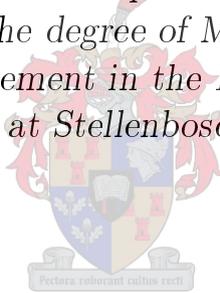


An Assessment of the Telemedicine Services within the Western Cape Public Health Care System

by

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*Assignment presented in partial fulfilment of the
requirements for the degree of Master of Science in
Engineering Management in the Faculty of Industrial
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April 2014

Declaration

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Abstract

An Assessment of the Telemedicine Services within the Western Cape Public Health Care System

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Telemedicine is defined as an electronic exchange of medical information and/or the delivery of clinical health care over a distance, by means of Information and Communication Technology (ICT). South Africa is faced with the problem of providing health care to a population in urban, as well as across vast rural areas. In addition to this, the South African health care system must deal with economical imbalances and a shortage of human resources to provide quality health care. Telemedicine services could provide a solution.

Since the introduction of the first national telemedicine services initiative in the late 1990s, a number of South African telemedicine services have been implemented in the public health care system. The majority of these telemedicine services have been prone to failure and many were prematurely terminated. The circumstances which influence the failure or success of these services are not unknown. The lack of insight, and the high failure rate of telemedicine services implemented in the South Africa were the reasons for conducting this study.

The purpose of the study is to assess telemedicine services implemented in the Western Cape public health care sector. The purpose is also to provide recommendations for improving the current and future telemedicine services in the Western Cape and other provinces.

A telemedicine services assessment was conducted on a total of 26 telemedicine services identified at 6 health care facilities located in the Western Cape.

The assessments were based on the TeleMedicine Services Maturity Model (TMSMM), which was developed specifically for the purpose of assessing telemedicine services. The TMSMM capability statements were used as a yardstick to assess the maturity of each of the elements of telemedicine services in terms of the three service level groups (micro-, meso- and macro-level) and five telemedicine domains (man, machine, material, method and money).

The assessment process included: (i) the identification of telemedicine services at the selected health care facilities; (ii) the gathering of the relevant telemedicine service data by means of structured interviews; (iii) the transformation of the complex flow of information into Data Flow Diagrams (DFDs); (iv) the loading of telemedicine services data into a data warehouse; and (v) the analysis of data by means of On-Line Analytical Processing (OLAP), as well as box-and-whisker plots and statistical correlations.

Based on the results of the TMSMM assessment, an electronic questionnaire was developed and administered amongst health care workers throughout the entire Western Cape. The questionnaire confirmed that the findings from the TMSMM assessment are indeed representative of the entire Western Cape.

The assessment of the telemedicine services provides information about the elements which affect the success or failure of these services. This therefore addresses the initial research problem and fulfils the purpose of the study. These results were used as an input to the analysis of strengths, weaknesses, opportunities and threats (SWOT) of the delivery of telemedicine services in the Western Cape public health sector. For future references and studies, the SWOT analysis provides a point of departure for a strategic telemedicine services framework for a province like the Western Cape.

Uittreksel

'n Evaluering van die Telegeneeskundige Dienste in die Wes-Kaap Stelsel vir Openbare Gesondheid

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Telegeneeskunde, per definisie, behels die deel van mediese inligting en/of die lewering van kliniese gesondheidsdienste oor 'n afstand, deur middel van inligting en kommunikasie tegnologie (ICT). Telegeneeskunde dienste is moontlik een van die oplossings vir die lewering van gesondheidsdienste vir 'n bevolking wat versprei is oor 'n groot landelike gebied binne 'n publieke gesondheidsektor wat mense hulpbronne kort om kwaliteit gesondheidsorg te lewer. Die publieke gesondheidstelsel van Suid Afrika het 'n drie-dubbele las van siektes, ekonomiese wanbalans and 'n tekort aan mediese praktisyns.

Sedert die eerste nasionale inisiatief vir telegeneeskunde dienste in die laat 1990s bekend gestel is, is 'n paar telegeneeskunde dienste in die publieke gesondheidsektor van Suid Afrika geïmplementeer. Die meerderheid van hierdie dienste blyk onsuksesvol te wees. The faktore wat die implementeringsukses beïnvloed is nog nie goed nagevors nie.

Die doel van hierdie studie is om telegeneeskunde dienste wat in die Wes-Kaap publieke gesondheidsektor geïmplementeer is te ondersoek. Die doel is verdermeer om aanbevelings te maak met die oog op die verbetering van bestaande en toekomstige dienste in die Wes-Kaap asook ander provinsies.

Eerstens is 'n telegeneeskunde diens assessering uitgevoer op 'n totaal van 26 dienste 6 fasiliteite. Hierdie assesserings is gebaseer of the Telegeneeskunde Diens Volwassenheidsmodel (TMSMM), wat ontwikkel is spesifiek met die doel om telegeneeskunde dienste te assesseer. Dit word gedoen deur die dienste te

meet in terme van drie vlakke (mikro-, meso- en macrovlak) en vyf domeine (man, masjien, materiaal, metode en geld). Die TMSMM vermoë-stellings word as maatstaaf gebruik.

Die assesseringsproses sluit in (i) die identifisering van telegeneeskunde dienste by die aangewese gesondheidsfasiliteite; (ii) die versameling van relevante telegeneeskunde data deur middel van gestruktureerde onderhoude; (iii) die transformasie van komplekse inligtings vloei na data vloei-diagramme (DFDs); (iv) die laai van telegeneeskundige dinstedige data in 'n databasis; and (v) die analise van data deur middel van aanlyn analitiese verwerking (OLAP) sowel as box-en-snorbaard grafiek en statistiese korrelasies.

Gebaseer op die resultate van die TMSMM assesseringsproses, is 'n elektroniese vraelys ontwikkel en geadministreer onder gesondheidswerkers regoor die Wes-Kaap ten einde te bevestig of die gevolgtrekkings van die TMSMM assessering die hele provinsie verteenwoordig.

Die assessering van die telegeneeskundige dienste verskaf inligting in terme van die faktore wat die sukses van telegeneeskundige dienste beïnvloed. So-doende word die aanvanklike navorsingsprobleem aangespreek. Hierdie resultate is toe gebruik as inset vir die analise van die sterk punte, swak punte, geleenthede en bedreigings (SWOT) in die publieke gesondheidssektor van die Wes-Kaap in terme van telegeneeskundige dienste. Hierdie SWOT-analise kan in die toekoms gebruik word as vertrekpunt vir die ontwikkeling van strategiese raamwerk vir die implementering van telegeneeskundige dienste in 'n provinsie soos die Wes-Kaap.

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List of Acronyms

- 3P** policies, procedures and protocols
- ADR** Analyse, Diagnose and React
- ATA** American Telemedicine Association
- CHC** Community Health Clinic
- CSIR** Council for Science and Industrial Research
- CTG** Cardiotocography
- DALY** Disability-Adjusted Life-Years
- DFD** Data Flow Diagram
- DHS** District Health Services
- DoH** Department of Health
- ECG** Electrocardiography
- EHR** Electronic Health Record
- EMR** Electronic Medical Record
- ETL** Extract, Transform and Load
- GBD** Global Burden of Disease
- GDP** Gross Domestic Product
- HIS** Hospital Information System
- HREC** Health Research Ethics Committee
- ICT** Information and Communication Technology
- MDG** Millennium Development Goals
- MRC** Medical Research Council
- NASA** National Aeronautics and Space Administration
- NDoH** National Department of Health
- NDoST** National Department of Science and Technology
- NHI** National Health Insurance
- NTTT** National Telemedicine Task Team

OLAP On-line analytical processing

PACS picture archiving and communication system

PHC Primary Health Care

RA Regional Average

SWOT strength, weakness, opportunity and threat

TMSMM TeleMedicine Services Maturity Model

WHO World Health Organisation

Chapter 1

Introduction

1.1 Introduction

During the mid 1990s, the South African public health care system underwent a restructuring, in an attempt to align it with the District Health Services (DHS). The focus of the DHS is the delivery of health care, based on the principles of the Primary Health Care (PHC) approach (Pillay *et al.*, 2001).

The then newly appointed South African Department of Health (DoH) saw the need for a people-orientated health care system. PHC was therefore made available at public sector clinics throughout South Africa, at no cost to the recipient at the point of care. The aim of the new health care system was to deliver quality health services to every South African citizen equally. This would ensure that the World Health Organisations (WHOs) Alma Ata Declaration's definition of health care, as a basic human right, would be taken cognisance of (Kautzky and Tollman, 2008; World Health Organisation, 2006).

Nineteen years have passed since the initial restructuring of the South African health care system. However, the aim to supply the South African population with an improved PHC is yet to be fulfilled. The National Department of Health (NDoH) has been unable to provide the basics of a district and people-orientated health care service to South Africans.

The pressure to deliver a people-orientated health care system is proving to be more demanding than the NDoH previously anticipated. A lack of qualified (medical and administrative) resources to facilitate the provision of health care in the public health care sector is one of the many roadblocks encountered by the new health care system.

Based on studies conducted by the WHO in 2006, there are on average 7.077 health care workers available per 1000 South African citizens. Normalising the

average number of health care workers per 1000 people, and taking the whole of Africa into consideration, results in a weighted Regional Average (RA) of 2.626 health care workers per 1000 South African citizens (World Health Organisation, 2006).

The stagnation in the progress to improve the current health care regime of the country is partly due to the vast geographical area of South Africa. Of the people living in South Africa, 60.7 percent reside within the confines of urban centres (i.e. Cape Town, Durban, Johannesburg). The remainder (39.3 percent) of the population is spread across the more rural regions of South Africa. The challenge of providing quality health care to every citizen equally is drastically complicated by the fact that a large portion of the population resides in the rural parts of South Africa (Trending Economics, 2012).

The quality of health care is affected because patients have to commute vast distances to reach either rural health care clinics or specialist health care facilities situated in urban centres. Such logistical issues increase the strain and discomfort of patients, and the commute accumulates unnecessary travelling expenses.

The discomfort, strain and expense suffered by the patients have a negative effect on the provision of the quality of health care, which is a pillar of the people-orientated health care system. To mitigate these negative aspects, the unnecessary costs incurred by patients must be reduced. The imbalance of wealth which South Africa rankles with is an important factor to take into consideration in achieving a worthwhile people-orientated health care system.

According to World Health Organisation (2011), the latest demographic data indicates that South Africa has a GINI coefficient of 63.14, which indicates a relatively high inequality. To put this in to perspective, a GINI coefficient of 100 represents maximal inequality. The high financial inequality is arguably one of the reasons why 84 percent of the South African public rely on public health care for their general health care needs. In addition to the already daunting statistics, 84 percent of the South African population which rely on public health care are treated by a health care workforce which has continuously been shrinking since 1989 (Gelb, 2004; Department of Health (South Africa), 2004; World Health Organisation, 2011).

Although there is a scarcity of medical expertise in the public health sector, the health care system implemented in South Africa aims to utilise these scarce resources effectively, by creating a seamless continuum of services for optimal care.

The system implemented by the NDoH is a hierarchical referral system. In

this system, district hospitals assume the central role between the PHC clinics, Community Health Clinics (CHCs) and the regional and tertiary hospitals. The district hospitals ensure that patients are treated at the appropriate level, according to the health care required. Although this system works perfectly in theory, in reality, the system has been less successful. The system does not function as intended due to the overly burdened case loads at higher level health care facilities. The reason for this is due to patients visiting higher level hospitals directly without having been referred by lower level facilities. All health related matters are therefore being treated at higher level health care centres, many of which should have been treated at the respective lower level health care facilities. The result of this problem is that unnecessary expenses are incurred and there is poor service delivery (Mojaki *et al.*, 2011).

A possible solution to providing free-of-charge and quality health care to every South African citizen, was proposed by the NDoH by the National Telemedicine Task Team (NTTT) convened in 1998. The purpose of the NTTT was to co-ordinate the introduction of the South African Telemedicine System into the South African health care delivery systems (Telemedicine Task Team, 1998; Mars, 2011).

Telemedicine is a rapidly developing applicator of clinical medicine. It can be defined as an electronic exchange of health care information and/or the delivery of clinical health care over a distance, by means of ICT. Since telemedicine transfers patient information electronically over a distance, the need to refer patients between hospitals can be reduced, minimising the costs involved and ensuring that quality health care is provided (Sood *et al.*, 2007).

The initial phase of the Telemedicine System, also referred to as the National Telemedicine Strategic Plan, commenced between April 1999 and March 2000. This initial phase provided 28 sites in 6 provinces with telemedicine services (Telemedicine Task Team, 1998; Mars, 2011).

According to Gulube and Wynchank (2002), the National Telemedicine Systems were "...to provide rural communities with access to the expertise of physicians and other specialists available at major South African medical centres, using telemedicine technology".

The National Telemedicine System was unsuccessful. As a result, phases 2 and 3 were amended to focus on the implementation of telehealth rather than telemedicine. Even though the initial attempts at implementation failed telemedicine caught the attention of the NDoH.

The notion that telemedicine could be beneficial to the current health care landscape of South Africa, was confirmed by the NDoHs statement, which was

as follows:

"The NDoH recognises the potential of telemedicine as an enabling tool that could bridge the gap between rural health care and specialist facilities." (Department of Health (South Africa), 2012)

According to Van Dyk *et al.* (2012), telemedicine has the ability to connect the rural communities with higher level health care services delivered in the urban areas. This enables the communities to benefit from the specialised care. Although the potential benefits of telemedicine have been acknowledged by the NDoH, only a select few telemedicine programmes and services have received the appropriate amount of support on all levels and are therefore sustainable (Mars, 2011).

An evaluation of the initial phase of the National Telemedicine Strategic Plans demonstrates the benefits of the system. For example, access to specialist radiologists who report in a shorter period of time, or the minimisation of unnecessary transfers from rural to urban, tertiary health care facilities (Gulube and Wynchank, 2002).

Although the benefits of the telemedicine system are clearly demonstrated, the systems and services themselves are unsustainable and non-functional. At the South African Telemedicine Conference, the Minister of Health, Aaron Motsoaledi reported that of the 86 telemedicine services implemented by the government since 2000, less than a third are functional at present (Department of Health (South Africa), 2010*b*).

Even though various enthusiast-driven telemedicine projects commenced all over South Africa, the NDoH realised that the majority of the services implemented, fail due to: (i) the health care work-force's lack of participation; (ii) the failure to fully appreciate the need for change management; (iii) inadequate support and training facilitated by the governing institutions; and (iv) the failure of provincial health care departments to take responsibility for the programmes (Mars, 2011; Gulube, 2000).

Only nine years after the initialisation of the National Telemedicine Strategic Plan's first phase was a Telemedicine Moratorium declared which restricted the use of ICT for telemedicine services.

In an effort to reduce the number of failing telemedicine services, the NDoH devised an eHealth Strategy for South Africa. The strategy was introduced to public and private telemedicine stakeholders in 2012. The aim of the strategy is to provide a foundation for the development of ehealth in South Africa (Department of Health (South Africa), 2012).

The compilation of issues, pertaining to the difficulties of providing quality health care and the failure to implement sustainable telemedicine applications, have led to the formulation of the problem statement and the consequent research purpose.

1.2 Research Scope, Problem Statement and Purpose

The next section elaborates on the problem statement which prompted this study. The research purpose and scope of the study are also identified.

1.2.1 The Research Scope

The scope of the study was restricted to public health care telemedicine services, implemented within the confines of the Western Cape.

According to the NDoH, the Western Cape DoH is the most advanced and reputable in South Africa. Great emphasis is placed on the improvement of information management systems and the optimisation of the PHC, with the support of advanced ICT (National Department of Health *et al.*, 2012).

Due to the advanced state of the Western Cape health care system, compared to the rest of the country's health care systems, logistical purposes, and time constraints, it was decided that existing telemedicine services implemented within the Western Cape would be investigated.

The parameters of the research were set to include a select volume of provincial health care facilities within the Western Cape. The selection process and criteria are elaborated in more detail in Section 5.1.1.

1.2.2 The Problem Statement

The introduction of the 2009 ICT moratorium and the eHealth Strategy in 2012, was the attempt by the NDoH to implement a strategic framework with the aim of mitigating the high premature termination rate of ehealth and telemedicine projects.

The more imminent issue, however, is not the implementation of high level strategic frameworks, but rather the lack or absence of insight pertaining to the telemedicine landscape of South Africa. More specifically, the lower level telemedicine service elements which affect the success or failure of such services.

The literary volume of information available on telemedicine services within the context of the South African public health care system is insufficient. Insight regarding the actual circumstances which influence the success or failure of telemedicine services is lacking. The limited information which is available suggests that the shortfall of telemedicine services implemented in South Africa is due to the lack of sustainability and funding, thus leading to the premature termination of the majority of the projects (Mars, 2011; Gulube, 2000).

The National Department of Science and Technology (NDoST) recognises the value of information pertaining to telemedicine services. With the aim to developing the growth and sustainability of telemedicine through research, the NDoST wants to generate a more sustainable model for telemedicine in South Africa. Furthermore, Strategic Priority 10, listed in the eHealth Strategy of South Africa, states that there is a need to assess ehealth (including telemedicine services) (Department of Health (South Africa), 2012).

To fully comprehend the elements which affect the success or failure of telemedicine services implemented in the public health care sector of the Western Cape, the telemedicine landscape of Western Cape needs to be assessed and analysed. Only once internal structures of a telemedicine services are understood, can these services evolve and become effective tools and assets to the health care system of South Africa.

