation of telemedicine services.* PubMed.U National Library of Medicine IEEE Trans Inf. Technol. Biomed 3(2): 84-91. [Online] Available: www.ncbi.nlm.gov/pubmed. [Accessed: 20/08/2010].

HOLLOWAY, I. AND WHEELER, S. 2002. *Qualitative Research in Nursing, (2nd* Ed.). Oxford: Blackwell Science Ltd.

HOWCROFT, D. AND TRAUTH, E. 2004. The choice of critical information systems research. In Kaplan, B., Truex, D., Wastell, D., Wood-Harper, T. and DeGross, J. (eds). Information systems research: Relevant theory and informed practice. Boston, MA: Kluwer Academic Publishers: 195-212.

HUMPHREYS, J., HEGNEY, D., LIPSCOMBE, J., GREGORY, G. AND CHATER, B. 2002. Wither rural health*?* Reviewing a decade of progress in rural health. *Aust. J. Rural Health,* 10: 2.

ILIA, F. 2006. *Connect Health Framework Architecture and Design Blue Print.* [Online] Available: www.microsoft.com//articles. [Accessed: 2/03/2010].

INSTITUTE OF MEDICINE (IOM) REPORT. 1999. *To err is human: Building a safer health system*. [Online] Available: www.iom.edu/Object. [Accessed: 11/11/2009].

INSTITUTE OF MEDICINE (IOM). 2001. *Crossing the Quality Chasm.* A New Health System for the 21st Century. Washington D C.: National Academic Press. [Online] Available: http://www.nap.edu/books/030907. [Accessed: 13/3/2008].

INTERNATIONAL TELECOMMUNICATION UNION (ITU). 2009. *Measuring the Information Society*. The ICT Development Index. Geneva. [Online] Available: www.itu.int/net. [Accessed: 24/2/2010].

ISO 27799 SOUTH AFRICAN STANDARDS. 2008. *SABS ISO/IEC 27799, Information Technology-Code of practice for information security management.* SABS edition 1/ISO/IEC edition. Pretoria: South African Bureau of Standards.

ISO TECHNICAL REPORT. 2007. *Measures for ensuring patient safety of health software.* [Online] Available: www.iso.org/iso/pressrelease.htm. [Accessed: 10/11/2010].

JACOBS, S.J. 2005. *A Quality Management System for Rural Community Centers*. Unpublished PHD Thesis. Pretoria: Tshwane University of Technology.

JENNETT, P., JACKSON, A., HEALY, T., HO, K., KAZANJIAN, A. AND WOOLLARD, R. 2003. A *study of a rural community's readiness for telehealth*. J Telecare 9:259-63.

JENNETT, P., JACKSON, A., HO, K., HEALY, T., KAZANJIAN, A. AND WOOLLARD, R. 2005. *The essence of telehealth readiness in rural communities: an organizational perspective.* Telemed J E Health, 11:137-45.

JENNETT, P.A., GAGNON, M.P. AND BRANDSTADT, H.K. 2005. Preparing for success: Readiness models for rural telehealth. J Posgrad Med, 51: 279-285.

JOHNSON, M., LONG, T. AND WHITE, A. 2001. *Arguments for British Pluralism in qualitative health research*. *J Adv Nurs*., 33(2):243-249.

JORGENSEN, T., HVENEGAARD, A. AND KRISTENSEN, F.B. 2000. *Health technology assessment in Denmark*. Int. Journal of Technology Assessment Health Care, 16:347-381.

KAPLAN, B. 1997. Addressing Organizational Issues into the Evaluation of Medical Systems*.* Journal of the American Medical Informatics Association, 4:94-101.

KAPLAN, B. AND MAXWELL, J.A. 1994. Qualitative Research Methods for Evaluating Computer Information Systems. In: *Evaluating Health Care Information Systems: Methods and Applications.* J.G. Anderson, C.E. Aydin and S.J. Jay (Eds.). Thousand Oaks, CA: Sage, 45-68.

KARAPETROVIC, S. AND WILBRORN, W. 1998. The system's view for clarification of quality vocabulary. *International Journal of Quality and Reliability Management* 15 (1):99-120.

KELLER, L.L. 2003. *Strategic Brand Management-Building, Measuring and Managing Brand Equity, (*2nd Ed.*)*. NJ, Upper Saddle River: Pearson Education.

KELLY, P.M., CODDINGTON, P.D. AND WENELBORN, A.L. 2006. *A simplified approach to web service development.* ACM International Conference Proceeding Series; Vol. 167. Proceedings of the 2006 Australasian Workshops on grid computing and e-research–Vol. 54.

KHOJA, S., SCOTT, R., ISHAQ, A.F.M. AND MOHSIN, M. 2007. Testing Reliability of e Health Readiness Assessment Tools for Developing Countries. *E-health International Journal.*3 (1).

KIND, T. AND SILBER, T. 2004. Ethical issues in pediatric e-health. *Clinical Pediatrics*, 43(7): 593-599.

KIRSHENBAUM, D. 2002. *E-health: Past, present, and future*. PowerPoint presentation, West End Associates. [Online] Available: http://www.nehimss.org/pubs/Kirshenbaum.ppt. [Accessed: 11/3/2006].

KLEIN, H.K. AND MYERS, M.D. 1999. A set of principles for conducting and evaluating interpretive field studies in information systems. *Management Information Systems Quarterly*, 23(1):67-94.

KOCH, E. 1993*. Interview Consultant, Mafisa and Member of friends of Makuleke; Johannesburg.*

KOTLER, P. 1973. The major tasks of marketing management. *Journal of Marketing*, 37(4):42-9.

KREFTING, L. 1991. Rigor in Qualitative Research: The Assessment of Trustworthiness. *The American Journal of Occupational Therapy*, Volume 45, No. 3: 214-222.

KUNHARDT, H. 2009. E-health and Evidence- Based IT. Medical Torism Magazine. [Online] Available: www.medicaltourismmag.com. Accessed: 10/02/2011.

KUPERMAN, G.J., BOBB, A., PAYNE, T.H., AVERY, A.J., GANDHI, T.K., BURNS, G., CLASSEN, D.C. AND BATES, D.W. 2001. Medication-related Clinical Decision Support *in* Computerized Provider Order Entry Systems: A Review. J*. Am. Med. Inform. Assoc.*14(1):29-40.

KWANKAM, S. 2004. What e-Health can offer? *World Health Organization: Bulletin of the World Health Organization*, 82(10): 800-802.

LACITY, M.C. AND JANSON, M.A., 1994. Understanding Qualitative data: A framework of Text Analysis Methods. Journal of Management Information Systems, 11 (2), 137-155.

LAERUM, H., ELLINGSEN, G. AND FAXVAAG, A. 2001. Doctors' use of electronic medical records systems in hospitals: cross sectional survey. *BMJ*. 323(7325):1344-8.

LAMMER, A. AND GERMANY, A.G. 2008. A procedure Model for a SOA-Based Integration of Enterprise System. Hershey PA. IGI Publishing; *International Journal of Enyerprise Information System.* Vol.4 (2).

LANDAUER, T.K. 1995. *The Trouble with Computers*. Cambridge, MA: MIT Press.

LANSENG, J. AND ANDREASSEN, T.W. 2007. Electronic Healthcare: a study of people’s readiness and attitude toward performing self-diagnosis. *International Journal of Service Industry Management*, 18(4): 394-417.

LARSON, S.L. AND FLEISHMAN, J.A. 2003. *Rural-urban differences in usual source of care and ambulatory service use*: analyses of national data using Urban Influence Codes. Med Care, 41(7 Suppl):III65-III74.

LATOUR, B (1987). *Science in Action*. Cambridge, Mass.: Harvard University Press.

LEE, A.S. 1989. A Scientific Methodology for MIS Case Studies. *MIS Quarterly* (13:1): 33-52.

LEEDY, P.D. 1997*. Practical Research: Planning and Design*. Columbus, Ohio: Merrill.

LEVY, Y., AND ELLIS, T. J. 2006. A Systems Approach to Conduct an Effective Literature Review in Support of Information Systems Research. *Informing Science*, *9*, 181.

LEWIN, K. 1951. *Field theory in social science.* New York: Harper and Row.

LI, J., LAND, L.P.W., CHATTOPADHYAY, S. AND RAY, P. 2008. *E-health readiness framework from electronic health records perspective*. [Online] Available: www.ingentaconnect.com/content/ind/ijiem. [Accessed: 13/10/2009].

LIU, L., HADER, J., BROSSAR, B., WHITE, R. AND LEWIS, S. 2001. Impact of rural hospital closures in Saskatchewan, Canada. *Social Science and Medicine*, 52: 1793-1804.

LJUNGBERG, F. 1999. Practical Informatics. In: Informatics in the next millennium. Ljungber, F. (Ed.). Student litteratur, Lund Sweden.

LOCKE, K. AND GOLDEN-BIDDLE, K. 1997. Constructing Opportunities for Contribution*:* Structuring Intertextual Coherence and "Problematizing" in Organizational Studies. *The Academy of Management Journal*, Vol. 40(5): 1023-1062.

LUK, R.L., HO, M. AND AOKI, P.M. 2007. *A Framework for Designing Teleconsultation Systems in Africa*. Proc. Int'l Conf. on Health Informatics in Africa (HELINA), IMIA.

MALLEY, T. AND STORTO, D.E. 2002*. Integration of a Patient's Care within a Health Care Network*. Top Stroke Rehabil; 9(3):87–88. [Online] Available: www.thomasland.com. [Accessed: 10/10/2010].

MALONEY, S., ILIC, D. AND GREEN, S. 2005. *Accessibility, nature and quality of health information on the Internet: A survey on osteoarthritis*. Rheumatology, 44(3): 382-385.

MANNAN, R., MURPHY, J. AND JONES, M. 2006. Is primary care ready to embrace e-health? A qualitative study of staff in a London primary care trust. *Information Prime Care*. 14 (2): 121-31.

MARKUS, M.L. 1983. Power politics and MIS implementation. *Communications of the Association for Computing Machinery*, 26(6):430-444.

MAYER, M., SLIFKIN, R., COCKRELL, C AND SKINNER, A. 2005. The Effects of Rural Residence and Other Social Vulnerabilities on Subjective Measures of Unmet Need. *Medical Care Research and Review*, 62(5):617-628.

MCLVER, W.J. AND O'DONNELL, S. 2005. *Community-Oriented Technology Assessment. Community Informatics Research Network*. National Research Council of Canada.NRC48292.

MCNIFF, J. 2002. Action research for professional development. [Online] Available: http://www.jeanmcniff.com/booklet1.html. [Accessed: 10/10/2010].

MEYER, S. 2001. *What it means for Privacy and Security?* [Online] Available:

MIFFLIN, H. 2003. A Research Based-Framework. [Online] Available: www.hmheducation.com. [Accessed: 13/10/2010].

MILES, M.B. AND HUBERMAN, A.M. 1994. Qualitative data analysis., Thousand Oaks. Sage Publications.

MOHD-NOOR, K.B. 2008. Case study: A strategic Research Methodology: Malaysia. *American Journal of Applied Science*, 5(11): 1602-1604

MORSE, J., BARRETT, M., MAYAN, M., OLSON, K. AND SPIERS, J. 2002. Verification strategies for establishing reliability and validity in qualitative research. *Intl J Quarl Meth.* 1(2):1-19.

MOUTON, J. 2003. *How to succeed in your master's and doctoral studies: a South African guide and resource book*. Pretoria: Van Schaik Publishers.

MYERS, M.D. 1994. A disaster for everyone to see: An interpretive analysis of a failed IS project. *Accounting, Management and Information Technology*, 4(4):185-201.

MYERS, M.D. 1997. Critical Ethnography in Information Systems. In: *Information Systems and Qualitative Research,* A.S. Lee, J. Liebenau and J.I. DeGross (Eds.). London: Chapman and Hall, 276-300.

MYKKÄNEN,J., PORRASMAA,J., KORPELA, M., HÄKKINEN, H., TOIVANEN, M., TUOMAINEN, M., HÄYRINEN, K. AND RANNANHEIMO, J. 2004. *Integration Models in Health Information Systems: Experiences from the Plug IT Project*. MEDINFO: Amsterdam: IOS Press

NANDHAKUMAR, J. AND JONES, M. 1997. Too close for comfort? Distance and engagement in interpretive information systems research. *Information Systems Journal*, 7(2):109-131.

NATIONAL COMMITTEE ON VITAL AND HEALTH STATISTICS. 2001. *Information for Health*: A strategy for building the National Health Information Infrastructure. Washington D.C. [Online] Available: http://asperhhs.gov. [Accessed: 15/3/2008].

NATIONAL INSTITUTE OF HEALTH (NIH). 2006. Electronic Health Records Overview. National Center for Research Resources. Virginia. [Online] Available: http://www.ncrr.nih.gov/publications/informatics/EHR.pdf. [Accessed: 4/2/2010].