1.2.3 Research Purpose

The purpose of the study is to assess telemedicine services implemented in the Western Cape public health care sector. The purpose is also to provide recommendations for the improvement of current and future telemedicine services implemented in the Western Cape.

1.3 Methodology

The research phases, and respective research questions listed in Table 1.3.1 and 1.3.2, provide an overview and structure to the study. The research questions in particular were designed to aid in the flow of the study.

During the process of the study, a multitude of research methodologies enabled the acquisition of information, which facilitated responses to the predefined research objectives mentioned previously. The progression of the research and an overview of the chapter structure of the document is graphically depicted in Figure 1.3.1.

The sections to follow provide a description for each of the methodology phases detailed on the right hand side in Figure 1.3.1.

Table 1.3.1: Research Phases and the respective Research Questions

Research Phases	Research Questions
1 - Review the state of the art of (i) the South African health care system (Chapter 2)	1.1 - What is the health status of the South African population? 1.2 - What health care approach does South Africa implement.?
2 - Review the state of the art of (ii) telemedicine services within the context of South Africa (Chapter 3)	2.1 - Where does Telemedicine originate from, i.e. what are its roots? 2.2 - Which existing definitions of telemedicine are presented in literature and how do they correspond with the research study? 2.3 - What is South Africa's current position with regard to telemedicine in the public health care sector? 2.4 - Which telemedicine service is most commonly utilised in the health care sector?
3 - Review the state of the art of (iii) the TMSMM (Chapter 4)	3.1 - Why assess telemedicine services? 3.2 - What features of a telemedicine service are determinant features with regard to assessment of its success or failure? 3.3 - What tool or model can be utilised for the assessment of telemedicine services?
4 - Analyse the telemedicine services assessment data and establish an understanding of the public health care telemedicine services implemented in the Western Cape. (Chapter 5)	4.1 - How is the assessment data integrity ensured? 4.2 - Which data synthesis techniques and analysis methods were implemented to transform the assessment data? 4.3 - What is the general composition of the telemedicine services assessed during the progress of the study? 4.4 - Does the assessment data suggest any statistical correlations? 4.5 - What knowledge can be obtained from the maturity assessment? 4.6 - Which research tools and techniques are incorporated in the telemedicine services data Extract, Transform and Load (ETL) process?

Continued in Table 1.3.2

Table 1.3.2: Research Objectives and the respective Research Questions cont.

Research Objective	Research Questions
5 - Validate that the conclusions drawn from the analysis are representative of the entire Western Cape telemedicine community. (Chapter 6)	5.1 - What methods can be utilised to validate the results of the TMSMM assessment? 5.2 - How is the validation process conducted? 5.3 - What are the outcomes of the validation process?
6 - Generate a strategic framework for the Western Cape DoH, exploiting the opportunities and strengths of telemedicine landscape and pointing out the threats and weaknesses. (Chapter 7)	6.1 - What business management tool can be utilised to interpret the results of Chapters 5 and 6? 6.2 - How can a business analysis technique be utilised to interpret the TMSMM data obtained during the study? 6.3 - What are the results and recommendations obtained by applying these business management and analysis tools?

1.3.1 Review Current State of Research

Chapters 2, 3 and 4 are an account of the information accumulated from the relevant researched literature. The review aims to establish a general understanding of the research field and forms the backbone of the study, presenting the reader with the required information to appreciate the work presented.

The review elaborates on important topics such as; (i) the health care status of the South African population; (ii) the current health care system implemented in South Africa; (iii) the origins and definitions of telemedicine, specifically telemedicine in the South African context. Furthermore the state of the art review also focuses on (iv) the identifying factors which define a telemedicine service. A understanding of the South African health care society and system, telemedicine services commonly implemented in the health care sector, as well as document detailed reviews of telemedicine service evaluation models, such as the TMSMM, should thus be established.

The literature research is presented throughout the entire study in a structured way, to support the flow of the information presented.

1.3.2 Site Selection and Data Gathering

The intention of site selection and data gathering is to identify operational and non-operational telemedicine services. These services are investigated by

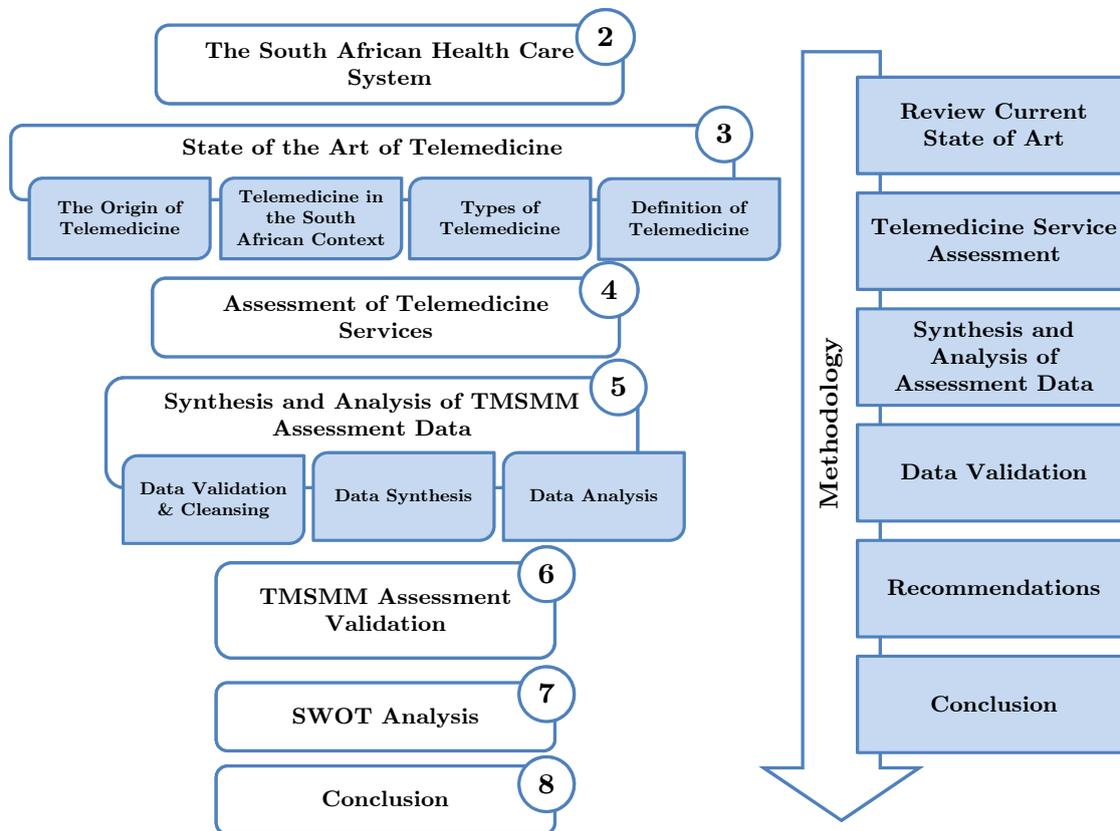


Figure 1.3.1: Research Overview

means of a suitable evaluation and assessment method to extract the required information. This information is then incorporated into recommendations, aimed at an audience of decision- and policy-makers at a governmental level, regarding the improvement of telemedicine services implemented in the Western Cape.

The initial phase of data acquisition involves the investigation of public health care facilities situated in the Western Cape, with regard to telemedicine services. A select group of health care facilities were short-listed with the assistance of the Medical Research Council (MRC) and consulting experts in the field of telemedicine. A more detailed account of the health care facility selection method is given in Section 5.1.1

Data gathering was conducted by way of a structured interview with the Medical Officer in charge at the facility. Relevant information pertaining to the implementation of telemedicine services was obtained. The construction and purpose of the structured interview is discussed in detail in Section 5.1.2.

1.3.3 Telemedicine Services Assessment

Phase 1 of the assessment was to identify suitable public health care facilities which have been actively exposed to telemedicine services. The second phase of the study was executed by conducting structured interviews with the medical officers in charge, in order to establish which telemedicine services, active or in-active, were implemented at the facilities.

The assessment of a telemedicine service is not a straight forward procedure. There are no clearly defined standards or criteria which enables the evaluation of such services. Literature is not explicit regarding which aspects of a telemedicine service are most relevant. Bashshur (1995) argues that the most important facets of a telemedicine service are accessibility, cost, and quality.

Chapter 4 elaborates on the topic of the evaluation of telemedicine services and concludes by suggesting the TMSMM is suitable tool for the assessment study. The assessment of the telemedicine services data utilising the TMSMM tool forms part of the ETL process, detailed in Section 5.1.4.

1.3.4 Ethical Approval

A research study involving the acquisition and aggregation of health care data requires ethical approval from the respective authorities. In this study the Stellenbosch University Health Research Ethics Committee (HREC) and the Western Cape DoH had to give the required ethical clearance.

Approval to conduct the study was granted by the HREC, conditional on the study being conducted according to the ethical guidelines and principles of the international Declaration of Helsinki, South African Guidelines for Good Clinical Practice and the MRCs Ethical Guidelines for Research (see Appendix A).

Conducting research within the Western Cape health care system required ethical clearance from the Western Cape DoH. This has subsequently been granted.

1.3.5 Description of Service

During the telemedicine data extraction phase of the assessment process, information regarding telemedicine services is gathered. The data on its own are at times challenging to process and thus complicate the service description process. In order to simplify the description process, the complex telemedicine service is converted into a DFD.

More detail regarding the reasons for converting telemedicine services with the help of DFDs is documented in Section 5.1.3.

1.3.6 Synthesis and Analysis of Assessment Data

By utilising an array of synthesis and analysis methods and techniques, the assessment data obtained via the ETL process is transformed and manipulated. Extracting relevant and valuable information from the digital TMSMM data store required the use of pivot tables, box plots and statistical correlations. Chapter 5 elaborates on the synthesis and analysis techniques used and discusses the results thereof.

The data gathered during the preceding research stages were stored in a data warehouse. The data aggregation is obtained by compiling information from a detailed database, which entails the process of extracting relevant info-techniques and by using of pivot tables. Visualisations of the extracted information aided the analysis of the data.

1.3.7 Data Validation

A questionnaire was constructed with the aim of validating the TMSMM data analysis hypotheses. The questionnaire was designed to be aligned with the hypotheses established, based on the analysis outcomes. These questionnaires were distributed amongst a predefined target population in the Western Cape.

The purpose of the questionnaire was to obtain evidence which suggested that the analysis outcomes are representative of the entire Western Cape telemedicine community. A detailed account of the questionnaire construction and the validation process is documented in Sections 6.2 and 6.3.

1.3.8 Recommendations

The resolve of the TMSMM assessment and analysis is and in-depth understanding of the elements which influence the success or failure of telemedicine services implemented in the Western Cape public health care sector.

The utilisation of a SWOT analysis and the newly gained insight pertaining to telemedicine services enables the identification of strengths, weaknesses, opportunities and threats faced by the Western Cape telemedicine services. The identification of the strengths and weaknesses aids in the formulation of a set of recommendations aimed at improving the status of telemedicine services implemented in the Western Cape public health care sector.

1.3.9 Research Structure/Layout

This study is arranged in such a way as to guide the reader through the entire research process, beginning with the investigation of the health care and telemedicine state of research, and concluding with the a final framework aimed at supporting existing and future telemedicine services in South Africa (see Figure 1.3.1).

Chapter 2: - The South African Health Care System

Chapter 2 establishes part of the study context with regard to South African health care. It provides a detailed account of the status of the South African health care and the means by which health care is provided to the South African population. The background information provided is required to fully appreciate and understand the information presented during the study.

Chapter 3: - State of the Art of Telemedicine

Chapter 3 provides background knowledge to the telemedicine landscape, by adding to the context of the study. The assessment of telemedicine services is part of the purpose of the study. To ensure a comprehensive understanding of telemedicine, Chapter 3 provides information about the origins of telemedicine, within a global and South African context. Chapter 3 also provides the definition of telemedicine which is adopted for the remainder of the study.

Chapter 4: - Assessment of Telemedicine Services

Chapter 4 provides a detailed literature review on telemedicine services, to identify the determinants which assess the success of a service. The review supplies the required knowledge to assist in the selection of the assessment method and process, namely the TMSMM, which is utilised in conjunction with structured interviews, coupled with DFD.

Chapter 5: - Synthesis and analysis of TMSMM assessment data

The synthesis and analysis of the TMSMM assessment data obtained during the ETL process is presented in Chapter 5. The aim of the analysis is to provide a detailed insight into the assessed telemedicine services, to help gain an understanding of what aids in the success or failure of the services implemented in the public health care sector of the Western Cape.

Chapter 6: - TMSMM Assessment Validation

The analysis of the TMSMM data resulted in the formulation of hypotheses pertaining to the telemedicine services identified and assessed during the process of the study. Chapter 6 documents the validation of these hypotheses by means of a questionnaire.

Chapter 7: - Western Cape Telemedicine Services Strategic Framework

Chapter 7 presents a SWOT analysis of the telemedicine services implemented in the public health care sector of the Western Cape, based on the insight obtained in Chapters 5 and 6. Chapter 7 also provides a set of recommendations pertaining to the improvement of the Western Cape telemedicine services.

Chapter 8: - Conclusion

Chapter 8 reflects on what was done during the study, on the accomplishments and discusses potential future work based on the outcomes of the study.

Chapter 2

The South African Health Care System

The purpose of the study is to assess telemedicine services implemented in the Western Cape public health care sector. To fully comprehend and appreciate the study and its outcomes, it is essential to clearly defined the context within which the study was conducted.

Chapter 2 aims to provide the necessary knowledge and background pertaining to the state of the art of the South African health care system. Elaborating on the current health status of the South African population, and discussing the health care approach implemented by the South African Government since 1994, will provide the necessary context with regard to the state of the art of the South African health care system for the study.

Research Question 1.1

What is the health status of the South African population?

Research Question 1.2

What health care approach does South Africa implement.?

2.1 The South African State of Health

South Africa is a relatively large, middle income sub-Saharan country with a landmass of over 1 million square kilometres and has a documented Gross Domestic Product (GDP) of \$227 billion per year. Compared with other developing countries, South Africa is ranked third highest with a per capita GDP of \$5 685, following Brazil and Botswana in the list (World Health Organisation, 2006).

Although South Africa is one of the driving economies in Africa, accounting for a quarter of the entire GDP, the country's unemployment rate is estimated to be at a staggering 21 percent (unofficial unemployment rate 41 percent). Half of the population are living under the poverty datum. Furthermore a substantial portion of the population (46 percent) reside in rural South Africa, especially complicating the delivery of quality health care (World Health Organisation, 2006; Mars and Seebregts, 2008).

The South African health care system is under immense strain, not only due to the high unemployment, grave poverty, and rural nature of the country; but also due to the unique burden of disease synonymous to South Africa (EconEX, 2009).

2.1.1 South Africa's Quadruple Burden of Disease

According to World Health Organisation (2006) a double burden of disease is normally experienced in developing countries. South Africa's health profile is synonymous only to the Southern African Development Community and the added burden of injuries and HIV/AIDS, thus gravely impacting the health status of the country.

Since the Millennium Development Goals (MDG) were set in 1990, the child mortality has increased, South Africa's health outcomes are worse than in many low-income countries (EconEX, 2009; Coovadia *et al.*, 2009).

The Global Burden of Disease (GBD) study conducted in 1996 defined three groups for the cause of death in South Africa. Group one includes communicable diseases, maternal and prenatal conditions, and nutritional deficiencies also classified as all poverty-related illnesses. Group two consists of all non-communicable diseases and group three was defined to include violence and injuries (intentional and non-intentional) (EconEX, 2009).

Although HIV/AIDS is considered to be a communicable disease for the purpose of the GBD study it was defined as the fourth group, seeing that South Africa has the highest HIV-positive rate in the world and considering the un-

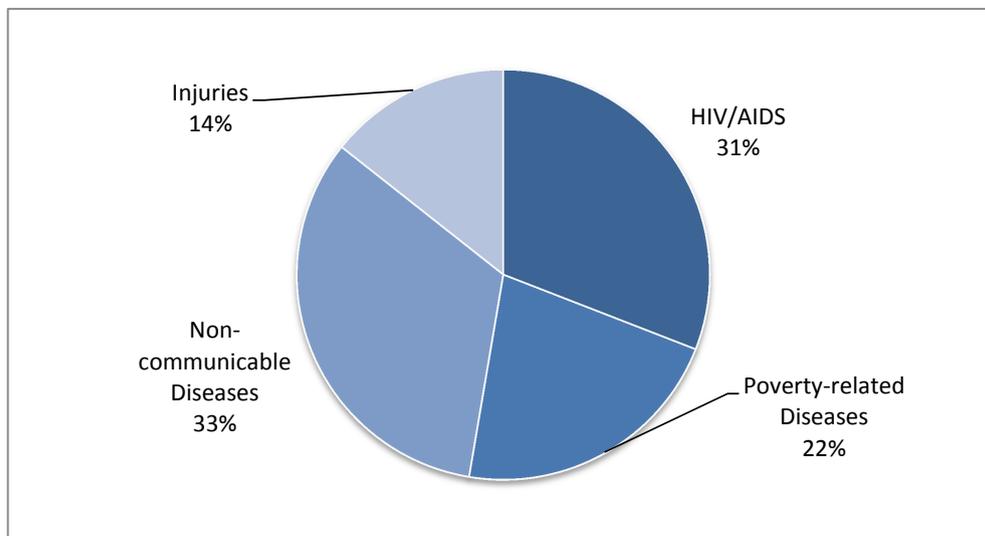


Figure 2.1.1: Estimated Disability-Adjusted Life-Years for South Africa, adopted from EconEX (2009)

usually large burden HIV/AIDS has on the society. The prevalence of HIV in adults aged 15 and older is 16.6 percent. Figure 2.1.1 depicts the four groups defined, according to Disability-Adjusted Life-Years (DALY), underlining the severity of the South African health care situation. On average the burden of disease experienced in South Africa is for times as high as in other developing countries, the life expectancy is as low as 42 years. Although South Africa has a relatively high GDP rating, the health outcomes do not commensurate the rating (Mars and Seebregts, 2008; Department of Health (South Africa), 2010a; EconEX, 2009).