NATIONAL RESEARCH COUNCIL. 1997. *For the Record: Protecting Electronic Health Information*. Washington, D.C.: National Academy Press. [Online] Available: http://books.nap.edu/catalog/5595.htm. [Accessed: 10/2/2010].

NEUBAUER, B.J. 2007. Introducing SOA and Workflow Modeling to Non-Technical Students. *J. Comput. Small Coll*., 22(4): 101-107.

NIHAT-YURT, M.D. 2008. Turkey's e-health Activities. A country case study. [Online] Available: www.amia.org. [Accessed: 24/11/2009]

NORMAN, D.A. 1988. *The psychology of everyday things*. NY: Basic Books.

OATES, B.J. 2008. Action research: Time to take a turn? In Kaplan, B., Truex, D. Wastell, D., Wood-Harper, T. and De Gross, J. (eds). *Information systems research: Relevant theory and informed practice*. Boston, MA: Kluwer Academic Publishers: 315-333.

OATES, B.J. 2008. *Researching Information Systems and Computing*, (2nd Ed.) London: SAGE Publications Ltd.

O'DONOGHUE, T. AND PUNCH, K. 2003. *Qualitative Educational Research in Action: Doing and Reflecting.* London: Routledge,78.

OJO, S.O., OLUGBARA, O.O., EMUOYIBOFARHE, O.J., ADIGUN, M.O., XULU, S.S., KABANDA,S.K.,ZULU, H.S., LALBAHADUR, M.M., NDLOVU, T., NXELE, C.N AND NTSHEMBENI,G.N. 2006. A formal model for rural e-healthcare readiness assessment in a developing country context. *Journal of e-Service.* [Online] Available: www.e-sj.org [Accessed: 10/05/2008].

OLIVER, M.S. 2004. *Information Technology Research: A practical guide for Computer Science and Informatics*, (2nd Ed.). Pretoria: Van Schaik Publishers.

OLIVER, R.L. 1980. A cognitive model of the antecedence and consequences of satisfaction decisions. *Journal of Marketing Research*, 17:46-9.

OPEN CLINICAL. 2007. *Knowledge Management for Medical care*. E-Health. [Online] Available: www.openclinical.org/e-Health.htm. [Accessed: 12/10/2007].

ORLIKOWSKI W. J., 2000. Using technology and constituting structures: Using a practice lens for studying technology in organizations. *Organization Science,* 11(4), pp404-428.

ORLIKOWSKI, W.J. AND BAROUDI, J.J. (1991). Studying Information Technology in Organizations: Research Approaches and Assumptions. Information Systems Research, 4 (2), 1-28.

OVERHAGE, J.M., EVANS, L. AND MARCHIBRODA, J. 2005. Communities' readiness for health information exchange: the national landscape in 2004. *J Am Med Inform Assoc.*, 12:107-12.

OXFORD, M. 2004. *Rural Voice Working in South Africa*. The Social Change Assistance Trust (SCAT).South Africa: David Publishers.

PAGLIARI, C., SLOAN, D., GREGOR, P., SULLIVINS, F., DETMER, D., KAHAN, I.P., OORTWIJN, W. AND MACCILLIVRAY, S. 2005. *What is e-Health (4): A Scope?* Exercise to Map the Field. Journal of Med. Internet Res.7 (1) e9.

PANAGARIYA, A. 2000. E-commerce, WTO and developing countries. *The World Economy*, 23(8):959–978.

PAPAZOGLOU, M.K. AND HEUVEL, W.J. 2007. Service Oriented Architectures: Approaches, Technologies and Research Issues. *The VLDB Journal*, 16(3): 389-415.

PARAHOO, K. 1997. *Nursing Research: Principles, Process and Issues*. New York: Palgrave Macmillan.

PARASURAMAN, A. 2002. Service quality and productivity: A synergistic perspective. *Managing Service Quality*, 12 (1):6-9.

PARASURAMAN, A., ZEITHAML, V. AND BERRY, L. L. 1988. SERVQUAL: A multi-item scale for measuring consumer perceptions and service quality. *Journal of Retailing*, 64 (1):12-41.

PICKETT, W., HARTLING, L., BRISON, R.J., GUERNSEY, J.R. AND PROGRAM CANADIAN AGRICULTURAL INJURY SURVEILLANCE. 1999. Fatal work-related farm injuries in Canada, 1991-1995. *Canadian Medical Association Journal*, 160:1843-1848.

PITBLADO, R, J. 2005. So, what do we mean by "rural", "remote", and "northern"? *Canadian Journal of Nursing Research*, 37: 163-168.

POLIT, D.E. AND HUNGLER, B.P. 1993. *Essentials of nursing research: Methods, Appraisal and Utilisation*. (3rd Ed.). Philadelphia: J.B. Lippincott Company.

PONG, R.W. AND PITBLADO, R.J. 2001. Don't take "geography" for granted! Some methodological issues in measuring geographic distribution of physicians. *Canadian Journal of Rural Medicine*, 6: 103-112.

POZZEBON, M. 2004. Conducting and evaluating critical interpretive research Examining criteria as a key component in building a research tradition. In Kaplan, B., Truex, D., Wastell, D., Wood-Harper, T. and De Gross, J. (eds). *Information systems research: Relevant theory and informed practice*. Boston, MA: Kluwer Academic Publishers: 275-292.

POZZEBON, M. AND PINSONNEAULT, A. 2005. Challenges in conducting empirical work using structuration theory: Learning from information technology research. *Organization studies*, 26(9):1353-1376.

PRATIKAKIS, I., KARAHALIOU, A., VASSIOU, K., VIRVILIS, V., KOSMOPOULOS, D. AND PERANTONIS, S. 2007. *E*-MedI: Web-Based E-Training for Multimodal Breast Imaging. *World Academy of Science, Engineering and Technology,* 31.

PRETORIUS, J.D. 2000. Can industrial techniques improve in higher education*? South African Journal of Higher Education* 14(2):1990-196.

PROCHASKA, J.O. AND DICLEMENTE, C.C. 1982. Transtheoretical therapy: Toward a more integrative model of change. *Psychotherapy, Theory, Research, and Practice*, 19: 275-288.

PROTTI, D. 2002. A proposal to use a balanced scorecard to evaluate information for Health: an information strategy for the modern NHS (1998-2005*). Computer Biol Med*., 32:221-36.

RASMENI, M. 2007. *Budget Speech for the Department of Health for the financial year 2007/2008.* Presented by the MEC for Health, at the North West Provincial Legislature. [Online] Available: http://www.nwhealth.gov.za/nwhealth_web/dir_prog.php. [Accessed: 18/3/2008].

REDMOND, P. AND LOCK, J.V. 2006. A flexible framework for online collaborative learning. *Elsevier: Internet and Higher Education* 9:267-276.

RICKETTS, T., JOHNSON-WEBB K. AND RANDOLPH, R. 1999. Populations and Places in Rural America. In: Ricketts T.C., (Ed.). *Rural Health in the United States*. New York City: Oxford University Press.

ROGERS, E.M. 1983. *Diffusions of innovations,* (3rd Ed.). New York: Free Press.

ROGERS, E.M. 2003. *Diffusion of Innovations*, (5th Ed.). New York: Free Press

ROLFE, G. 2006. Validity, trustworthiness and rigour: Quality and the idea of qualitative research. *J Adv Nurs*. 53(3):304-310.

ROMANO, C.A. 1995. *Predictors of nurse adoption of a computer information system as an innovation*. Pt 2(8):1335-9. [Online] Available: http://www.ncbi.nlm.nih.gov/pubmed/8591440. [Accessed: 12/12/2009].

ROMANOW, R.J. 2002. *Building on values: The future of health care in Canada*. Ottawa, Ontario. Commission of the Future of health Care in Canada.

ROODE D.1993. Implications for teaching of a processed-based research framework for information systems. Proceedings of the Eighth Annual conference of the International Academy for Information Management, Orlando, 03-05 December 1993.

ROSENBLATT, R. AND HART, G. 1999. Physicians in Rural America. In: Ricketts, T. (Ed.). *Rural Health in the United States*. New York City: Oxford University Press.

ROURKE, J. 2008. Increasing the number of rural physicians. *Canadian Medical Association Journal*, 178: 322-325.

SA HEALTH INFO. 2006. *Health Technology Assessment .SA National Steering Committee on technology assessment*. [Online] Available: http://www.sahealthinfo.org/hta/index.htm. [Accessed: 15/3/2008].

SAMIEE, S. 1998. The Internet and international marketing: is there a fit?. *Journal of Interactive Marketing*,12(4):5–20.

SANDELOWSKI, M. AND BARROSO, J. 2002. Reading qualitative studies. *Intl J Quarl Meth.*, 1(1):1-47.

SAUNDERS, M., LEWIS, P. AND THORNHILL, A. 2003. *Research methods for business students,* (3rd Ed.). London: Prentice Hall.

SCHOT, J. AND RIP, A. 1997. The Past and Future of Constructive Technology Assessment. *Technological Forecasting and Social Change*, 54: 251-268.

SCHULTZE, U. 2000. A confessional account of an ethnography about knowledge work. *Management Information Systems Quarterly*, 24(1):3-41.

SHIELDS, P.M. AND TAJALLI, H. 2006. *Intermediate Theory: The Missing Link to Successful Student Scholarship*. Faculty Publications-Political Science. Paper 39. Available: http://ecommons.txstate.edu. [Accessed: 20/3/2010].

SHIPMAN, M. (1982). The Limitations of Social Research. Longman, London.

SILBER, D. 2003. *The Case for e-Health European Commission's first high-level conference on e-Health*. European Institute of Public Administration. (EC).

SINGH, V. 2004. *The rural-urban income gap within provinces*: An update to 2000. Rural and Small Town Canada Analysis Bulletin, 5: 7.

SLOMAN, M. 2002. *The e-learning revolution from propositions to actions*. London: British Library Cataloguing-in Publication Data. [Online] Available: www.cipd.co.uk. [Accessed: 12/4/2010].

SNYDER-HALPERN, R. 2001. Indicators of Organizational readiness for clinical information technology/systems innovation: Delphi study. *International Journal of Med. Information,* 63:179-204.

SOUTH AFRICA GOVERNMENT DEPARTMENT OF HEALTH. 2006. White *paper on the transformation of the health system in South Africa*. [Online] Available: http://www.polity.org.za. [Accessed: 15/5/2008].

SOUTH AFRICAN INTERIM HEALTH COMMITTE. 2004. *Health Technology Assessment: Discussions on a Strategy for the future*. [Online] Available: http://www.treasury.gov.za/documents. [Accessed: 15/3/2008].

SPARKES, A.C. 2001. *Myth 94: Qualitative health researchers will agree about validity*. *Quarl Health Res*., 11(4):538-552.

STAKE, R.E. 2005. *Qualitative case studies*. Thousand Oaks, CA: SAGE

STATISTICS SOUTH AFRICA (STATS SA). 2006. *ZA North West Province Language Map.* [Online] Available: http://www.statssa.gov.za/copyrightdisclaimer.asp. [Accessed: 12/12/2009].

STRAUSS, A. AND CORBIN, J. 1998. *Basics of Qualitative Research: Techniques and procedures for developing Grounded Theory*, (2nd Ed.). United States of America: Sage Publications, Inc.

STUFFLEBEAM, C. 2001. *Evaluation models*. New Directions for Evaluation. 89:7-9.

SUOMI, R. 2006. *Introducing Electronic Patient Records to Hospitals*: Innovation Adoption Paths. USA: Ideal Group Inc.

SWAN, K. 2005. A constructivist model for thinking about learning online. In: J. Bourne and J.C Moore, (Eds.). *Elements of quality online education: Engaging Communities Needham*. [Online] Available: www.kent.ed/rcet/Publications.pdf. [Accessed: 10/12/2009].

TAGGART, W.H.J. 1997. *Enablement and the Community: A Policy Approach for the Future.* Ottawa, ON: Canada Mortgage and Housing Corporation.

TANG, P.C. 2003. *Key capabilities of an electronic health record system.* [Internet] Available: www.nap.edu/openbook/NI000427/html/index.html. [Accessed: 15/05/2008].

TAYLOR, H. AND LEITMAN, R. 2002. European physicians especially in Sweden, Netherlands, and Denmark, lead in use of electronic medical records. *Harris Interactive Health Care News.* 2(16):1–3.

TERRY, N.P. 2004. *Electronic health records:* International, structural and legal perspectives. *J Law Med*.,12:26–39.

TESCH, R. 1990. *Qualitative research: Analysis types and software tools*. Bristol, PA: Falmer Press.

TESSIER, C. AND WAEGEMANN, C.P. 2003. The continuity of care record. Organizations unite to create a portable, electronic record for use at transfer points in patients' care. *Healthcare Inform*, 20(10):54-6. [Online] Available: http://www.ncbi.nlm.nih.gov/pubmed/14598458. [Accessed: 10/12/2009].