Acknowledging that the tremendous burden of disease which South Africa is carrying, is in fact one of the major contributors, but not the sole determinant affecting the poor state of the health care system. Other determinants such as the burden of health care over-utilisation, economical inequality and the burden of providing quality health care to a population spread across a far-reaching area, multiply the challenges faced by the health care system.

2.1.2 Over-utilisation of the Public Health Care System

Through the process of independence South Africa inherited the health care system of a developed country, a over-priced, hi-tech, urban concentrated and curative health care system designed for the minority and made available to

the entire public post-1994. Population growth and a scarce availability of health care facilities throughout the country contribute the second major factor influencing the health system in a negative manner.

According to Department of Health (South Africa) (2010*a*): "Population growth between 2004-2009 appears to have outstripped the availability of health facilities", this is not entirely accurate. Contradicting the statement made by the Department of Health (DoH) is the fact that population estimates conducted mid 2009, indicate that the population growth rate has continuously been declining since 2001 (1.38) to as low as 1.07 in 2009 (Statistics South Africa, 2009).

Therefore it can be argued that the South African population growth is not to reason for the gross over-utilisation of the health care facilities, but rather that the use of these health facilities by a greater portion of the public is accountable for the increase in utilisation. Even to date 19 years after gaining independence, the population per clinic is 13 700 which is considerably higher than the recommended World Health Organisation norm of 10 000 people per clinic (Department of Health (South Africa), 2010*a*).

2.1.3 Economical Inequality is Causing an Imbalance Health Care

Health care in South Africa is provided by means of a two-tiered system, consisting of the state (National and Provincial Departments of Health) and a private health care sector.

During the fiscal year of 2011 South Africa expenditure on health care consisted of 8.3 percent of the its GDP (R248.6 billion). The total health care expenditure accumulates to more than that spent by any other African on the health care sector.

The majority (82 percent) of the South African population, represented by middle- to low-income families, are reliant on the public health care sector which is allocated approximately 40 percent of the total health care expenditure. Meanwhile the private sector is granted 60 percent of the allocated GDP and only serves a fraction of the population (Mars and Seebregts, 2008).

The imbalance in health care is further amplified by the lack of human resources employed in the public health care sector of South Africa (Kleinert and Horton, 2009; Mars and Seebregts, 2008).

Although the supply of physicians is considerably high compared with to African standards (approx. 77 000 per 100 000), the distribution across the

private and public sector is skewed considerably. The bulk of the physicians and medical personnel prefer to practice medicine in the private sector. Human resources allocated to the public health care sector are approximated to be 24 physicians and 10 specialists per 100 000 people. This means that 34 percent of posts in the public health care sector are reported to be vacant in (Mars and Seebregts, 2008).

Considering that the South African constitution binds the state to provide the right of health to each citizen and the comprehensive implementation of Primary Health Care (PHC), requires multi-sectoral and multi-disciplinary human resources, thus placing additional strain the public health system.

The result is an imbalance in the health care system, considering that the public health care sector has to cater for the majority of the population at a fraction of the budget and human resources which are available to the private sector (Kautzky and Tollman, 2008; Mars and Seebregts, 2008).

The inequality of the two-tired health care system is argued to be unstable in terms of access, poor financial and inadequate human resource allocation. Thus in an effort to salvage and improve what is left of the current system the National Department of Health (NDoH) has introduced the National Health Insurance (NHI) to promote access to efficient and quality health care. The NHI is currently being vetted and implemented at the pilot stage (Magawa, 2012).

2.1.4 The Challenge of Providing Health Care in Rural South Africa

The rural nature of South Africa further complicates the provision of health care in compliance with the PHC approach. Thus it is the final and fourth major contributing factor influencing the poor health care status of South Africa. Approximately 54 percent of the countries population reside within urban centres or in close vicinity to these centres defined by their higher population density. Thus leaving 46 percent of the South African population which reside in less the dense populated rural areas, considerably further away from urban centres and thus further away from qualified health care facilities. According to the definition, PHC should be accessible by all citizens including those situated rural South Africa (Mars and Seebregts, 2008).

The geographical disparities are a immense burden for the portion of the South African society residing in the more rural parts of the country, thus minimizing the access to appropriate, quality health care services. The philosophy of the Primary Health Care approach is to bring basic health care services as close to

the people in need of the services as possible. Therefore the aim of the health care system restructuring should be to minimise the distance required to gain access to the lowest appropriate level of care, this means having primary health facilities within walking distance (3-5 km) (Botha, 2011).

The South African health care department is faced with extensive challenges threatening the overall health care status of the entire South African people. The quadruple burden of disease along with the lack of human resources, economical inequality, health care facility over-utilisation and rural nature of the country are considered to be the substantial and most influential challenges affecting the quality of the South African health care system. The NDoH has recognised the matter and has thus devoted itself to improving the current situation, as stated in the Department of Health (South Africa) (2010*a*) NDoH Strategic Plan 2012/13 Mission Statement.

The National Department of Health Mission Statement:

"To improve the health status through the prevention of illnesses and the promotion of a healthier lifestyle and to continuously improve the health care delivery system by focusing on the access, equity, efficiency, quality and sustainability."

Knowing what determinants affect the health care system it is important to understand what health care approach is being implemented by the NDoH.

2.2 South African Health Care Approach

On May 24th, 1994 the newly elected President of South Africa, Nelson Mandela in his state of the nation address announced that health care for pregnant women and children under the age of 6 years would be provided free of charge. By the end of 1995 the administration declared the provision of Primary Health Care free of charge to the public, in accordance with the World Health Organisation (WHO) 'Health for All' initiative. This meant that health care became largely the burden of the state, due to heightened levels of poverty and unemployment.

The purpose of the new health care plan was to provide universal access to appropriate, effective, equitable, efficient and quality health care services to promote and improve the health of the people. The comprehensive implementation of the WHO recommended PHC approach would aid in the pursuit of these goals, defined at the 1978 International PHC Conference.

2.2.1 Primary Health Care Providing Quality Health Care to All

In the mid-70 explorations were made to identify different approaches enabling the improvement of health systems in the developing world. The grave health inequalities and burden of disease experienced by developing countries in the 1970s were the driving force which lead to the declaration of the PHC approach, defined at the 1978 International Primary Health Care Conference (also formally known as the Alma-Ata Declaration) World Health Organisation (1978); Kautzky and Tollman (2008).

South Africa was a worldwide leader in the conceptualisation and development of the PHC approach, but inadequate political support contributed to the failure of PHC. The successful implementation of PHC relies on a various factors such as integration, availability, effectiveness, efficiency, affordability and political commitment; which in particular has been impeding the process of achieving health for all and the desired outcomes.

As Magawa (2012) recalls: "This was aggravated by the intimidating state interventions during the apartheid era and weak leadership in the health sector post-independence...". What Magawa (2012) is referring to is the fact that the health care system existing at the time of independence was not designed to accommodate the health for all, PHC concept. The initial effect of making PHC freely available to the entire South African population had a dramatic impact on the utilisation of health care facilities.

Although the newly appointed NDoH showed great emphasis for the transformation of the health care system, the implementation of such a system proved problematic due to a lacked a coherent strategy. In addition the highly fragmented pre-independence health care system, required a realignment of all the health departments under one unitary Ministry of Health (Kautzky and Tollman, 2008; Harrison, 2010).

Despite the benefits of PHC, developing countries such as South Africa are unable to fully commit and incorporate all elements of PHC. Even 19 years after the health care restructuring programme was announced the promise of a refined and re-engineered system has been unfulfilled. The lagging implementation of PHC is largely accredited to the lack of oversight with regard to the decentralisation of the health care services, poor infrastructure and services, inadequate resource allocation, poor management and the unsettling health care status of South Africa (Kautzky and Tollman, 2008; Harrison, 2010).

2.2.2 Health Care via Referral System

The primary objective of PHC is the provision of quality health care to the entire population. To deliver on the objective, PHC has to deliver quality health care to patients as close to home as possible and at the lowest possible cost, which in a developing country proves to be challenging.

The economical inequality and a lack of human resources among other determinants mentioned earlier complicate the adequate implementation of PHC system. A health care referral system, is a positive contribution which has a mitigating effect on the burdens faced, by deliberately distributing expertise across various levels of health care (Hensher *et al.*, 2006).

The aim of a health care referral system is to distribute scarce, highly qualified physicians to the higher level health care facilities. By distributing these valuable and scarce health care resources among the different levels of the health care system a tiered health care system is established, which is categorised with respect to the level health care provided (Hensher *et al.*, 2006).

In theory such a system results in a cost-effective practice in which patients arriving at lower-level health care facilities are referred to a higher-level health care facility if more specialised care is required. Thus allocating already scarce resources to the people who require them.

According to Hensher *et al.* (2006) a referral system distinguishes between three levels of health care based on the availability of the expert personnel, the sophistication of diagnostics and therapeutic technologies. Figure 2.2.1 illustrates the referral structure of the South African health care system. An adaptation of Hensher *et al.* (2006) three levels of the referral system are described in more detail below.

Primary-Level Health Care:

Health care facilities limited to few specialities such as internal medicine, obstetrics, gynaecology, paediatrics, general surgery, general practice and finite laboratory facilities. The most basic form of health care within the primary-level is provided by Mobile Clinics catering for the more rural population, followed by Community Health Clinics (CHCs) and finally the District Hospitals. Each instance provides a higher level of primary health care.

Secondary-Level Health Care:

Health care facilities at the secondary-level are highly differentiated by functions and facilitate 5 to 10 specialities. The Regional, Provincial and General Hospitals are considerably more sizeable than the primary-level

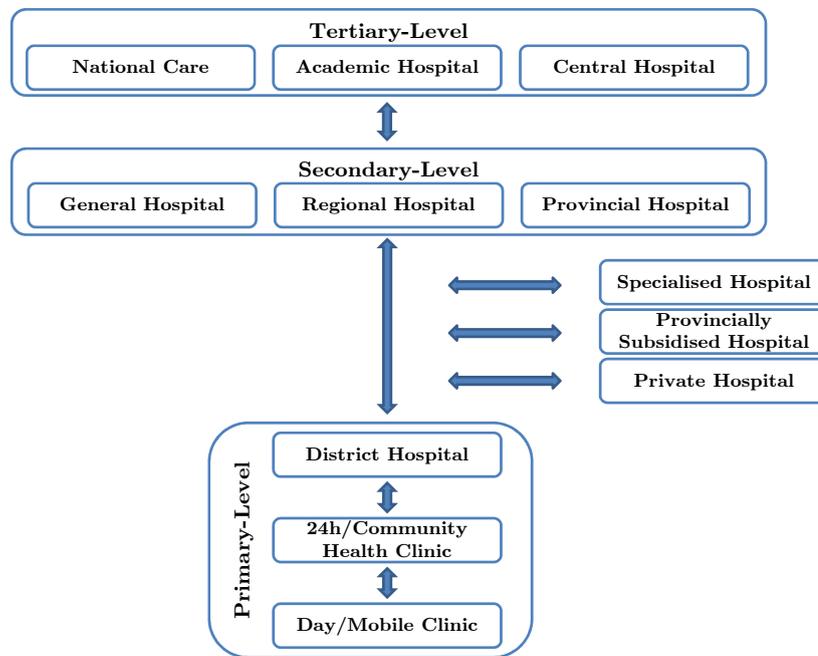


Figure 2.2.1: South African Health Care Referral Structure

health care facilities and generally provide 200 - 800 beds, dependent on the amount of lower-level facilities are linked to the hospital.

Tertiary-Level Health Care:

National, Central and Academic, Teaching or University Hospitals are considered as tertiary-level health care facilities. These facilities accommodate highly specialised medical staff and technical equipment, and facilitate specialised services for example cardiology, intensive care units, and specialised medical imaging units. Tertiary health care facilities provide the highest and most specialised health care within the referral system.

2.3 Chapter Conclusion

The objective of the state of the art review presented in the previous sections was to establish an understanding of the South African health care system and the health status of the South African population. Chapter 2 aimed to provide the health care context within which the study was conducted.

A review of the South African health status revealed that the South African population is facing a quadruple burden of disease, consisting of: (i) non-

communicable diseases; (ii) HIV/AIDS; (iii) poverty-related diseases; and (iv) injuries. The South African population struggles with a burden of disease unique to the Southern African Development Community, which adds to the strain encountered by the South African public health care system. An imbalance of the wealth in the country, a scarcity of human resources in the public sector and the complexity of providing health care to more than the rural regions of the country, add to the complexity of the current situation.

The implementation of the PHC approach and health care referral system helps to mitigate the negative impact of certain challenges. These challenges include the lack of qualified or suitable resources. By distributing the health care resources across three levels of health care (primary, secondary and tertiary) the negative effects of these challenge is minimised.

Chapter 2 provides the necessary health care context required to fully appreciate the outcomes of the Western Cape telemedicine services assessment.

Chapter 3

State of the Art of Telemedicine

The purpose of this chapter is to provide the necessary background and a better understanding of telemedicine. A sound understanding of telemedicine, including its origins both globally as well as within the context of South Africa creates the platform for the rest of the study. It is of further importance to clarify which of the multiple telemedicine definitions best aligns with the purpose of the research study.

The research questions listed below have a dual purpose: (i) provide a state of the art review of the telemedicine landscape; and (ii) they provide a structure for the discussion to follow.

Research Question 2.1

Where does Telemedicine originate from, i.e. what are its roots?

Research Question 2.2

Which existing definitions of telemedicine are presented in literature and how do they correspond with the research study?

Research Question 2.3

What is South Africa's current position with regard to telemedicine in the public health care sector?

Research Question 2.4

Which telemedicine service is most commonly utilised in the health care sector?

3.1 Telemedicine

Access, equity and quality are key issues facing health care in both developed and economically less developed countries. The provision of quality PHC to each citizen of South Africa has proven a major challenge, especially in the developing world. The vision of the WHO is to create and implement a health care approach which grants an entire population access to quality health care. The greater detail on the establishment of such a health care philosophy are expressed in the 'Health for All' strategy.

Increasing cost, inequitable access to quality health services and notable advances in technology, especially in the telecommunication sector have had a tremendous impact on the means of health care provision (Bashshur, 2002). According to Roh (2008), Bashshur (2002) and Sood *et al.* (2007) rapidly evolving Information and Communication Technology (ICT) is a driving force behind social change and combined with health services creates astonishing new possibilities for health care and delivery thereof. These social changes and the advancement of technology kindled the development of Telemedicine.

Craig and Patterson (2005) describes Telemedicine as "the area where medicine and information and communication technology meet". The term Telemedicine was first coined by Thomas Bird in 1970 and literally means "Healing at a distance" (from Greek "tele" - distance and Latin "medicus" - medicine)(Strehle and Shabde, 2006).

Telemedicine is a complex concept, largely dependent on Information and Communication Technology, promising numerous benefits, improving the delivery of PHC.

Before discussing the definition of telemedicine, it is necessary to understand where telemedicine originates from, how it came to be and why it is so effective at this day and age.

3.1.1 The Roots of Telemedicine

To pin point the exact origin of a innovation such as telemedicine is not possible, mainly because it cannot be tracked back to one single contributor, it is rather a culmination of important events and contributions which influenced the evolution of Telemedicine.

Although it may seem meaningless, the use of smoke signals by African villagers as a mechanism to warn neighbouring villages of a impending disease epidemic. The use of smoke signals to prevent the spreading of a disease can be viewed was an early form of preventive health care practised over a distance and thus in the broad sense of the word Telemedicine it can be defined

as such. Thus the basic principles and primitive concept of telemedicine has been around for quite some time.

The advances in field of Telemedicine can be primarily attributed to two major developments. Firstly the advances in electronic communication methods and the rapid growth of the computer technology industry influenced the development of telemedicine. The second major instance of telemedicine was driven by the National Aeronautics and Space Administrations (NASAs), for its manned space flight program, including the development of biomedical telemetry, remote sensing and communication in space (Bashshur, 2000; Craig and Patterson, 2005).

Although the two developments mentioned had a major influence on telemedicine, they were not solely responsible for the advancements and evolution of telemedicine. Table 3.1.1 lists a few isolated telemedicine applications mentioned in literature which played a role in the development of telemedicine as it is known today (Bashshur, 2000; Craig and Patterson, 2005).

Table 3.1.1: List of Telemedicine Services implemented during the late 1950s and early 1960s

Year	Details
1957	The transmission of radiographs from the Hotel Dieu Hospital in Montreal by Jutras. (Picot, 1998)
1959	The use of a closed circuit television to conduct psychiatric group therapy sessions at the Nebraska Psychiatric Institute in Omaha via the Norfolk State Hospital approx. 180 km away. (Wittson and Benschoter, 1972)
1965	Broadcasting of an open heart surgery in Switzerland using the worlds first communications satellite. (DeBakey, 1995)
1967	Development of the first prototype interactive telemedicine system, linking Boston's Logan International Airport (Medical Station) and the Massachusetts General Hospital. (Bird, 1971)

The first official mention and definition of the term telemedicine was documented in literature by Bird (1971). The interactive telemedicine services prototype Bird developed provided a complete range of emergency and PHC services. The system was staffed by registered nurses at the Airport end and dedicated remote physicians at the Massachusetts General Hospital.

Although this system and the earlier ones may have been primitive compared to today's technological possibilities, they paved the way for the systematic use of telemedicine in a multi service Primary Health Care facilities. Bashshur (2000) argues that these early, crude implementations of telemedicine services demonstrated the "...technological feasibility of telemedicine, ready acceptance of the technology by the users, substitution of technology for travels and greater co-ordination of medical functions".

3.1.2 The Roots of Telemedicine within the context of South Africa

Since the introduction of the Telemedicine System for South Africa: Strategic Outline in 1998 and the initiation of phase one during 2000, the new South African government has acknowledged the potential benefits of telemedicine toward the advancement of the public health. Nonetheless such services are still not fully established and the actual quantifiable worth of telemedicine has yet to be determined. Reason for the lack of understanding is partly attributed to the still young history of telemedicine in South Africa.

The continuous evolution of telemedicine is closely tied to the evolution of ICT and thus the integration of digital systems with telecommunication networks ushered in a new era, Bashshur (2000) terms the digital era by. The advancements in the computer industry during the 1980s and the growing integration of telecommunication and computer processing coupled with the transmission and storage of data

Although the confidence in telemedicine suffered towards the end of the telecommunications era, digital communication methods along with the reduction in cost for Information and Communication Technology lead to the rediscovery of telemedicine technology in the 1990s by a new generation of enthusiasts which were not influenced by the earlier failures of the technology (World Health Organisation, 2010; Yellowlees, 2005). The new found confidence and reduction of cost telemedicine sparked the interest of implementing telemedicine technology in developing countries, enabling a means of providing effective health care over vast distances (World Health Organisation, 2010).

One of the initial telemedicine service to be implemented in South Africa, in the early 1990s, involved the linking of CT scanners located in Provincial Hospitals within KwaZulu-Natal to the Academic Radiology Department Corr (1998). Other services consisted of provincial neurosurgeons providing teleradiology-assistance, physicians located in the rural areas of the country using store-and-forward based teledermatology, to overcome the vast distances Jithoo and Govender (2003) and linking an Ophthalmologist with a London

Hospital Kennedy *et al.* (2000).

As mentioned, in 1998 the newly appointed government saw the need for a strategic plan guiding the introduction of telemedicine services in support of the people orientated health care system. The National Telemedicine Strategic Plan made provisions for the implementation of services such as store-and-forward teleradiology, teleultrasonography and store-and-forward telepathology Telemedicine Task Team (1998); Mars (2011).

The initial phase of the strategic plan consisted these telemedicine services being implemented at 28 sites across six of the nine provinces. The only telemedicine service which was able to establish itself enough to be considered a success was the teleradiology service. Although even the initially successful teleradiology services failed to attain sustainability over the long run. Due to the high failure rate of telemedicine services implemented during the first phase of the National Telemedicine Strategic Plan, it was decided to not initiate phases two and three of the plan Mars (2011).

Due to the early failures with regard to the implementation of telemedicine services and the inactivity of most of the Provincial Departments of Health towards the topic, telemedicine activity was taken up by other governmental agencies. The agency which emerged as the driving forces behind telemedicine projects are the Medical Research Council (MRC) and the Council for Science and Industrial Research (CSIR).

Telemedicine services developed by the MRC include a mobile lab, with satellite communication and telemedicine capabilities, in corporation with the South African Defence Force (Science in Africa, 2004). In 2002 the MRC launched the development of a test bed linking two clinics with District Hospital via video conferencing (Mars, 2011). The MRC also worked closely with academic institutions such as the University of Stellenbosch, during the development of a primary health care telemedicine workstation (Fortuin and Molefi, 2006).

The CSIR is known to have developed and implemented a innovative wireless telemedicine solution, which were piloted in the Eastern Cape. And embarking on large-scale telemedicine projects linking 23 facilities via internet and video-conferencing.

Although development and the implementation of telemedicine services is ongoing in South Africa, the most common phrases associated with telemedicine are pilot project, not fully functional not yet assessed and replication not possible (Mars, 2011). The majority of telemedicine service implemented in South Africa to date have failed. The Minister of Health reported in 2010, of these 86 telemedicine services implemented in the public health sector only 32 were

functional at that stage.

An evaluation of the National Telemedicine Strategic Plan initial phase indicated that a lack of physician buy-in to the programs, inadequate training, lack of change management and the failure of provincial departments to take ownership of the services are the key factors forcing the failure of the services (Gulube and Wynchank, 2002). According to Mars (2011) the major challenges with regard to telemedicine in South Africa are an adequate buy-in from users, integration of the services into the work-flow, offering incentives for utilisation of the service and the requirement of a local telemedicine champion.

These are assumptions made based on the little information which is available on telemedicine services in South Africa. The factors which influence the success and or failure of existing telemedicine services are not known, due to the lack of assessment. In other words there is little to no literature documenting the nature and progress of telemedicine services within the South African context. This is true for both private and public telemedicine services being implemented in South Africa.

The scarcity of information available pertaining to telemedicine initiatives implemented in the public health care sector is alarming. Although telemedicine has been growing rapidly over the past decades limited research supports the medical- and cost-effectiveness of such services (Grigsby and Sanders, 1998).

The majority of the services are terminated before reaching a mature and sustainable stage, mainly because there are no means of measuring the performance of telemedicine services. Thus there is no evidence available which can prove the ability of telemedicine as an improvement mechanism for the provision of quality health care.

The potential solution telemedicine poses for the currently struggling health care system in South Africa cannot be realised, unless the existing telemedicine services are assessed to extract valuable information.

3.2 Definitions of Telemedicine

The fast evolving nature of Information and Communication Technology and as such also telemedicine has lead to a broad field of definitions for the application of telemedicine. Although in simple terms telemedicine is the provision of health care at a distance, there exists no singular definition unifying the term (Sood *et al.*, 2007).

Numerous definitions of telemedicine are readily available in literature, but there exists not one definitive definition, thus portraying the multiple perspective of telemedicine with regard to the various areas of use (World Health Organisation, 2010).

Sood *et al.* (2007) attempts to promote the understanding of telemedicine by investigating the various definitions documented in over 104 peer-reviewed articles. The meaning of telemedicine within these definitions varies with the context in which the term is applied, thus highlighting the importance of establishing a definition of telemedicine with regard to the context of the study.

Bird (1971), a pioneer of telemedicine provided the first definition of telemedicine: "...the practice of medicine without the usual physician-patient confrontation... via an interactive audio-video communication system". Bird clearly refers to key factors relevant to telemedicine services in his definition, the provision of medicine, the separation of patient and administrator, and the use of modern communication technology. The literature study Sood *et al.* (2007) conducted reveals four key aspects which define any telemedicine service. In principal it is a revision of the aspects addressed in the definition published by Bird (1971), except for the addition of one factor, benefits. The definition of telemedicine should clearly state the benefits of the particular service. World Health Organisation (2010) adopted these key elements and concurs that they are vital to the definition of telemedicine services (see Table 3.2.1).

Table 3.2.1: Key Elements in terms of the Definition of Telemedicine

Element	Description
Medical	... purpose to provide clinical support
Spatial	... overcome geographical barriers, connecting users who are not in the same physical location
Technological	... use Information and Communication Technology
Beneficial	... improve health outcomes

As mentioned earlier a multitude of telemedicine definitions available in literature, the reason for this being that the context and the perspective in which the service is applied is also of importance (Sood *et al.*, 2007). Here are a few definitions used by major contributors to the field of telemedicine.

World Health Organisation

"The delivery of health care services, where distance is a critical factor,

by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities" (World Health Organisation, 1997)

South African National Department of Health - eHealth Strategy

"Combined utilization of electronic communication and information technology to generate, transmit, store and retrieve digital data for clinical, educational and administrative purposes." (Department of Health (South Africa), 2012)

American Telemedicine Association

"Telemedicine is the use of medical information exchanged from one site to another via electronic communications to improve a patient's clinical health status." (American Telemedicine Association (ATA), 2013)

For the purpose of the research study the American Telemedicine Associations (ATAs) definition of telemedicine was considered to be the best suited. The definition published by the ATA contains all four key elements as per Sood *et al.* (2007) and World Health Organisation (2010) and defines the term telemedicine in the preferred context. The main aim of the research is to assess telemedicine services implemented on a district level enabling physicians in more remote areas to administer quality health care. Therefore the educational and preventive aspects, which are highlighted in the definition of telemedicine released by the World Health Organisation (1997) and Department of Health (South Africa) (2012) are not fully compliant with the context of this study.

3.3 eHealth, Telemedicine and mHealth

It is apparent that a variety of definitions of telemedicine, telehealth and eHealth are being used. It is argued that the confusion created by the sheer diversity of the terms has partly responsible the low success rate of such applications and services. Therefore to ensure that any confusion with regard to the meaning of eHealth, telehealth and mHealth is eliminated, Figure 3.3.1 depicts the relationship of these terms.

3.3.1 eHealth

The term eHealth is used as an umbrella term for a variety of health care delivery services utilising ICT. eHealth is commonly interchanged with the

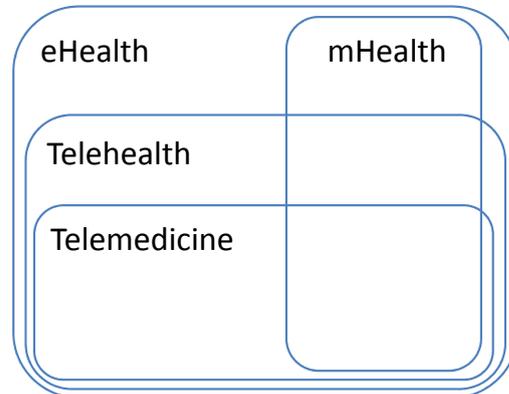


Figure 3.3.1: The relationship between eHealth, Telehealth, Telemedicine and mHealth, adopted from Van Dyk (2013)

term telehealth, but does not necessarily mean that they are exactly the same. Other than telehealth services, eHealth is not limited to providing health care at a distance (Van Dyk, 2013).

A few years ago the term eHealth emerged on the telemedicine scene, and considering these perspectives Eysenbach (2001) defined eHealth as follows:

"e-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology." (Eysenbach, 2001)

3.3.2 Telehealth

It is a common misconception that eHealth, telehealth and telemedicine are the same, this is mainly due to the lack of distinction between the three. Telehealth is seen to be a more encompassing term with regard to telemedicine and falls within the domain of eHealth (see Figure 3.3.1)(Scott, 2011; Maheu *et al.*, 2001).

Telehealth is the delivery of health care services and data via ICT, encompassing preventive, promotive as well as curative aspects, and as such is an

expansion of telemedicine. Telemedicine focuses purely on the curative aspects of providing health care via the use of ICT (Wikipedia, 2013; Maheu *et al.*, 2001).

3.3.3 mHealth

The use of a mobile communication device such as a mobile phones, tablet computers and PDAs to execute eHealth applications is termed mobile health or better known as mHealth. It is commonly defined as the practice of medicine or public health, supported by mobile devices. mHealth spans across all the fields of eHealth (see Figure 3.3.1) and implies the use of a mobile device to perform the respective services (Mishra and Singh, 2008).

3.4 Telemedicine Services

Telemedicine service refers to if curative health care service which is supplied at a distance by utilising modern communication technology for the benefit of the general health care status. A wide variety of telemedicine services are already being utilised to substitute the traditional services provided by physicians during face-to-face consultations. A list of the most commonly known telemedicine services utilised in the health care industry are listed below.

- Medical Tele-consultations
- Tele-cardiology
- Tele-dermatology
- Tele-dentistry
- Tele-ophthalmology
- Tele-Oncology
- Tele-pathology
- Tele-radiology
- Tele-neurology
- Tele-wound care

The telemedicine services can be split in two categories, namely asynchronous and synchronous. The later is generally preferred by practitioners due to the fact that it involves a real-time communication between for example a physician and a specialist at the receiving end of the service.

Attributes which are associated with synchronous telemedicine services are as mentioned previously are communication in real time, in which case both parties have to be available, thus making scheduling a challenge. Furthermore it utilises expensive technology requiring high bandwidths (Craig and Patterson, 2005).

Whereas asynchronous telemedicine services (also referred to as store-and-forward services) do not involve real-time communication as the name suggests. Contrary to synchronous services, medical information can be transmitted regardless of receiver availability, thus the service is more convenient. And these types of service require less expensive technology and bandwidth (Craig and Patterson, 2005).

The application of telemedicine services either synchronous or asynchronous technology is possible in all medical fields were a diagnoses can be obtained from data transferred via ICT.

3.5 Chapter Conclusion

The purpose of this study was to assess telemedicine services implemented in the public health care sector of the Western Cape. Chapter 2 already provided the required context for the health care aspect of the research purpose. The aim of Chapter 3 was to review telemedicine and create the required context for the study.

The review concluded that the increasing need for and use of telemedicine as a vehicle for the provision of clinical care is due to the ever increasing health care costs, inequitable access to quality health care and the recent advances in ICT.

One of the earliest documentations of telemedicine dates back to Bird (1971), officially defined telemedicine. The practice of providing medical advice or disease prevention dates back further African villagers used smoke signals to warn other tribesman of local diseases to prevent the disease from spreading and turning into an epidemic. For the remainder of the study, telemedicine refers to the ATAs definition of telemedicine.

The first official mention of telemedicine in the South African health system was in late 1998 with the introduction of the National Telemedicine System. Since then, telemedicine services have been actively present in the South African health care system. Although the benefits which these systems provide are apparent to the NDoH, the sustainable implementation of various telemedicine services available has not been successful.

Chapter 4

Assessment of Telemedicine Services

Part of the purpose of the study is to assess the telemedicine services implemented in the public health care sector of the Western Cape. Chapter 4 briefly reviews why there exists a need to assess telemedicine services. Furthermore, the chapter focuses on identifying the determining factors which define telemedicine services which in turn support the selection of the TeleMedicine Services Maturity Model (TMSMM) as the appropriate assessment tool.

Research Question 3.1

Why assess telemedicine services?

Research Question 3.2

What features of a telemedicine service are determinant features with regard to assessment of its success or failure?

Research Question 3.3

What tool or model can be utilised for the assessment of telemedicine services?

4.1 The Need for Telemedicine Service Assessment

The aim of the research study and that of telemedicine services assessment is to produce objectives and credible evidence regarding circumstances which influence telemedicine services implemented in the public health care sector of South Africa (Bashshur *et al.*, 2005).

A vast literary body of knowledge is available pertaining to telemedicine and telemedicine services. But on the other hand only a limited number of studies, reflected in literature, focus on the assessment of existing telemedicine services or applications (Taylor, 2005; Bashshur, 1995).

This phenomenon is especially apparent within the South African telemedicine context. An evaluation of the National Telemedicine System, demonstrated the benefits of such a system, but also highlighted the fact that the majority of the implemented systems are not sustainable. The NDoH recognises multiple that telemedicine services are terminated prematurely, but does not undertake further investigation assess the precise factors which lead to the termination.

The lack of assessment is especially apparent in the case of the MRC Telemedicine Workstation, a telemedicine service intended for the District Hospitals all over South Africa. Of the 86 telemedicine workstations supplied to health care facilities by the NDoH in 2006, only 32 are reported to be partially functional. The factors influencing the failure, or in the case of the 32 functional systems, the success are not assessed and thus no insight is gained to improve future services (Department of Health (South Africa), 2012).

In order to generate a body of knowledge regarding the circumstances which influence the success of telemedicine applications, it is necessary to assess fully functional and non-functional telemedicine services and applications.

According to Taylor (2005): " Assessment implies a description or evaluation with a view to answering a question or a set of questions " and Wikipedia (2013) defines it as "... a systematic determination of a subject's merit, worth, and significance, using criteria governed by a set of standards".

An assessment study is considered to be research study that aims to make a contribution to the cause. Therefore to obtain worthy assessment data the correct questions need to be answered to obtain the right data. Determining which criteria generates the right questions with respect to telemedicine services in an ongoing effort. The following section will highlight evaluation aspects of telemedicine services deemed relevant by literature.

4.2 The Determinant Factors of a Telemedicine Service

Bashshur *et al.* (2005) implies that creativity and flexibility is required to evaluate a complex field such as telemedicine. There are namely two methods of assessing telemedicine services, for one by focusing on a specific set of effects thus termed the categorical method. Or secondly by encompassing a array of influences from a variety of perspectives simultaneously, therefore describing the service comprehensively. (Bashshur, 1995).

The later method of evaluation is considered to be the most suitable approach to assessing the merits of a flexible and complex system, such as telemedicine. A comprehensive approach, according to Bashshur (1995) generates a realistic and analytical basis for the evaluation of telemedicine services.

In an effort to establish which factors of a telemedicine service are most relevant regarding the determination of its worth or merit three respected and frequently published authors were consulted. Taylor (2005) insists that three questions require answering when assessing a telemedicine system, and these are the safety, practicality and worthiness of the system. Whereas Bashshur (1995) is of the opinion that the merit of a telemedicine system or application rests on the accessibility, cost and quality of the health care provided. And the third literary reference, Broens *et al.* (2007) believes that telemedicine can be quantitative and qualitative improvement for health care. Similarly to Bashshur (1995), he believes that telemedicine improves access, cost and quality, but classifies five major determinant categories which influence the success of telemedicine systems. Namely technology, acceptance, financing, organization, and finally policy and legislation.