THE ALLIANCE FOR BUILDING CAPACITY. 2003. *Framework for remote and rural readiness in the teleheath: Final report for the office of Health and Information Highway*. [Online] Available: http://www.fp.ucalgary.ca/telehealth. [Accessed: 15/1/2009].

THOMAS, D.R. 2003. *A general inductive approach for qualitative data analysis*. [Online] Available: http://www.fmhs.auckland.ac.nz/soph/centres/hrmas Accessed: 6/03/2010.

TOMHAVE, B.L. 2006. *The Total Enterprise Assurance Management (TEAM) Model: A Unified Approach to Information Assurance Management*. Unpublished Master's Thesis. Washington, D.C. George Washington University

TRAUTH, E. AND HOWCROFT, D. 2006. Social inclusion and the information systems field: Why now? In Trauth, E., Howcroft, D., Butler, T., Fitzgerald, B. and DeGross, J. (eds). *Social inclusion: Societal and organizational implications for information systems*. Boston: Springer: 3-12.

TRAUTH, E.M. AND JESSUP, L.M. 2000. Understanding computer-mediated discussions: Positivist and interpretive analyses of group support system use. *MIS Quarterly, 24*(1)

TURNER, P.D. AND POL, L.G. 1995. Beyond patient satisfaction. *Journal of Health Care Marketing*, 15(3):45-9.

TUYIKEZE, T. AND POTTAS, D. 2005. *Information Security Management and Regulatory Compliance in the South African Health Sector*. Proceedings of the ISSA 2005 New Knowledge Today conference. [Online] Available: www.informatik.uni-trier.de/~ley/db/conf/issa/issa2005.html. [Accessed: 10/10/2010].

U S CONGRESS: OFFICE OF TECHNOLOGY ASSESSMENT. 1994. *Protecting privacy in computerized medical information*. Washington, D.C: US Government Printing Office.

U.S DEPARTMENT OF HEALTH AND HUMAN SERVICES. 2003. *Trends in rural hospital closure 1990-2000*. Available: http://oig.hhs.gov/oei/reports/oei-04-02-00610.pdf. [Accessed: 10/12/2009].

UMHOFF, B. AND WINN, J. 1999. The healthcare profit pool: who stands to gain and lose in the digital economy? *Health Forum Journal*, 1.

UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC). 2003. Development and Transfer of Technologies: Workshop on enabling environment for technology transfer. [Online] Available: www.unfccc.int/resource/docs. [Accessed: 10/10/2010].

VAN MAANEN, J. 1979. The fact of fiction in organizational ethnography. *Administrative Science Quarterly*, 24(4):539-550.

VASSALLO, D.J., SWINFEN, P., SWINFEN, R. AND WOOTTON, R. 2001. *Experience with a Low-Cost Telemedicine System in Three Developing Countries*. J Telemed. Telecare 7: 56-58.

VENKATESH, V., MORRIS, M.G., DAVIS, G.B. AND DAVIS, F.F. 2003. *Use*r acceptance of information technology: Towards a unified view. *MIS Quarterly*, 7(3).

VESELÝ, A., ZVÁROVÁ, J., PELEŠKA, J., BUCHTELA, D. AND ANGER, Z. 2006. Medical guidelines presentation and comparing with Electronic Health Record. *International Journal of Medical Informatics,* 75(4):240-245.

VRIES, E.J. DE AND ROEST, D. 1999. Case research in IS: state of affairs. In Proceedings of the seventh European Conference on Information Systems, 704-718, Copenhagen.

WALSHAM, G. ~~&~~and SAHAY, S. 2006. Research on information systems in developing countries: Current landscape and future prospects. *Information Technology for Development*, 12(1):7-24.

WALSHAM, G. 1993. *Interpreting Information Systems in Organizations*. Chichester: Wiley.

WALSHAM, G. 1995. The emergence of interpretivism in IS research. *Information Systems Research*, 6(4):376-394.

WALSHAM, G. 1999. GIS for district-level administration in India: Problems and opportunities. *Management Information Systems Quarterly*, 23(1):39-65.

WALSHAM, G. 2006. Doing interpretive research. *European Journal of Information Systems,* 15(3):320-330.

WANKE, M., JUZWISHIN, D., THORNLEY, R. AND CHAN, L. 2006. *An Exploratory Review of Evaluations of Health Technology Assessment Age*ncies. ALBERTA HERITAGE FOUNDATION FOR MEDICAL RESEARCH.HTA INITIATIVE #16.

WARSHAWSKY, S.S., PLISKIN, J.S., URKIN, J., COHEN, N., SHARON, A. AND BINZTOK, M. 1994. *Physician use of a computerized medical record system during the patient encounter*: *A descriptive study*. Comput Methods Programs Biomed, 269–273.

WATSON, P.J. 2006. *Electronic Health Records–Manual for Developing Countries*. [Online] Available: www.wpro.who.int/NR/rdonlyres. [Accessed: 9/2/2010].

WEBSTER, J., ~~&~~and WATSON, R. T. 2002. Analyzing the past to prepare for the future Writing a literature review. *MIS Quarterly*, *26*(2), 13-23.

WELMAN, J.C. AND KRUGER, S.J. 2005. *Research Methodology for the Business and Administrative Science*, (2nd Ed.). Oxford: Oxford University Press.

WHETTEN, D.A. 1989. What constitutes a theoretical contribution? *Academy of Management Review*, 14(4):490-495.

WHITTINGTON, R. 1992. Putting Giddens into action: Social systems and managerial agency. *Journal of Management Studies,* 29(6):693-712.

WICKRAMASINGHE, N.S., FADLALLA, A.M.A., GEISLER, E. AND SCHAFFER, J.L. 2005. A Framework for Assessing E-Health Preparedness. *Int.J.Electronic Healthcare*, 1(3).

WILLIAMS, S.T., MAY, C., MAIR, F., MORT, M. AND GASK, L. 2003. *Normative models of health technology assessment and the social production of evidence about telehealth care*. SCIENCE-DIRECT Health Policy 64(1): 39-54.

WILSON, E.V. AND LANKTON, N.K. 2004. Strategic implications of asynchronous healthcare communication. *Int J Healthc Technol Manage*. 5:213–31.

WILSON, P., LEITNER, C., AND MOUSSALLI, A. 2004. Mapping the Potential of e-Health. Empowering the Citizen through e-health tools and services.Presented at the e-Health Conference. Cork, Ireland, 5-6 May .

WORLD BANK. 2008. *Health Workers Needed*: Poor Left Without Care in Africa's Rural Areas. [Online] Available: http://go.worldbank.org/IUY3J2M0A0. [Accessed: 12/08/2009]

WORLD HEALTH ORGANIZATION (WHO). 2004. *Developing Health Management Information Systems: A Practical Guide for Developing Countries.* Geneva: World Health Organization.

YELLOWLEES, P. 1997. Practical evaluation of telemedicine system in the real world.*TeleMed,* 97:90-93.

Yin, R. K. 1994. Case study research: design en methods., Thousand Oaks. Sage Publications.

YIN, R.K. 2003. *Case study research*: *Design and methods*, (3rd Ed.). Thousand Oaks, CA: SAGE Publications, Inc.

APPENDIX A: QUESTIONNAIRE FOR HOSPITAL ADMINISTRATORS

About this questionnaire

All information will be treated as confidential. The completion of this questionnaire is voluntary and your participation will be highly appreciated

Aim: The purpose of this questionnaire is to establish the:

- **Background history and settings of the hospital/clinic**
- **Existing infrastructure and e-resources available**

1. Briefly describe the geographical location and setting of your hospital/clinic by responding to the items below.

Name of hospital/clinic	
Postal Address	
Street Address	
Province	
Magisterial District	
Telephone Number	

2.What is the population size of the area which your hospital/clinic serves?

3. What is the size (Km2) of your hospital/clinic?

4 How many doctors does your hospital /clinic have? Indicate the number of general practitioners and specialist practitioners below.

Practitioners	**Number**
General practitioners	
Specialist practitioners	

5. Do you have access to a telephone at the hospital/clinic? Mark with X

Yes ☐ No ☐

If **No**, how close is the nearest phone to your hospital/clinic?

State in the space provided below.

6. Is the hospital/clinic providing any ICT application in the following?

Mark (with X) those applicable to your situation.

Dermatology	ECG Diagnostics	Radiology	Histopathology	E-health record

E-diagnosis	E-prescription	E-referrals	E-consultation	Telemedicine

7. What network/hardware and other facilities does the hospital/clinic have?

Please write the number in the space provided.

Item	Number	Item	Number
No of laptops		No of consultation rooms (for general practitioners)	
No of desktops		No of consultation rooms (for specialists)	
No of monitors		No of beds in wards (general wards)	
No of printers		No of beds in wards (ICU)	
No of document scanners		No of beds in wards (high care)	
No of Photocopiers			
No of phones(ISDN)			
TV based video conferencing system		Others (specify)	
PC based video conferencing system			
No of web cam digital cameras connected to the laptop/PC			
No of computers connected to digitalized X-ray equipment			
No of computers connected with high resolution digital camera monitored on microscope.			

8. What are the standard software and operating systems installed on the laptop(s) and the PCs? (E.g. windows XP, windows 98, Linux) Please specify.

9. Do you have Internet access? Yes ☐ NO ☐

If yes, what are the connectivity options? Select what is applicable to your situation. (Please mark with X)

ADSL	SDSL	SHDSL	Dial UP	ISDN	Other(specify)

10. State the software/programme installed for running the following.

Item	Software/programme
E-Health Record	
E-Prescription	
E-Consultation	
E-Referrals	
E-Learning	

11. Do you have any software/programme installed for training your staff in the use of any of the above? Please, specify.

12. Do you have e-mail facilities? Yes ☐ NO ☐

13. Specify IT equipment that is out of order and the period for which it has been out of order. (Please, list all equipment).

14. What type of IT equipment is needed? (E.g. printer, PC etc).

Please, specify and state why.

SERVICES PROVIDED BY THE CENTRE

15. How many out patients does the hospital/ clinic serve per day?

Day of Week	Mon	Tues	Wed	Thurs	Fri	Sat	Sun
Minimum							
Maximum							

16. On the average how many patients do you have in the wards?

Please indicate the number below and state any other comments.

Wards	Number	Any other comments
General ward		
Special ward		

17. How many complaints/cases are referred to external hospital/clinic per week? What are they? Please indicate below

Number referred per week	Typical complaints/cases

18. If a doctor/senior nurse makes specific diagnoses, is the hospital/clinic able/ equipped to realize the treatment or procedure?

Please, specify cases where this is impossible in terms of:

18.1 Medical equipment/facilities.

18.2 Medical personal/specialists.

19. How often are the following external services used?

Please mark the appropriate block with X .

Resources/Items	Very Often	Often	Seldom	Never
Phone calls to specialists for advice				
Phone calls to other colleagues for advice				
Referral to other hospitals/ clinics for specialist treatment				

LINKAGES to other centres

20.1 How often do you communicate with other hospitals/clinics? Mark with X.

Weekly	Monthly	Quarterly	Half- yearly	Yearly	Other (specify)

20.2 What means/medium of communication is used when communicating with other hospitals/clinics? Please mark applicable one(s) with X.

Letters (print)	E-letters (e-mail)	Meetings	Phone calls	Workshops	Other (specify)

20.3. What are the main topics communicated with other hospitals/clinics?

21. What are the main problems that are experienced by your hospital/ clinic?

22. What are the ICT needs of your hospital/ clinic? (e.g. training, advice, soft and hardware equipment, etc.?).

23. Do you have any ICT plans or vision for the future of the hospital/ clinic?

Please, state in the space provided.

THE END

THANK YOU FOR YOUR PARTICIPATION

APPENDIX B: QUESTIONNAIRE FOR DOCTORS, NURSES AND WARD ATTENDANTS.

About this questionnaire

All information will be treated as confidential. The completion of this questionnaire is voluntary and your participation will be highly appreciated.

Aim: The purpose of this questionnaire is to determine:

- **The baseline data for processes and procedures in using e-patient health record, e-consultation, e-prescription and e- referrals.**
- **The baseline data for post training activities in the hospital/clinic.**

1.1. What is your role in your hospital/clinic? Please mark with X

Doctor ☐ Nurse ☐ Ward Attendant ☐ Other ☐

1.2 Do you conduct your practice as a multidisciplinary clinical team? Please mark with X.

Yes ☐ NO ☐

1.3 Do you need to share patients' health records with other healthcare practitioners? Please, Mark with X.

Yes ☐ NO ☐

2. Patient health record.

2.1 What is the current system of creating patient health record?

Please state.

2.2 What is the current system of maintaining patient health record?

Please state.

2.3 Does each doctor create and maintain each patient's record or the records are centralized? Mark with X

Maintain each patient's record ☐ Centralized ☐

2.4 State the means of recording. (E.g. handwritten, dictaphone, transcription, word processor, etc)

2.5 State staff responsible for recording . Please mark with X

Physicians ☐ Nurses ☐

Ward attendants ☐ Other (specify) ☐

2.6. State the standard format for collecting patient information (e.g. a form, minimum fields for clinical notes, etc).

2.7. State the average time spent on the maintenance of patient health record per day.

3.1 Where are the patients' health records kept? (e.g. registry, records room etc). Please, indicate below.

3.2 What is the **current procedure** for the storage and retrieval of patient health record? (e.g. means of storage - locked/unlocked filing cabinets, cupboards etc).