The categories defined by literature are essential to the success of telemedicine services and systems and thus they present the perfect criteria for the assessment of telemedicine services. A evaluation tool which incorporates all the aspects mentioned is the TeleMedicine Services Maturity Model.

4.3 The TeleMedicine Services Maturity Model

The TMSMM was developed precisely for a purpose such as the one required by this study, it enables the maturity assessment and management of a telemedicine application. As elaborated in previously in the section, an evaluation is an assessment of the merit of a subject with respect ot a set of criteria. The TMSMM enables an assessment of a telemedicine service by applying a comprehensive set of capability statements to gauge the service maturity (Van Dyk, 2012).

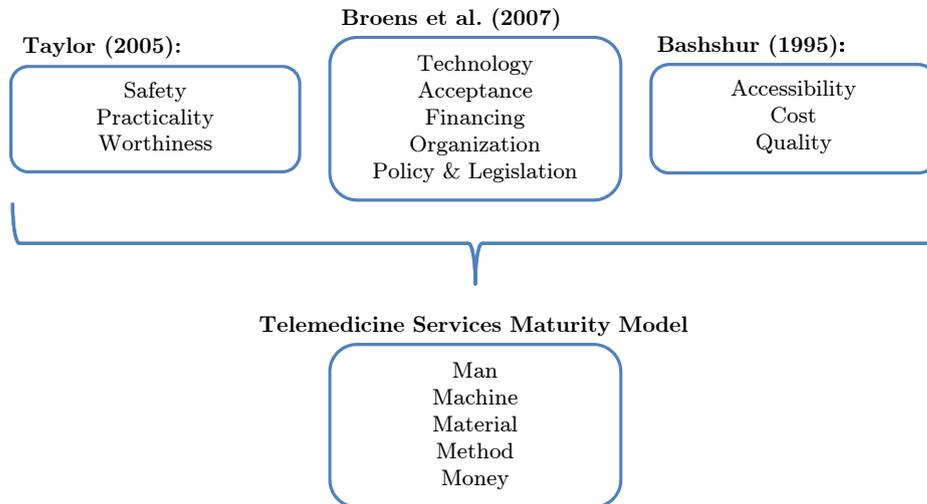


Figure 4.3.1: Telemedicine determinants incorporated in the five domains of the TMSMM

An maturity assessment is well suited to assist in the process of determining which factors of the telemedicine service, implemented in the public health care sector are the most infantile and require the most attention. According to Van Dyk (2012) the term maturity is defined as the competency, capability, level of sophistication of a selected parameters. Thus the TMSMM supplies a comprehensive set of capability statements with which the maturity of a telemedicine service can be qualitatively rated.

In 4.2 the most relevant determinants of telemedicine services, according to literature were discussed. Any model used to evaluate a telemedicine service should aim to address these factors in the assessment process. The TMSMM does this by categorising five determinant domains (Man, Machine, Material, Method and Money) which essentially represent the determinants discussed, see Figure 4.3.1 (Van Dyk, 2012).

The measurement of a telemedicine applications maturity level as a whole and broken down in to its various domains, enables the establishment of a "...framework that can be used to measure and grow the maturity of existing and prospective telemedicine services", Van Dyk (2012).

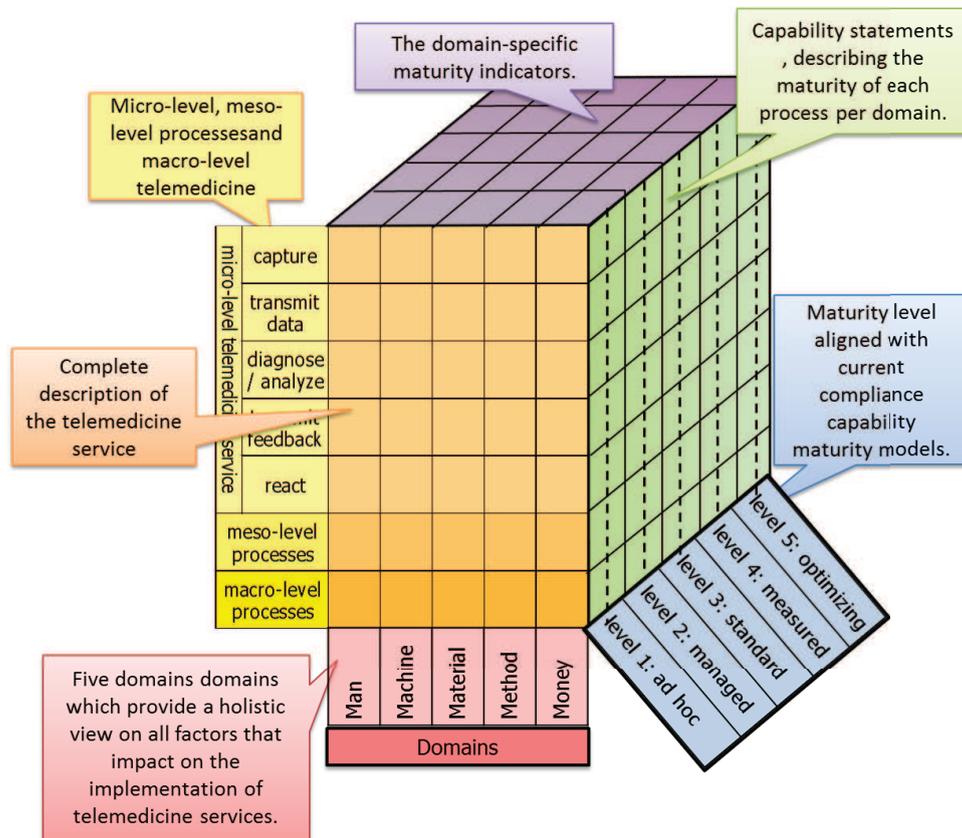


Figure 4.3.2: Graphical representation of the TMSMM (Van Dyk, 2012)

4.3.1 The structure of the TMSMM

The TMSMM enables the assessment of a telemedicine service by describing the service according to three dimensions (domain, telemedicine service and maturity), visualised in a 3D cube (see Figure 4.3.2). Each of the blocks generated by the interception of the three dimensions represents a matrix of specific significance and function, thus enabling the evaluation of every aspect of a complex system such as a telemedicine service.

4.3.1.1 Telemedicine Domain Dimension

Van Dyk (2012) categorises a telemedicine service as consisting of five major domains; namely Man, Machine, Material, Method and Money providing a holistic view of every factor influencing the implementation of a telemedicine service (Van Dyk, 2012).

Man

The Man domain is representative of a wide range of users which interface

with the telemedicine system or service. The pool of users consists of a variety of people ranging from patient with no health care background, trained hospital staff to medical specialists, thus the domain is structured to accommodate for all user types.

Machine

The Machine domain refers to the technological aspect of telemedicine services, considering appropriateness, maintainability, availability and interoperability of a device or software. The TMSMM is developed to be assess technology independent of technological innovation.

Material

A telemedicine process converts raw medical information into useful information and as such Material is one of the five domains, referring to the quality and standards of electronic health records.

Method

Every telemedicine service provided requires work protocols, ethical guidelines and policies to govern the process. Therefore the maturity of such policies and protocols is an essential component of the holistic telemedicine service maturity and as such is referred to as the Method domain.

Money

The costs associated with telemedicine services are related to financial funding, operational, maintenance costs and therefore are a major determinant with regard to the success of a telemedicine service. Thus the fifth and final domain is the Money domain.

4.3.1.2 Telemedicine Service Dimension

Each telemedicine service consists of a series of sub-services, these sub-telemedicine services are captured by the y-axis of the TMSMM cube and are structured hierarchically. Van Dyk (2012) defines three levels within a telemedicine service, these consist of five services representing the micro-level, one meso-level and one macro level.

The micro-level is broken up into five key generic processes, of which a combination is present in every telemedicine service. These processes effect the entire telemedicine service and thus form the foundation of the service. The five key processes highlighted by Van Dyk (2012) refer to the capturing of raw medical information (Capture) which is then transmitted via ICT (Transmit Data) to a secondary location where it is inspected (Analyse) and processed (Diagnose). Once the information has been processed it is sent back, enabling the user to act upon the feedback information (React).

Every telemedicine service is part of the larger health care system and thus part of a complex system of systems. The meso- and macro-level refer to the higher up (Regional and National) levels of the telemedicine service and do not exclusively relate to telemedicine services.

Although all the tiers (service, regional and national) of the telemedicine service are of high relevance with regard to the evaluation of the entire system, the sole purpose of the research study is to evaluate the service in particular, not breaching out to the higher levels. Thus the meso- and macro-level are of less relevance to the research study.

4.3.2 Maturity Dimension

The TMSMM uses a maturity scale based on generic capability statements, adopted from the capability maturity model. Thus providing the user of the model with a useful and validated maturity scale according to which the telemedicine service is rated. Five generic maturity levels have been defined by Van Dyk (2012) and are described below:

Maturity Level 1 Ad hoc - The service is unpredictable, experimental, and poorly controlled

Maturity Level 2 Managed - The service is characterised by projects and is manageable

Maturity Level 3 Standard - The service is defined/confirmed as a standard business process

Maturity Level 4 Quantitatively managed - The service is quantitatively measured and controlled

Maturity Level 5 Optimising - Deliberate focus on continuous improvement

Each Maturity Level is subdivided into two capability statements, thus providing an extensive set of ten comprehensive capability statements for each of the five domains (see Appendix C). The capability statements add the third dimension, enabling a descriptive assessment of each intersection on the model. Essentially the capability statements provide a means to convert the qualitative telemedicine service data into maturity data (qualitative data).

4.4 Chapter Conclusion

The assessment and determinants of telemedicine services were the focal point of Chapter 4. The purpose of the study is the assessment of telemedicine services utilised in a public health care setting, in the Western Cape.

For a proper and comprehensive assessment service, such as telemedicine, it was important to establish what defines the service and which determinants influence the failure or success of this service. A literature review was therefore conducted to determine which factors of a telemedicine service provide the relevant information for the assessment of the service.

An appropriate assessment method had to be identified which takes all the relevant determinants into account. The TMSMM was chosen for the purpose of the study, as the model accommodates a collection of all the telemedicine determinants suggested by Taylor (2005); Broens *et al.* (2007); Bashshur (1995).

The TMSMM model utilised comprehensive capability statements (Appendix C) to convert qualitative telemedicine services data into quantitative data, enabling the assessment and analysis of telemedicine services.

Chapter 5

Synthesis and Analysis of TMSMM Assessment Data

The purpose of this study is to assess telemedicine services implemented in the public health care sector of the Western Cape. The aim of this Chapter is to: (i) elaborate on the data collection procedure implemented, more specifically the methodologies employed to extract, transform and load telemedicine services data; (ii) present a brief overview of the data cleansing techniques utilised; and (iii) provide the synthesis and analyses of the TMSMM assessment data, followed by a discussion of the outcomes.

Detailed accounts of the synthesis and analysis techniques, such as On-Line Analytical Processing (OLAP), pivot tables, box plots and statistical correlations used to convert the raw telemedicine maturity data are documented in the analysis section. Followed by detailed discussions of the analysis results.

Research Question 4.1

How is the assessment data integrity ensured?

Research Question 4.2

Which data synthesis techniques and analysis methods were implemented to transform the assessment data?

Research Question 4.3

What is the general composition of the telemedicine services assessed during the progress of the study?

Research Question 4.4

Does the assessment data suggest any statistical correlations?

Research Question 4.5

What knowledge can be obtained from the maturity assessment?

Research Question 4.6

Which research tools and techniques are incorporated in the telemedicine services data Extract, Transform and Load (ETL) process?

5.1 Data Extraction, Transformation and Loading Process

It has thus far been established, through literary research, which aspects of a telemedicine service required evaluation to generate a general consensus of telemedicine service maturity. The population of a database with data from multiple data sources, also known as the extraction, transformation and loading of data, is the next step in the assessment process. The following section concentrates on the "data migration" process involved in generating an adequate telemedicine services database for the purpose of the research study (Boyno, 2003).

The TMSMM provides the overall guidelines for the entire telemedicine evaluation procedure and thus the data extracted, transformed and loaded conforms to the standards of the model. The quality of the research outcomes depends greatly on the sources and quality of information. With this in mind, great care and detailed planning went into the data source selection procedure.

5.1.1 Health Care Facilities selected for the Study

The scope of the research study was restricted to health care facilities situated in the Western Cape Province. Thus greatly narrowing down the spectrum of possible health care facilities applicable for the research study. Only health care facilities, which provided medical care to the public sector and are recorded to have at least one telemedicine service implemented, functional or non-functional, were short listed. The determining criteria as to which facilities would be included in the final pick, was the MRC-MTN Telemedicine Workstation.

Following the call for telemedicine services by the NDoH in 1998, the Telemedicine branch of the MRC was established with the purpose of promoting research in the field of telemedicine. In 2006 the MRC in collaboration with the Stellenbosch University and MTN initiated the development of a telemedicine workstation purposed for the rural communities. By 2011, the implementation of sixty Telemedicine Workstation was commenced, distributed over all nine provinces of South Africa. Five of these Telemedicine Workstations were delivered to Provincial Hospitals located in the Western Cape (Medical Research Council, 2012).

The final selection was further aided by consulting Prof. HOFFIE Conradie with regard to the facilities chosen. The expertise of Prof. Conradie within the field of telemedicine provided an optimal sounding board as to whether the health

care facilities chosen would yield the expected results.

The final selection of health care sites deemed suitable for the evaluation of existing telemedicine services was then finalised and is represented in Table 5.1.1 along with the respective Medical Officers in charge at the facilities.

Table 5.1.1: List of Health Care Facilities visited

Healthcare Facility	Hospital Level	Contact Person
Robertson Hospital	Primary	Dr. Klaus von Pressentin
Caledon Hospital	Primary	Dr. Anthony Hess
Ceres Hospital	Primary	Dr. Hans Hendricks
Hermanus Hospital	Primary	Dr. Stephanie Perold
Swellendam Hospital	Primary	Dr. Jacques du Toit
Worcester Hospital	Secondary	Dr. HOFFIE Conradie

The data extraction, transformation and loading process explained in the subsequent section was conducted at the six provincial hospitals listed in Table 5.1.1.

5.1.2 The Structured Interviews

Data extraction is the initial phase of data migration, and refers to the collection of information from multiple sources. In the case of the study the source of information are telemedicine services installed at public health care facilities listed in Table 5.1.1.

A variety of techniques are available which enable the extraction of data. The method most suitable for the extraction of information, was chosen to be in the form of an interview. The simple reason being that the information regarding the telemedicine services would need to be extracted from the medical officer in charge of the facility.

The information required is governed by the principles on which the TMSMM is constructed and thus a structure is required when extracting data to ensure relevant data is captured. Regarding the uncertain nature of the actual telemedicine services landscape at the facilities a certain flexibility is required to ensure that all types and forms of telemedicine are identified. The best suitable interview method which is characterised by the attributes mentioned is a semi-structured interview (Mason, 2004; Gillham, 2005).

According to Mason (2004) and Barriball and While (1994) a semi-structured interview contains a structured sequence of questions organised around the

data that is to be extracted. It acts as a guide and is not bound by standardised questions. Flexibility is ensured by not binding the questioned to a specific sequence, allowing different areas of the interview to develop with different interviewees and services, such " . . . that the interview can be shaped by the interviewee's own understandings as well as the researcher's interests, and unexpected themes can emerge" (Mason, 2004).

As stated previously, according to Bashshur *et al.* (2005) the evaluation of a telemedicine services should bear in mind the creativity and flexibility of the service, thus semi-structured interviews were conducted. Although the general structure of the interviews was predetermined, an allowance was made for slight deviations from structured path, to incorporate flexibility.

Each interviews was conducted with the approval of the Western Cape Department of Health and that of the Stellenbosch University Health research Ethics Committee. Each of the interview participant was asked to sign an informed consent form acknowledging that the interview was conducted and data was collected in an ethically correct manner.

5.1.3 The Description of Service via Data Flow Diagram

Data migration is comprised of three stages extraction, transformation and loading. The data extraction process was completed via the semi-structured interviews described earlier. The second stage is the data transformation which is conducted in two steps, one of them is the generation of Data Flow Diagram (DFD). The secondary transformation phase will be elaborated at a later stage.

Telemedicine services are extremely complex systems involving a multitude of data. And seeing that telemedicine is essentially the flow of information from one geographical location to another geographical location, via information and communication technology, the stream of information can be graphically represented utilising a Data Flow Diagram (Gane and Sarson, 1979; Bruza and der Weide, 1989).

The DFD provides a visual representation of the information (medical data), external entities (physician or specialist) and the processes (i.e. capture) involved in a telemedicine service. Figure 5.1.1 depicts the DFD for the orthopaedic telemedicine services implemented at the Swellendam Provincial Hospital (the remaining 25 DFDs are stored on the CD attached). Although the DFD simplifies the visualisation and comprehension regarding the stream of information within the service, its only function is to act as a support structure for the evaluation process. The cumulative information gathered during the interview and in the DFD is then combined to complete the final step of

the evaluation process.

5.1.4 The TMSMM Tool

The initial semi-structured interview enabled the identification of telemedicine services implemented at the health care facility, and the extraction of relevant data. The DFD visualises the information flow of the telemedicine service and is thus forms part of the transformation process, converting the information into a new set of data.