3.3 What is the **standard format** for storage? (e.g. alphabetically or date wise, number of copies, security, etc).

3.4 Accessibility (staff with authorized access to patient records e.g. physicians, and assistants such as nurses). Please, state.

3.5 What is the average time for retrieving a patient's record? Please, indicate below.

4. In your opinion, does the current patient health record system provide a complete and accurate patient health record? Yes ☐ No ☐
Please, give a reason for your choice.

5. Is the format and quality of patient health record satisfactory for effective sharing of patient information between healthcare professionals?

Yes ☐ No ☐

Please, give a reason for your choice.

6. Does the current patient health record system provide optimal cost effectiveness and efficiency of healthcare service delivery in allowing:

6.1 Optimal / minimal time for creating and retrieving relevant patient health record? Yes ☐ No ☐

Please give a reason for your choice

6.2 Minimal time for diagnosis and treatment? Yes ☐ No ☐

Please give a reason for your choice

6.3 Confidentiality of patient health record? Yes ☐ No ☐

Please give a reason for your choice

7. What are the main limitations/drawbacks of the current system of:

7.1 Creating patient health record?

7.2 Maintaining patient health record?

7.3 Storing patient health record?

7.4 Retrieving patient health record?

Determination of e-consultation and e-prescription

8. What is the current system of consultation between physicians and patients?

Face-to-face ☐ Through electronic means ☐

8.1 If electronic means, mark the medium/media (Mark more than one if applicable).

e-mail (computer) ☐ e-mail (cell phone) ☐ Telephone ☐ sms ☐

Other ☐ Specify

9. What is the current system of consultation between physicians and physicians?

9.1 Within the hospital/clinic?

Face-to-face ☐ Through electronic means ☐

9.1.1 If electronic means, mark the medium/ media (Mark more than one if applicable)

e-mail (computer) ☐ e-mail (cell phone) ☐ Intranet ☐ sms ☐

Telephone ☐ Other ☐ Specify ☐

9.2 With other hospitals/clinics?

Face-to-face ☐ E-video consultation ☐ Through electronic means ☐

9.2.1 If electronic means, mark the medium/media (Mark more than one if applicable)

e-mail (computer) ☐ e-mail (cell phone) ☐ Internet ☐ sms ☐

Telephone ☐ Other ☐ Specify ☐

10. Does your hospital/clinic have telemedicine facility? Yes ☐ No ☐

If yes, describe how it is used.

11. What method is used for referrals of patients to the pharmacy department for collection of medicine? (e.g. given paper prescription or electronic transfer of prescribed medicine). Please, indicate below.

12. In your point of view, what are the advantages and disadvantages of the current system of referrals of patients to the pharmacy department for the collection of medicine in your hospital?

Advantages	
Disadvantages	

Determination of training opportunities

13. How often do you use a personal computer? Please, mark with X.

Daily ☐ Weekly ☐ Monthly ☐ Never ☐

13.1 For what purpose(s) do you use the computer? Please, specify.

14. How does your access or lack of access to a computer and Internet impact on your daily work? Please, indicate below.

15. How many hours do you spend on your computer per day? Indicate below.

16. How will you rate your knowledge of computer usage? Mark with X.

Novice ☐ Average ☐ Experienced ☐

. Have you ever had any training or direct experience in using **e-health record system**? Yes ☐ No ☐

If yes, please give details of the type of training received or your experience in using **e-health record system**.

17. Do you think you need training for the use of an **e-health record system** or any other system? Yes ☐ No ☐

If yes, indicate **which system** and **how much time** you will prefer to spend for this training?

18. Do you have any other comments or recommendations? Please, indicate in the space below.

THE END

Thank you for your patience and your participation.

APENDIX C: INTERVIEW QUESTIONS FOR ADMINISTRATORS, DOCTORS, NURSES AND WARD ATTENDANTS

About this interview

All information will be treated as confidential. Participation in this interview is voluntary and will be highly appreciated. The interview will be recorded for analysis.

Aim: To determine the acceptance level and perceived usefulness of e-patient health record, e-prescription, e-consultation and e-referrals and their potential benefit to the hospital/clinic.

1. What benefits will you expect if the following e-health applications were installed in your hospital/clinic?

E-patient health record system • Time for recording patient information • Time for retrieving patient information • Diagnosis and treatment time • Confidentiality of patient information
E-consultation system
E-prescription system
E-referral system
E- training system

2. If any of the above systems was implemented at your local hospital/clinic, what will be your personal expectations in terms of solving some of the current problems the hospital/clinic is faced with, or improving the quality of healthcare services provided?
   Name such a system and explain your expectations.
3. What problems do you anticipate that may arise from the implementation and use of such a system? Name the system and state the anticipated

problem.

4. What basic technologies do you currently have in your hospital/clinic
that support e-health application? Name any that you know of.

5. Will you like to have further training in computer usage to enhance
your job performance?

6. Will you like to access e-health application outside your work environment?
And why?

7. Is there anything else you will like to suggest, recommend or comment on?

THE END

Thank you all for your time, participation and valuable contributions.

APENDIX D: ETHICS APPROVAL LETTER FROM NMMU

• PO Box 77000 • Nelson Mandela Metropolitan University
• Port Elizabeth • 6031 • South Africa • www.nmmu.ac.za

Nelson Mandela Metropolitan University

for tomorrow

NORTH CAMPUS
FACULTY OF ENGINEERING,
THE BUILT ENVIRONMENT AND
INFORMATION TECHNOLOGY
Tel . +27 (0)41 5043446 Fax. +27 (0)41 5049446
Rushda.Jappie@nmmu.ac.za

Ref: H09-Eng-ITe-003 Student number: 209202630

3 December 2009

Mr A Coleman
PO Box 3947
The Reeds
CENTURION
0158

Dear Mr Coleman

DEVELOPING AN E-HEALTH FRAMEWORK THROUGH ELECTRONIC HEALTHCARE READINESS ASSESSMENT

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 Ethics clearance reference number is H09-Eng-ITe-003, and is valid for three years, from 4 November 2009 – 4 November 2011. 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.

Yours sincerely

Jappie

Rushda Jappie
MANAGER: FACULTY ADMINISTRATION

cc: Promoter/Supervisor
HoD
School Representative: Faculty RTI

APENDIX E: ETHICS APPROVAL LETTER FROM NORTH WEST DEPARTMENT OF HEALTH.

From: To:T00865720614 23/06/2002 01:29 #422 P.002

Health & Soc Dev
Department:
Health & Social Development
North West Provincial Government
REPUBLIC OF SOUTH AFRICA

DIRECTOR:
POLICY & PLANNING
15 FEB 2010
DEPARTMENT OF HEALTH
PRIVATE BAG X2068 MMABATHO 2735

2ND Floor Tirelo Building
Dr. Albert Luthuli Drive
Mafikeng, 2745
Private Bag X2068
MMABATHO, 2735

DIRECTORATE POLICY, PLANNING AND RESEARCH

Tel: (018) 387 5757
Fax: 086 631 8540
smalakane@nwpg.gov.za

To : Mr A. Coleman
Tshwane University of Technology
From : Director: Policy, Planning & Research Directorate
Mr K.Rabanye
Date :15 February 2010

Subject: Request for approval: Developing an E-health framework through health care readiness assessment

The above stated subject matter has the following reference

This communiqué serves to inform your good self that permission to undertake a study as indicated above has been granted by the Office of the Superintendent –General of the Department of Health and Social Development.

Arrangements with managers at District level will be facilitated by the researcher. We apologize for any inconvenience caused.

Attached please find an agreement letter to be signed by you , an indication as to when the final results would be furnished to the Department is quiet crucial.

Yours truly

Mr K.Rabanye
Chairperson: PHRC –Health Branch
North West Department of Health and Social Development

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APENDIX F: ETHICS APPROVAL LETTER FROM NORTH WEST DEPARTMENT OH HEALTH: RUSTENBURG SUB DISTRICT OFFICE.

Health & Soc Dev

Department:
Health & Social Development
North West Provincial Government
REPUBLIC OF SOUTH AFRICA

Kerkstreet 125
PRIVATE BAG X 82055
RUSTENBURG
0300

RUSTENBURG SUB DISTRICT OFFICE
SUB DISTRICT MANAGER

Enq: Mr L.K. Tlhowe
Cell:: 0828070449
E-Mail: ltlhowe@nwpg.gov.za
Tel: 014 594 8300

TO: **MR.A. COLEMAN**
TSHWANE UNIVERSITY OF TECHNOLOGY

FROM: **SUB DISTRICT MANAGER**
RUSTENBURG
0300

DATE: **24TH MARCH 2010**

SUBJECT: **APPROVAL TO CONDUCT RESEARCH ACTIVITIES IN THE NORTH WEST PROVINCE (RUSTENBURG – CLASSIC HOUSE CLINIC)**

Following the approval for the above mentioned request, this office further grants you permission to access the Classic House Clinic situated in Rustenburg Sub District for activities limited to your research scope only.

You are expected to present this authorization to the Operational Manager of Classic House Clinic each time you present yourself to the facility in question. Kindly note that you may not access our facility for this purpose unless this letter of authorization is presented.

We wish you the best of luck and success in your endeavours and hope you find our contribution important to the latter.

Kind regards,

Tlhowe 24/05/2010

L.K. TLHOWE (MR)
SUB DISTRICT MANAGER
RUSTENBURG SUB DISTRICT

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"THE RUSKKO HEALTH SERVIVE COMPLEX.....A CUT ABOVE!"

APENDIX G: INFORMATION LEAFLET AND INFORMED CONCENT.

Nelson Mandela Metropolitan University

for tomorrow

Faculty of Engineering, the Built Environment

and Information Technology

NMMU NORTH CAMPUS

Tel: +27 (0)41 504 3604

Fax: +27 (0)41 504 9480

3 September 2009

Ref: (H09-Eng-ITe-003)

Dear Participant

You are being requested to participate in a research study. We will provide you with the necessary information to assist you to understand the study and explain what would be expected of you (participant). These guidelines would include the risks, benefits, and your rights as a study subject. Please feel free to ask the researcher to clarify anything that is not clear to you. Participants should note that participation in this research study is voluntary.

To participate, it will be required of you to provide a written consent that will include your signature, date and initials to verify that you understand and agree to the conditions. This consent form is indicated below.

You have the right to query 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.

Furthermore, 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, Nelson Mandela Metropolitan University, PO Box 77000, Port Elizabeth, 6031.

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

If you do partake, you have the right to withdraw at any given time during the study without penalty or loss of benefits. However, if you do withdraw from the study, you should return for a final discussion in order to terminate the research in an orderly manner.

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.

Please note that interviews will be recorded by audio tape for transcription and analysis of data.

This informed consent statement has been prepared in compliance with current

statutory guidelines.

I understand that by signing this form I am consenting to participate in this study.

Participant's surname and initials……………………………......................

Signature: …………………………………. Date…………………………

Thanking you for your participation.
Yours sincerely

…………………….
Alfred Coleman
Researcher
Tel: 0123829170
Cell: 0731370859

………………………….
Prof. M. Herselman
Supervisor
NMMU
Tel: 0128413081

APENDIX H: NORTH WEST DEPARTMENT OF HEALTH EXPERT REVIEW OF E-HEALTH FRAMEWORK- PEHF

NORTH WEST DEPARTMENT OF HEALTH

Healthy Living for All

North West Province
Republic of South Africa

Ground Floor opp HR
Kerksdorp Hospital
Private Bag A14
Klerksdorp 2570

INFORMATION & COMMUNICATION TECHNOLOGY

Tel: (018) 406 4017
Fax: (018) 462 8931
Email: smogatusi@nwpg.gov.za

Enquiries: A.S.Mogatusi

TO :Mr Alfred Coleman
FROM :Mr. A.S. Mogatusi
DATE : 02/09/2010

SUBJECT : Expert Review

The e-health framework proposed is approprite for the North West health department. The Infrastucture network linkage and the topological processes are also very relevant to the hospitals/clinics. The e-health framework will be a major contribution to the North West health department if implemented.
It was also suggested that memory stickers and scanning of patient files can be added.

Thank you sir.

asmogatusi---
Mr. A.S. Mogatusi
Deputy ***Director: Information & Communication Technology (K/T. Complex)***

GESONDHEIDSDIENSTE
KLERKSDORP / TSHEPONG
HOSPITAAL KOMPLEKS
Privaatsak / Private Bag A14
02 SEP 2010
KLERKSDORP 2570
KLERKSDORP / TSHEPONG
HOSPITAL COMPLEX
HEALTH SERVICES

02/09 2010 15:38 FAX 0184622156 REGISTRASIE 001