The TMSMM comprises the secondary transformation operation mentioned in Section 5.1.3 and the data loading process of the data migration procedure.

By utilising the TMSMM the qualitative data extracted is converted into quantitative data. By appointing a maturity capability criteria to each block of the telemedicine service a quantitative maturity level is assigned to that block.

An Excel interfaced TMSMM tool, based on the fundamental principles of the TMSMM, was used to transform the telemedicine services data. The tool essentially represents a plain view of the 3D cube (see Figure 4.3.2), depicting the domain and telemedicine service dimensions. The 2D image of the TMSMM graphically portrays the entire telemedicine service and is termed the telemedicine service "Dashboard". The third dimension, namely the maturity capability is incorporated as the criteria according to which each block is rated. Figure 5.1.2 depicts a screen shot of the telemedicine service dashboard for the orthopaedics telemedicine service evaluated at the Swellendam Provincial Hospital. The TMSMM dashboards for the remaining 25 telemedicine service are available on the CD attached.

CHAPTER 5. SYNTHESIS AND ANALYSIS OF TMSMM ASSESSMENT DATA

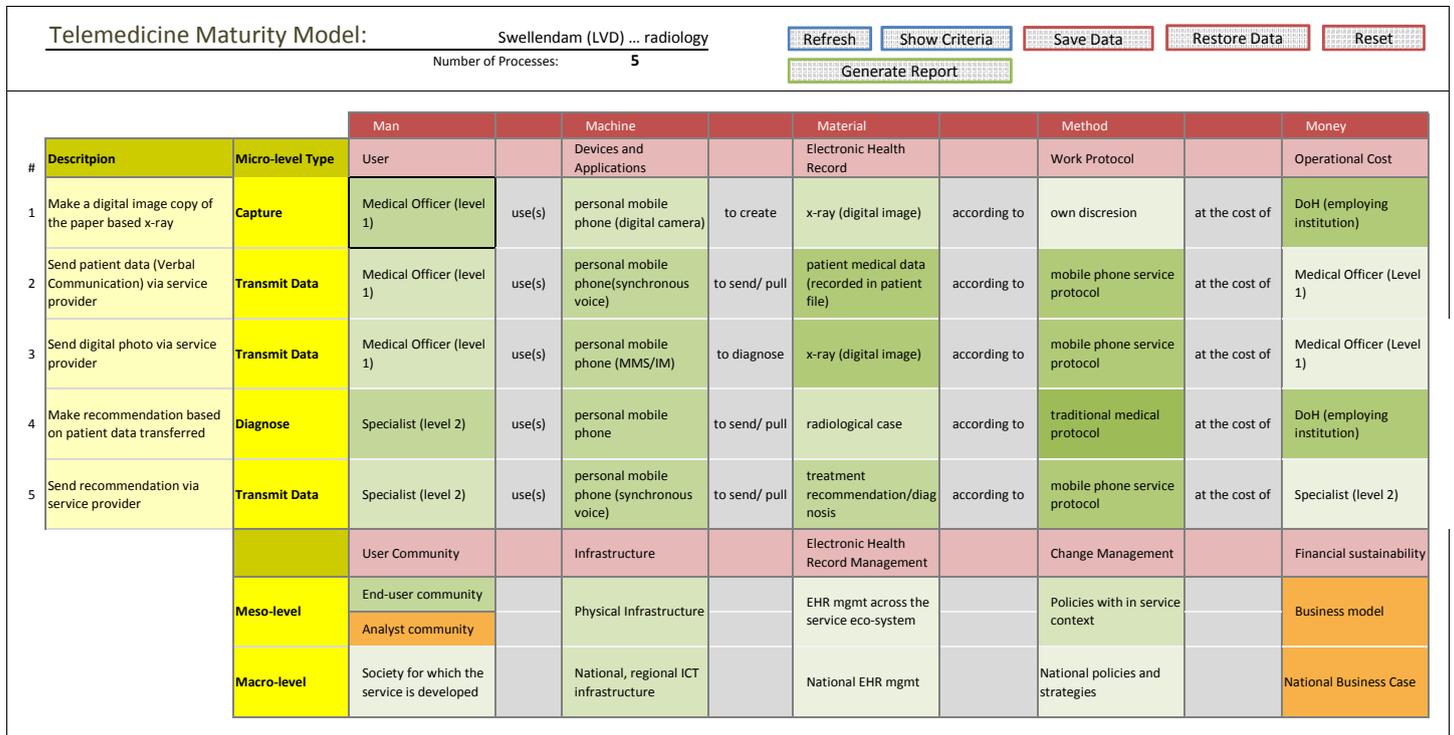


Figure 5.1.2: Swellendam Orthopaedics TMSMM Dashboard

The maturity level of each block is represented in green. An optimal maturity rating of 5 (Optimising) is represented by a dark green tile and fades to a lighter green as the maturity decreases to a rating of 1 (ad-hoc). An orange tile indicates that the particular intersection of the telemedicine service is non-existent.

The population, otherwise known as loading of the data warehouse is conducted during the transformation procedure explained previously. All the information pertaining to the telemedicine service being evaluated is entered using the same interface and thus stored directly in the multidimensional TMSMM database.

5.2 TMSMM Data Cleansing Operation

The ETL process described in Chapter 4 is utilised to generate an extensive telemedicine services database. The database pertains to telemedicine services implemented in the Western Cape public health care sector.

Processes such as data extraction, transformation and loading conducted by individuals are prone to human error (for example spelling mistakes and omissions)(Peterson, 2003; Yue, 2012). A corrupted and faulty telemedicine services database would compromise the integrity of the entire study. A data cleansing operation is therefore required to ensure the quality and authenticity of the data.

The process of cleansing the TMSMM assessment data can be segmented into three distinct cleansing stages. These stages are discussed in the following sections.

5.2.1 TMSMM Data Validity

According to Han and Kamber (2006), a validation operation is generally performed during the loading of the data to the data warehouse. Due to the limited amount of time available at the various sites the validation process is conducted after the entire ETL process is completed.

The validation stage of the cleansing operation is essentially a "go" or a "no-go" operation. The purpose of the validation stage is to determine whether the information stored in the TMSMM data warehouse conforms to the specifications of the specific data categories (i.e. telemedicine domains).

The validation process can be split into two segments. First, the blank data entries are eliminated, which results in a rejection rate of 87 percent of the total data entries. The high number of blank data entries is a by-product of the TMSMM Excel tool, which is utilised to load the telemedicine services information into the database. The TMSMM tool allocates a set amount of data locations to each loaded telemedicine service which explains the large number of empty data locations.

The second segment of the validation operation is a detailed inspection of the data entries. This inspection ensures that the data entered into a certain TMSMM domain conforms to the respective specifications of that domain. Once the validation stage has been completed, the data is considered legitimate in terms of the specifications of the TMSMMs next data cleansing stage can then commence.

5.2.2 TMSMM Data Integrity

The remaining data entries (13 percent) which passed the initial validation stage of the cleansing process are then assessed to ascertain the integrity of the data set.

According to Van Dyk (2013), each telemedicine service consists of a set of internal telemedicine sub-services, which in turn are composed of five domains. The integrity of the telemedicine database depends on the completeness of the sub-services and each domain needs to have a maturity rating. The telemedicine data is inspected in considerable detail to identify telemedicine services which are not complete or invalid and to ensure that these are amended or omitted from the sample.

5.2.3 TMSMM Data Consistency and Uniformity

The concluding stage of the data cleansing operation is to investigate and ensure the consistency and uniformity of the information stored in the data warehouse. Hellerstein (2008) defines consistency as the lack of contradiction. Ensuring consistency therefore means eliminating any possible data contradictions. For example, ensuring that medical data is actually captured by one telemedicine service user, then transmitted to an independent second user who analyses/diagnoses the medical data, and subsequently transmitted back the analysis/diagnosis data to the original sender of the medical data. As per the definition of a telemedicine service.

Uniformity on the other hand refers to the grouping of the domains. During the extraction and loading process, a variety of domain descriptors are entered, but they are not necessarily of a uniform nature. The initial step in ensuring a uniform data set is to assign data entries of a similar type to respective groups. Once all the data have been assigned their respective groups, a singular descriptive term is defined which represents the collective along with a description of the group. (Han and Kamber, 2006).

All of the TMSMM data entries submitted to the unification process, results in five unification tables for each of the domains (see Appendix D.1).

The data cleansing and validation operation described ensures that the final database used for the analytical section of the research study has a certain level of data integrity. Data Integrity refers to maintaining and assurance of a consistency of information across the entire database, thus in turn assuring the integrity of the research outcomes. (Business Dictionary, 2013).

5.3 Analytical tools used for data synthesis

Following the ETL process described in Chapter 4 and the cleansing process elaborated on in the previous section, the next phase of the study utilises the telemedicine data. According to Codd *et al.* (1993), the primary approach to synthesising information from multidimensional data sources, is through data processing and analysis methods.

The following sections elaborate on the analytical tools and data synthesis methods utilised to extract information which pertains to the maturity of telemedicine services, implemented in the public health care sector of the Western Cape.

5.3.1 On-Line Analytical Processing

Codd *et al.* (1993) state that the general consensus of data analysis is "...centred around the comparison of one single static data value with that of another single static data value".

In the case of the TMSMM database, generated utilising the ETL process, elaborated on in Sections 5.1.2, 5.1.3 and 5.1.4, the analysis of the TMSMM data does not involve a simple straight forward procedure. More sophisticated and dynamic navigation methods are required to aggregate information which is logged in the complex multidimensional database structure.

On-Line Analytical Processing provides a data mining tool from the field of business intelligence which is well suited for the manipulation and navigation through large multidimensional databases (Indik and Whitehead, 1995; Codd *et al.*, 1993).

The application of OLAP, according to Indik and Whitehead (1995), greatly simplifies the process of extracting and synthesising relevant data, stored in the multidimensional TMSMM database, for analysis. The process of exposing the various dimensions and facets locked within the dataset is executed with the help of predefined OLAP operations.

The OLAP operations listed in Table 5.3.1 enable the manipulation of a multidimensional dataset, such the TMSMM. Whilst the operations simplify the transformation of the TMSMM data, the intra database relationships are respected and incorporated in the newly transformed database (Codd *et al.*, 1993).

The TMSMM database which is represented as a cube, is arranged according to three principle dimensions: (i) the domain; (ii) telemedicine service processes;

Table 5.3.1: List of OLAP operations

OLAP Operation	Description
Selection/Dice	Enables the user to choose a subset of data points of interest out of the whole three dimensional space.
Roll-up	Allows the user to group cells in a cube on an aggregated hierarchy.
Drill-down	Is the counterpart to the Roll-up operation, which expands on the hierarchy and shows more information.
Changing base	Is the reordering of the dimensions and the interchanging of rows and columns to generate a new set of data. (also known as Pivoting)
Projection	Enables the user to select a subset of measures from the available measures.

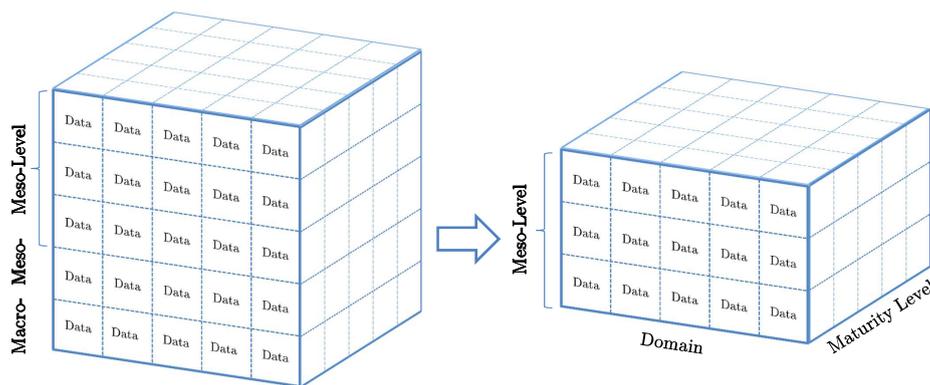


Figure 5.3.1: Example of a OLAP Selection operation

and (iii) maturity scale. Figure 5.3.1 depicts how simple a database can be transformed by executing a selection operation. The OLAP selection operation isolates the micro-level of the TMSMM micro-level services from the meso- and macro-level services of the model, without compromising the integrity of the data.

5.3.2 Box Plots

The OLAP operations provide the method and technique with which the TMSMM assessment data can be transformed. The integrity of the data is not affected during the transformation. The application which provides the

means to transform the TMSMM assessment data is Office Excel's pivot tables, which provide a simple yet effective method of applying the previously discussed OLAP operations to the multidimensional TMSMM database.

According to Roberts (1987), the most effective method of analysing and communicating information about a large volume of data is by drawing a picture that simplifies the interpretation of the data. Explanatory analysis techniques, such as histograms and box plots provide the tools to rapidly convert, graphically summarise and interpret tabular data (McGill *et al.*, 1978; Hoaglin *et al.*, 1983).

Properties of explanatory data analysis techniques which useful for the analysis of the data stored in the TMSMM data warehouse, include the fact that barely any assumptions are required to interpret the visualised data. In addition the emphasised visual display highlights important landmarks which are otherwise hidden (Tukey, 1977).

Although a histogram is the more traditional method of visualising data distributions, it is the least informative means of visualising tabular data. On the other hand, a box plot captures a larger array of information hidden in a table of data. A single box plot visualises five key values of tabular data: the median; upper and lower quartiles; as well as the minimum and maximum data extremes (Tukey, 1977).

An example of a box plot which visualises the average maturity distribution of all the telemedicine services across all five TMSMM domains, is depicted in Figure 5.3.2.

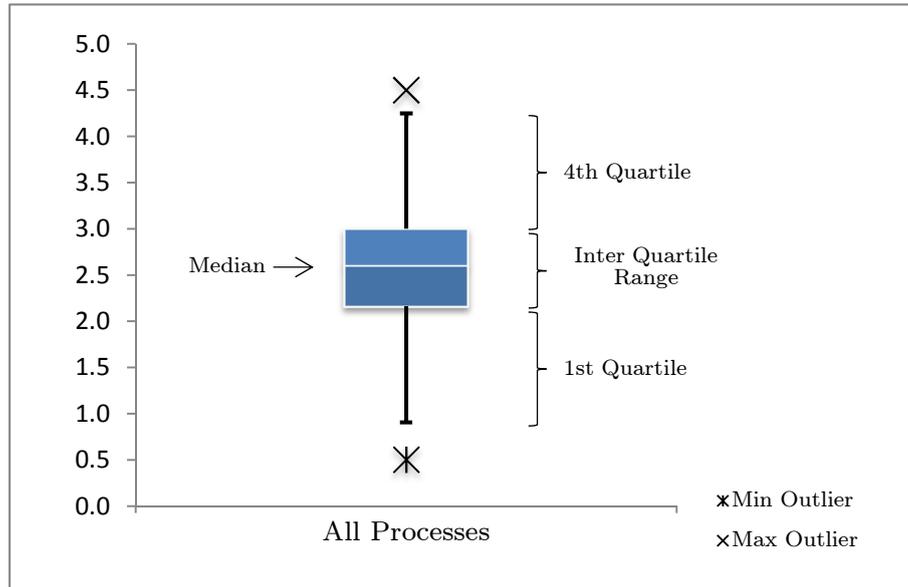


Figure 5.3.2: Example of a box plot representing the average maturity distribution for all telemedicine services assessed

More importantly, a box plot provides a suitable means to display quantitative data, visualising patterns, which are normally hidden within the data, and enables the comparison of multiple distributions (Tukey, 1977; Tufte and Graves-Morris, 1983).

5.4 Synthesis and Analysis of TMSMM Data

The synthesis and analytical tools and techniques described in the previous section were applied to interpret the TMSMM assessment data and reveal relevant information pertaining to the identified and assessed telemedicine services. With the help of transformed telemedicine services information, the subsequent sections aim to resolve research questions 5.3 - 5.5.

5.4.1 Establishing an Overview Telemedicine Services Landscape within the Context of the Study

The purpose of the research study is to assess the implementation of telemedicine services specifically in the Western Cape public health care sector. The purpose of this particular section is to utilise the transformed and synthesised telemedicine services data and to establish a general overview of the Western Cape public health care telemedicine landscape.

It is important to remember that the overview presented in this section, provides basic information regarding the telemedicine services implemented in the

Western Cape, independent of the maturity assessment. A detailed analysis focusing on the maturity assessment of the various telemedicine elements will follow in Section 5.4.3 of this chapter.

An analysis of the TMSMM data, with a focus on the composition of the data, will help in establishing a general idea regarding the number of telemedicine services and the type of telemedicine services assessed. Table 5.4.1 contains a list of questions which will assist in resolving research phase 4.

Table 5.4.1: Questions to establish a general understanding of the telemedicine landscape of the TMSMM assessment.

#	Question
1	How many telemedicine services were identified and assessed?
2	How many telemedicine services are there per health care facility?
3	What is the average number of telemedicine services implemented per site?
4	The telemedicine services identified are utilised to provide what type of health care service?
5	What ICT devices are utilised to perform these telemedicine services?
6	How are these devices distributed among the services?
7	Which device is primarily used?
8	Who makes use of the assessed telemedicine services?

According to the TMSMM database, a total of 26 telemedicine services were identified and assessed with the assistance of the TMSMM, at a select group of rural health care facilities (see Section 5.1.1). The theoretical average number of telemedicine service per facility is 4.33. In reality, the actual distribution of the services is far less balanced.

Along with the amount of telemedicine services identified, and the calculated average telemedicine services per facility, the study also provides information pertaining to the actual distribution of telemedicine services among the public health care facilities in the Western Cape. Table 5.4.2 contains all the relevant data pertaining to the facilities and the services identified at each of these health care facilities.

Section 5.2.3 describes the unification process applied to organises the telemedicine services data entries (see Appendix D). A closer inspection of Table 5.4.2 reveals a noticeable trend with regards to the telemedicine services provided at

Table 5.4.2: OLAP Roll-up on Telemedicine Processes (from Processes to Regions)

Region (# of Services)	Telemedicine Service
Caledon (5)	Caledon (AH) - CTG
	Caledon (AH) - Dermatology
	Caledon (AH) - ECG
	Caledon (AH) - Mobile Nurse
	Caledon (AH) - MRC Telemedicine Workstation
Ceres (5)	Ceres (AH) - CTG
	Ceres (AH) - Dermatology
	Ceres (AH) - ECG
	Ceres (AH) - MRC Telemedicine
	Ceres (AH) - Orthopaedics
Hermanus (5)	Hermanus (AH) - CTG
	Hermanus (AH) - Dermatology
	Hermanus (AH) - ECG
	Hermanus (AH) - Orthopaedics
	Hermanus (AH) - PACS
Robertson (6)	Robertson (AH) - CTG
	Robertson (AH) - Dermatology
	Robertson (AH) - ECG
	Robertson (AH) - Patient Referral
	Robertson (AH) - Radiology
	Robertson (AH) - Radiology (Fax)
Swellendam (4)	Swellendam (AH) - CTG
	Swellendam (AH) - Dermatology
	Swellendam (AH) - ECG
	Swellendam (LVD)- Radiology
Worcester (1)	Worcester (AH) - Radiology

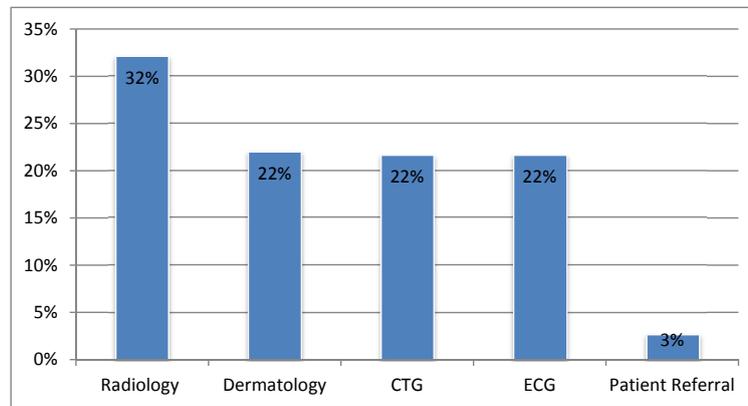


Figure 5.4.1: Distribution of health care services utilising telemedicine services assessed during the study

the various health care facilities. The majority of the health care services substituted by the respective telemedicine services are Dermatology, Radiology, Cardiococography (CTG) and Electrocardiography (ECG) services (see Figure 5.4.1).

The telemedicine services data indicates that Radiology (33 percent) is the health care service most frequently administered via telemedicine services. Teleradiology has become considerably well established in South Africa ever since the initial implementation of telemedicine services in the country. According to Mars (2011), the South African Government and other agencies such as the MRC and CSIR implemented a wide array of telemedicine services from 2000 onwards. The only services which showed any promise of sustainability were, however, telemedicine services which focus on radiology. The offers and explanations for the increased usage of telemedicine in the field of radiology.

The three remaining health care services which contribute to the aforementioned majority group are all equally represented across the study with 22 percent distribution for each service. The remaining 3 percent of the telemedicine services are patient referral services, which are generally classified as an administrative application.

Collectively speaking all the identified service, are utilised as part of a referral process. Examples include, using a teleradiology service to confer with a specialist at a secondary health care facility via ICT, or determining whether a patient needs to be transferred to a higher-level facility, based on transmitted radiological data. The teleradiology services is therefore used to establish if a referral is indeed necessary.

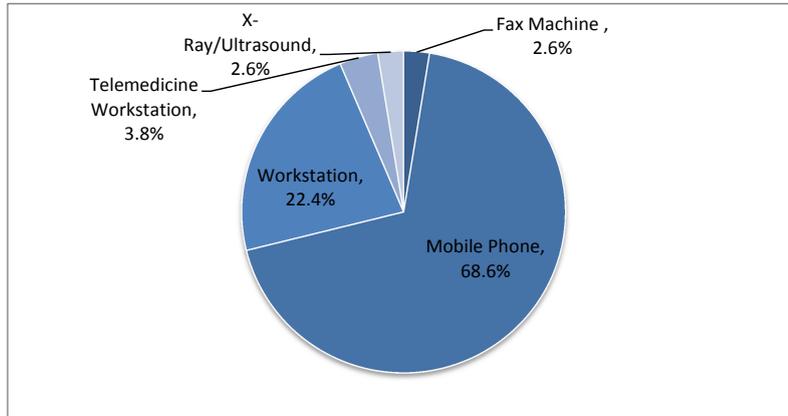


Figure 5.4.2: Distribution of ICT devices utilised for telemedicine services, with regard to the TMSMM assessment study

Having established the composition and determined the concentration of health care services utilising ICTs, it is of interest to determine what type of ICTs are utilised to administer the health care services mentioned above.

Applying the various OLAP operations discussed in Section 5.3.1, facilitates the transformation of the TMSMM cube. by slicing the Man domain and applying an OLAP drilled-down operation on the micro-level processes. TMSMM data pertaining to telemedicine devices are then exposed. The transformed TMSMM data, graphically illustrated in Figure 5.4.2 portrays the assessed telemedicine device distribution with respect to the services.

Figure 5.4.2 indicates that 68.6 percent percent of telemedicine services in the Western Cape are conducted by way of mobile phones.

Non-mobile workstations, including all devices and applications which are used in conjunction with a desktop computer (designated as workstation), count for 22.4 percent of the telemedicine services in the Western Cape. Devices and applications which are affiliated with workstations include scanners, e-mail services and Picture Archiving and Communication Systems (PACSs). However e-mail services and PACS are not limited to the utilisation via workstation. Telemedicine services utilising such application by means of a mobile devices fall within the mobile phones segment, illustrated in Figure 5.4.2.

To complete the aforementioned overview of the telemedicine services landscape of the Western Cape, the following sections elaborate on the composition of the telemedicine service users.

A noticeable observation is that all the structured interviewees, which form

part of the ETL process, were conducted with registered physicians. This suggests that the assessed telemedicine services, exist within a telemedicine environment which is limited to physician-specialist rather than patient-physician interaction.

The TMSMM data captured in Table 5.4.3 confirms the aforementioned observation. The convincing majority (93.4 percent) of the users is composed of registered medical staff (i.e. Medical Officers, Specialist Physicians and Radiologists). The remainder of the sample consist of medical support staff such as Nurses, Radiographers and Health Care Administrators.

Table 5.4.3: Distribution of telemedicine users and the number of occurrences with regard to the processes types

User	Type of Process	# Occurances	%
Medical Officer	Analyse	1.0	
	Capture	21.0	
	Diagnose	1.0	52%
	React	22.0	
	Transmit Data	33.0	
Specialist Physician	Analyse	8.0	
	Diagnose	20.0	36%
	Transmit Data	26.0	
Radiologist	Analyse	2.0	
	Transmit Data	2.0	3%
	Capture	2.0	
Nurse	React	3.0	5%
	Transmit Data	3.0	
	Capture	3.0	
Radiographer	Transmit Data	2.0	3%
	Analyse	1.0	
Health Care Administrator	Transmit Data	1.0	1%

Table 5.4.3 lists additional information regarding the number of user occurrences registered in terms of the various processes which constitute a telemedicine service. The later information provides an overview of what type of telemedicine user is associated with which internal telemedicine service, namely Diagnose, Analyse, Capture, Transmit Data or React.

A noticeable exception to the trend is found in telemedicine services utilised by mobile nurses. These telemedicine services include the medical officer as part of the telemedicine procedure at the intermediate stage, which entails the

diagnose and analysis process. For the remainder of the telemedicine services the medical officer is involved in capturing, data transmission and reaction procedures. The implication is that medical officers are end-users of telemedicine services within the context of the study.

Telemedicine processes such as analysis, diagnosis and data transmission are mainly associated with specialist physicians and radiologists. It is commonly the case that the specialist physicians and radiologists are located at secondary and tertiary health care facilities and thus provide the higher-level support which is not available at the lower levels.

Summary Remarks:

In summary a total of 26 telemedicine services were identified and assessed by means of the TMSMM. The services are fairly evenly distributed across the six selected health care facilities at an average of 4 telemedicine services per facility. The majority of the services identified are utilised to administer radiological, dermatological, CTG and ECG health care services to patients in the rural areas of the Western Cape.

The bulk of the telemedicine services assessed are limited to interaction between medical officers (district and community health care facilities) and specialist physicians (secondary and tertiary health care facilities), who primarily utilise mobile phones to administer these telemedicine services.

5.4.2 Telemedicine Service Domain Correlations

The use of correlation is a widely accepted and recognised statistical method, implemented to summarise scientific research data. Within the context of this study, Pearson's product-moment coefficient is utilised to identify relationships between the various domains of the telemedicine services, utilised in the Western Cape public health care sector (Taylor, 1990).

The Pearson's product-moment coefficient is the most commonly applied correlation method. It provides a statistical measure which indicates the extent to which two or more variables fluctuate together. In other words, it measures the degree or strength of a linear relationship. Implementing the statistical method of correlation does not only provide information regarding the possible likelihood of a link or relationship between two domains, but it also indicates the degree to which these domains deviate from a straight line (trend line) (Taylor, 1990; Aldrich, 1995).

The application of statistical correlations, in combination with the TMSMM assessment data, provides a means of determining whether relationships between the telemedicine service domains (i.e. man, machine, material, method and money) exist and is assesses the strength of these relationships.

By utilising OLAP operations (Section 5.3.1), it is possible to manipulate the three dimensional TMSMM dataset to extract relevant information required for the calculation of the correlation coefficients.

The correlation coefficients listed in Table 5.4.4 focus on the five telemedicine domains defined by the TMSMM (Van Dyk, 2012). The telemedicine services data which are used to calculate the correlation coefficients, listed in Table 5.4.4 are restricted to the micro-level maturity data of the TMSMM (see Appendix D.2).

Table 5.4.4: Telemedicine services domain correlation (N/S: Not Significant)

	Machine	Man	Material	Method	Money
Machine	1.00				
Man	0.18	1.00			
Material	0.69	N/S	1.00		
Method	0.31	0.32	0.28	1.00	
Money	N/S	0.20	N/S	0.72	1.00

The correlation coefficients listed in Table 5.4.4 can be grouped into four distinct categories. According to Taylor (1990), "...correlation coefficients (in absolute value) which are smaller than 0.35 are generally considered to represent low or weak correlations, 0.36 to 0.67 modest or moderate correlations, and 0.68 to 1.0 strong or high correlations". The fourth category represents correlation coefficients which were deemed not applicable according to the p-values obtained from the significance tests.

Based on the correlation coefficients listed in Table 5.4.4, and the categories previously defined, the inter domain relationships are analysed in more detail throughout the following sections.

5.4.2.1 Method and Money Correlation

The correlation data listed in Table 5.4.4 indicates a strong positive relationship between both the method and money domain. This suggest that both the domains experience parallel fluctuations and do not deviate extensively from the trend line.

A correlation coefficient of 0.72 strongly suggests that the two domains in question (method and money) are linked. The exact nature of the link is, however, unknown. A more in depth investigation of the five micro-level telemedicine processes reveals that the only significant correlation between the method and money domain is indicated in the transmit data process.

The correlation coefficient therefore indicates that any changes to the maturity of the telemedicine services transmit data process, will affect both the method and money domains equally.

5.4.2.2 Machine and Material Correlation and Causal Relationship

It is argued that the quality of technology dictates or influences the quality of the material captured or transmitted by means of the technology. For example, a higher grade digital camera produces higher grade digital images. This suggests that there is a strong relationship between the two factors.

A similar argument can be made with respect to ICT utilised in the telemedicine services industry. According to the data listed in Table 5.4.4, there is a strong correlation (0.69) between both the machine and material domain. This confirms that there is a link between the two domains.

The conventional dictum that a correlation coefficient does not imply causation, means that a correlation cannot generally be used to assume a causal relationship. Although in the case of the machine and material domains, it is plausible that a causal relationship between the respective domains exists.

To corroborate that a causal relationship between the machine and material domains exists the correlation coefficients of each telemedicine micro-level process was investigated. The investigation of the micro-level processes revealed that four of the processes register a significant correlation between the respective domains.

A look at the machine and material domain with respect to the capture process (Figure 5.4.3) reveals a correlation coefficient of 0.90, thus indicating a strong parallel relationship between the two domains. The correlation coefficient combined with the argument that a better quality telemedicine devices (i.e. digital camera) results in the capturing of higher quality medical data (i.e. digital image) suggests that an improvement of the machine domain maturity status improves the maturity status of the material domain.

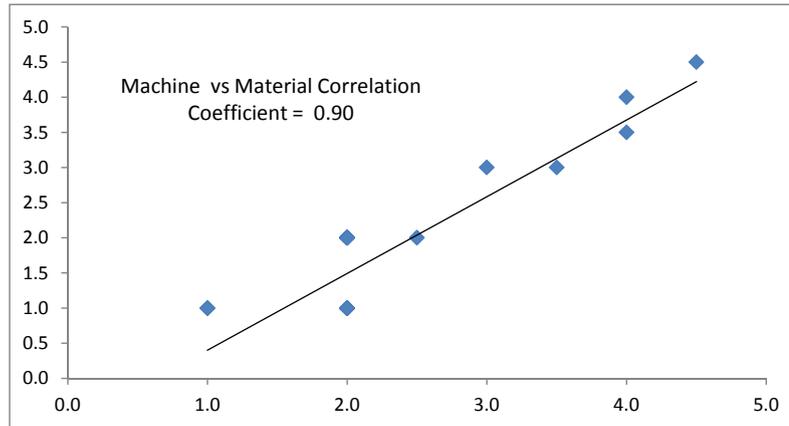


Figure 5.4.3: Machine and Material correlation with respect to the telemedicine service capture process

It can therefore be argued that the high correlation coefficient of 0.72, with regard to machine and material domains, implies a causal relationship between the two domains, in which a development in the machine domain positively affects the material domain.

5.4.2.3 Correlation trend regarding the Method Domain

A closer inspection of the correlation data listed in Table 5.4.4 reveals an interesting trend with regard to the method domain. Prior to discussing the relevance of the correlation trend, it is important to establish the context of the method domain. According to Van Dyk (2013) TMSMM, method domain is defined as follows:

Every telemedicine service provided requires work protocols, ethical guidelines and policies to govern the process. Therefore the maturity of such policies and protocols is an essential component of the holistic telemedicine service maturity and as such is referred to as the Method domain.

The identified correlation trend (see Figure 5.4.4) combined with the TMSMM definition of the method domain, strongly suggest that work protocols and ethical guidelines, used in conjunction with telemedicine services are of major relevance to internal telemedicine services. Although the correlation coefficients for machine and method (0.31), man and method (0.32) and material and method are representative of a considerably weaker relationship, they nonetheless provide confirmation of a link between the respective domains.

It can therefore be argued that the method domain is an essential component of telemedicine services, as it is positively linked to the remaining domains. In

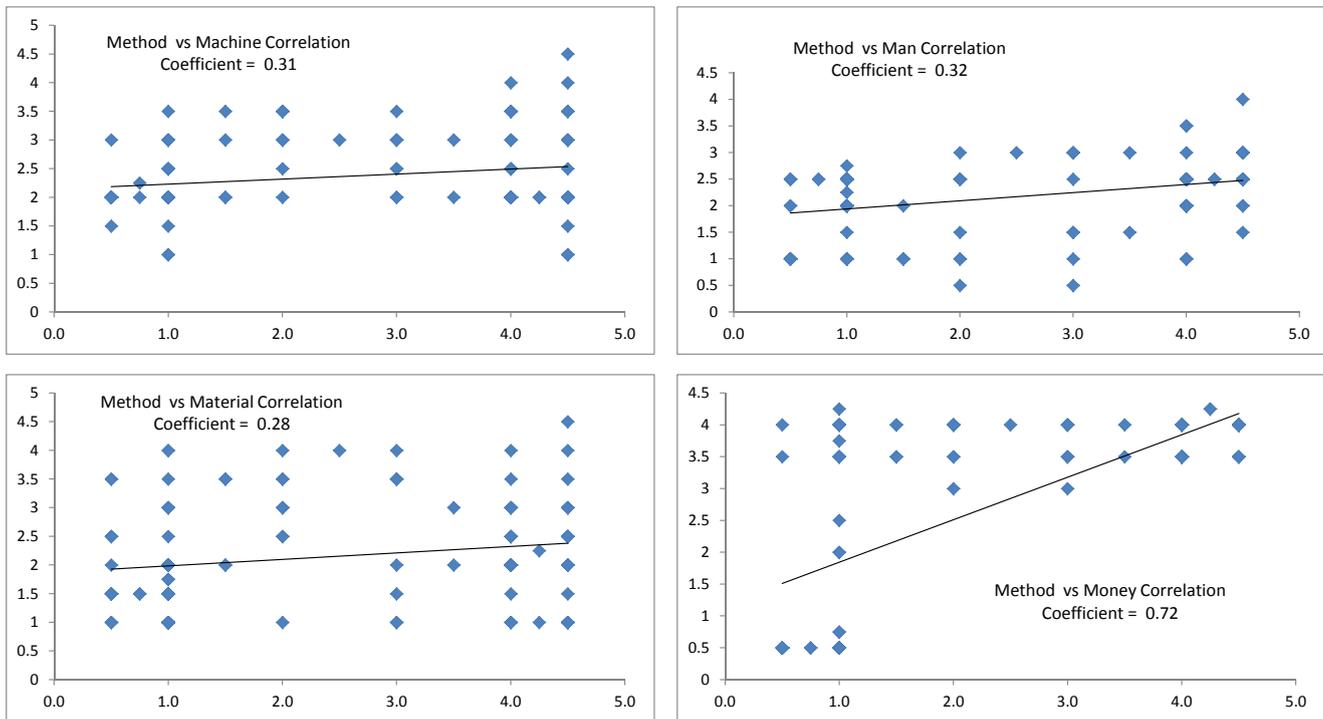


Figure 5.4.4: Method correlation trend with respect to the machine, man, material and money domain

other words, the remaining four domains experience parallel fluctuations with the method domain, some more strongly than others.

Summary Remarks:

The analysis of the telemedicine services data by means of correlation has revealed three factors of particular interest regarding the telemedicine services implemented in the Western Cape public health care sector.

The most relevant and influential discovery made during the correlation analysis is that the method domain is linked to the four remaining domains. Although the relationship between the money and the method domain is the strongest, and the link with the remaining domains is weaker, the data confirms that a link does exist.

Furthermore, a causal relationship between the machine and material domains was confirmed by the correlation analysis. This indicated that the machine utilised to capture and or transmit medical data does affect the material quality.

Table 5.4.5: Telemedicine services micro-level maturity map

	Machine	Man	Material	Method	Money	Average
Analyse	2.1	2.5	1.5	4.3	4.0	2.9
Capture	2.3	2.1	1.8	1.8	3.8	2.4
Diagnose	2.5	2.5	2.0	4.2	3.8	3.0
React	2.2	2.2	2.3	4.2	3.9	2.9
Transmit Data	2.4	2.1	2.3	1.2	1.5	1.9
Average	2.3	2.2	2.1	2.4	2.8	2.4

5.4.3 An Analysis of the TMSMM data

The TMSMM, in conjunction with the ETL process described in Chapter 4, enables the assessment of telemedicine service data. The model converts qualitative telemedicine services information into quantitative telemedicine maturity data. This is done by means of predefined comprehensive capability statements which are linked to the respective maturity scale.

The TMSMM therefore provides empirical datasets for telemedicine services, which, if synthesised and analysed, can provide information which establishes the determinants of a telemedicine service which are the most influential and affect the success or failure of such services.

To provide an overview of the Western Cape public telemedicine services maturity distribution, OLAP operations were applied to roll-up processes (from processes to type-of-process). The maturity map (Table depicted in 5.4.5) illustrates the collective micro-level maturity ratings for all of the telemedicine service assessed during the study. Each of the domain and service-type intersections (i.e. Capture-Man) represents a capability area, thus providing a comprehensive maturity map.

Similarly the maturity map illustrated in Table 5.4.6 is a continuation of Table 5.4.5. This maturity map lists the capability areas of the meso- and macro-level telemedicine processes.

The methodology behind the separation of the micro-level and the meso- and macro-level processes will become more evident in Chapter 7. In essence, the micro-level is representative of the internal procedures of a telemedicine service, whereas the meso- and macro-levels represent higher-level external entities linked to a telemedicine service.

A detailed observation of both Tables 5.4.5 and 5.4.6 indicates that the overall average maturity of telemedicine services is 2.4 as indicated in Figure 5.4.5

Table 5.4.6: Telemedicine services meso- and macro-level maturity map

	Machine	Man	Material	Method	Money	Average
Meso-level	1.9	2.4	0.9	1.6	0.9	1.5
Macro-level	0.9	1.2	0.8	0.3	0.2	0.7
Average	1.4	1.8	0.8	0.9	0.6	1.1

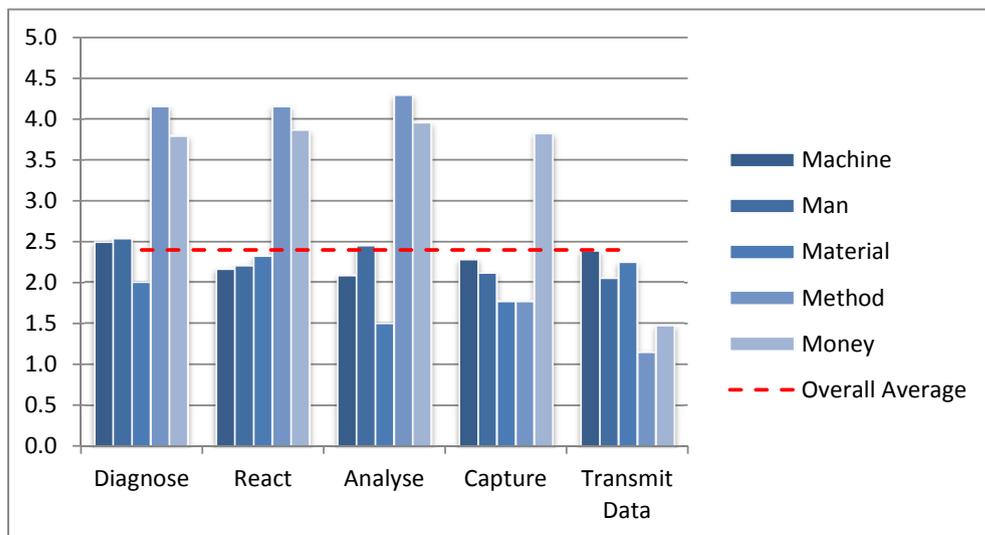


Figure 5.4.5: Types-of-processes vs the average maturity rating of the five domains

by the red dotted line. According to the TMSMM capability statements (Appendix C), the telemedicine services implemented in the Western Cape public health care sector are perceived to be defined or confirmed as a standard business process. Section 5.4.4 provides a detailed investigation and analysis of the distinctive micro-level capability areas.

The meso- and macro-levels of the Western Cape public telemedicine services, however, have a considerably lower overall maturity rating in comparison to the micro-levels. Identifying and analysing the factors which result in such a noticeably low average maturity are discussed briefly in Section 5.4.5.

As mentioned previously, Tables 5.4.5 and 5.4.6 provide an overview of the telemedicine services maturity landscape. A detailed and in-depth analysis and discussion of the micro-level maturity data be discussed in the following

sections. The discussion will provide insight and assist in determining which factors influence the success or failure of telemedicine services implemented in the Western Cape public health care sector.

5.4.4 A Detailed Analysis and Discussion of the Telemedicine Services Micro-Level

Table 5.4.5, is illustrated graphically in Figure 5.4.5. The red dotted line represents the overall average maturity of all the telemedicine services assessed. It becomes clearly visible that a few of the domains score an above average maturity, whereas others score exceptionally low maturity scores. For example, the extent by which the maturity of both the method and money domains exceeds that of the overall average maturity. The two bars to the right of each process grouping represent the method and money domains respectively. The remaining man, machine and material domains score a maturity rating between 1.5 and 2.5.

According to the data illustrated in Figure 5.4.5 and the TMSMM capability statements, the average telemedicine service implemented in the Western Cape public health care sector is characterised by projects, and is manageable and considered to be a standard process (Maturity Level 2 and 3) (Van Dyk, 2012).

The subsequent sections will investigate and discuss the type-of-services and domains in detail, to identify factors which influence the success or failure of telemedicine services implemented in the public health care sector of the Western Cape.

5.4.4.1 Transmit Data Process: Lowest Average Maturity Rating

An initial observation of the data depicted in Figure 5.4.5 highlights the distinctively lower levels of the transmit data process, compared to those of the remaining four processes. The transmit data process is the process represented on the graph with the lowest average maturity for both the method and money domains.

Identifying the factors which result in the lower average maturity ratings for both the method and money domains required an in depth analysis of the transmit data process.

As mentioned in Section 5.3.2, box plots provide a graphical summary of tabulated data. The combination of the box plot analysis tool and OLAP operations, provides a detailed account of the transmit data process, as seen in Figure 5.4.6.

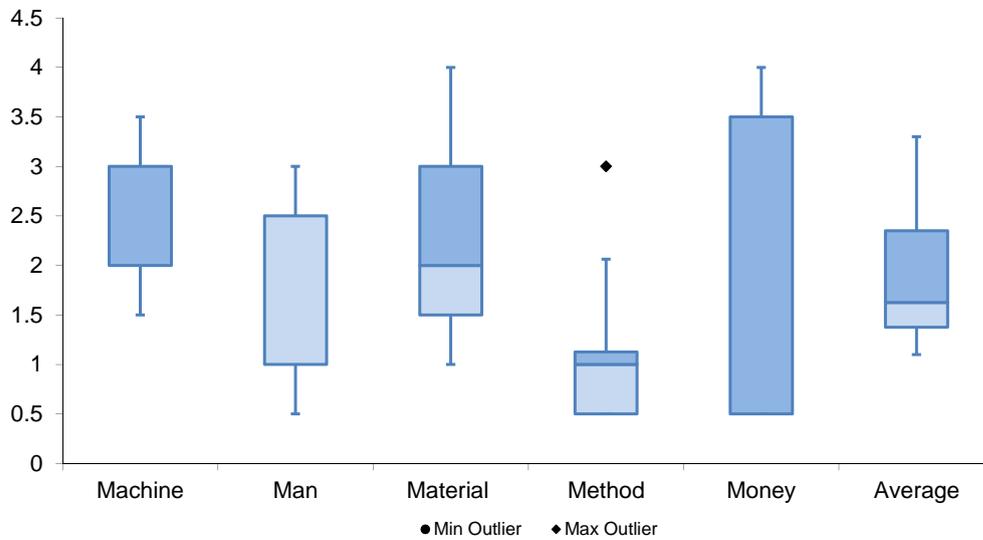


Figure 5.4.6: Box Plot summarising the TMSMM assessment data referring to the transmit data processes

According to Table 5.4.5, the capability area representing the intersection of the transmit data and method domain indicates the lowest maturity rating (1.2) of all 30 micro-level capability areas. The low maturity rating is corroborated by the box plot (Figure 5.4.6). This suggests that maturity distribution ranges between 0.5 and 2.0.

The box-and-whiskers plot supplies information regarding the maturity distribution of the method domain. That is, however, not the limit to the information stored in a box-plot. The high median line and the long upper whisker are an indication that the majority of the transmit data processes tend to receive a maturity rating between 1.0 and 2.0.

The transmit data box plot (Figure 5.4.6) also provides additional information regarding maturity values which deviate significantly from the rest of the sample. PACS is one of these outliers. Due to the fact that these telemedicine services are the only services with proper work protocols in place, they are given a higher maturity rating.

The second transmit data capability area of interest is the area which intersects with the money domain, rated at a maturity of 1.5. Contrary to the observations for the method domain in Figure 5.4.6, the money domain matu-

ity assessed for all 26 telemedicine services, leans towards the a low maturity.

According to the money domain box-and-whisker plot, 50 percent of the telemedicine services achieve a maturity rating of 0.5 during assessment. The remaining 50 percent is spread across the maturity scale from 0.5 to 4.0. This indicates a large variance and confirms that the money domain is negatively skewed. This draws attention to the question of why 50 percent of the services have no finance structures in place.

The information obtained from the analysis, in conjunction with the method and money domain capability statements (Appendix C), provides the required insight into the factors which cause such a low maturity rating.

Summary Remarks:

The preceding analysis and the capability statements (Appendix C) conclude that the transmission of medical data, within the context of telemedicine services implemented in the Western Cape public health care sector, achieves an average maturity of 1.9.

The more mature telemedicine service have standardised data transmission services and thus achieve higher maturity levels (3.0). Whereas, the majority of the data transmission processes have a maturity rating well within the region of the overall average (1.9). This means that the data transmission is executed by means of a reliable service provider at consistent levels in the worst case scenario these services are provided ad-hoc.

The detailed analysis of the data transmission service confirms the initial research hypothesis referring to the lack of health care policies and service level agreements integrate the telemedicine services into the normal work-flow. The method and money domains are proven to be the most influential of the five domains, hindering the transmission of medical data process to achieve a higher maturity level.

5.4.4.2 Analyse, Diagnose and React Process: High Maturity for both the Method and Money Domains

In the previous section the considerably low maturity of the transmit process method and money domains was discussed and elaborated on. This section is aimed at analysing the high average maturity of the same domains, with regard to the Analyse, Diagnose and React (ADR) processes.

Figure 5.4.5 indicates that the method and money domains of the ADR pro-

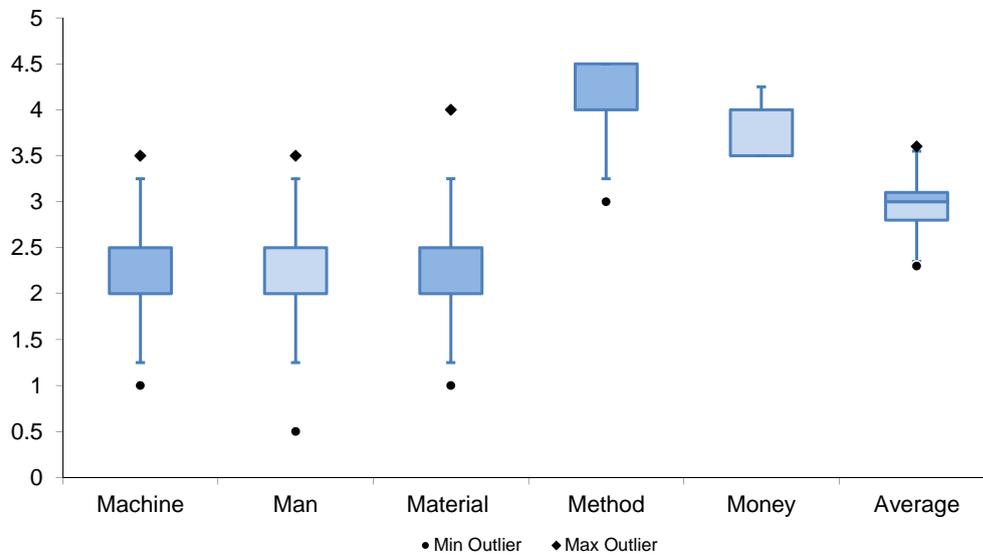


Figure 5.4.7: Box Plot summarising the TMSMM assessment data referring to the Analyse, Diagnose and React process

cesses exceed the average maturity of the telemedicine services by a considerable margin. As part of a detailed analysis of the ADR processes, a box plot was generated, see Figure 5.4.7.

Based on the TMSMM assessment data summarised in Figure 5.4.7, noticeable observations can be made.

The box-and-whisker plots, illustrated in Figure 5.4.7 are condensed and thus suggest that the various telemedicine services implemented in the Western Cape public health care sector, and particularly the ADR processes of these services are consistent.

The maturity of a diagnose process, executed in conjunction with a mobile device driven telemedicine service, is equal to that of a react process, administered via a MRC Telemedicine Workstation.

The three box-and-whisker plots summarising the machine, man and material domain are close to identical, if the outliers and the skewness of the data is ignored. Based on these observations, and the TMSMM capability statements (Appendix C), it can be argued that the machine, which in 70 percent of the ADR services is a mobile device (see Section 5.4.1), is effective, reliable, available and considered standard among health care personnel. Similarly the user

executes the ADR services consistently and as a standard procedure utilises consistently created material of an acceptable quality.

Having established that machine, man and material domains average maturity rating of 2.4, the question that remains is why both the method and money domains exceed the average telemedicine service maturity by such a large margin.

The analysis conducted in Section 5.4.2.1, regarding the relationships between the various domains, indicates a strong correlation between the method and money domain. The strong relationship between the two domains can offer an explanation as to why both domains are rated so strongly.

A more detailed examination of the ADR services reveals that these services are executed by qualified and trained medical staff (see Table 5.4.3). Thus the work protocols (methods) which govern the actions of the telemedicine service user are standard medical procedures and mature guidelines.

Similarly, the physician or specialist administering the ADR service, is acting in the capacity of the employee of the Western Cape DoH. The operational costs are therefore financed by the institution, which results in a considerably higher maturity rating, ranging between 3.5 and 4.25.

Summary Remarks:

According to the TMSMM assessment, the combined average of the ADR services is 2.7. In conjunction with the respective capability statements (Appendix C), these services are considered to be standard procedures.

The noticeably higher maturity of the ADR service, compared to the remaining telemedicine services, is a result of the high maturity ratings achieved by the method and money domains.

5.4.4.3 Capture Process: Discrepancy between the Method and Money Domains

Section 5.4.2 elaborates on the relationships which exist between the various domains. As pointed out earlier, the method and money domains have a strong positive correlation (see Figure 5.4.4). A closer inspection of the capture process, illustrated in Figure 5.4.5, indicates that the method (1.8) and money (3.8) domains differ considerably with regard to average maturity. This poses the question of why could be.

A detailed inspection of the capture process reveals that the majority of the telemedicine services users, who execute the capture process, are registered

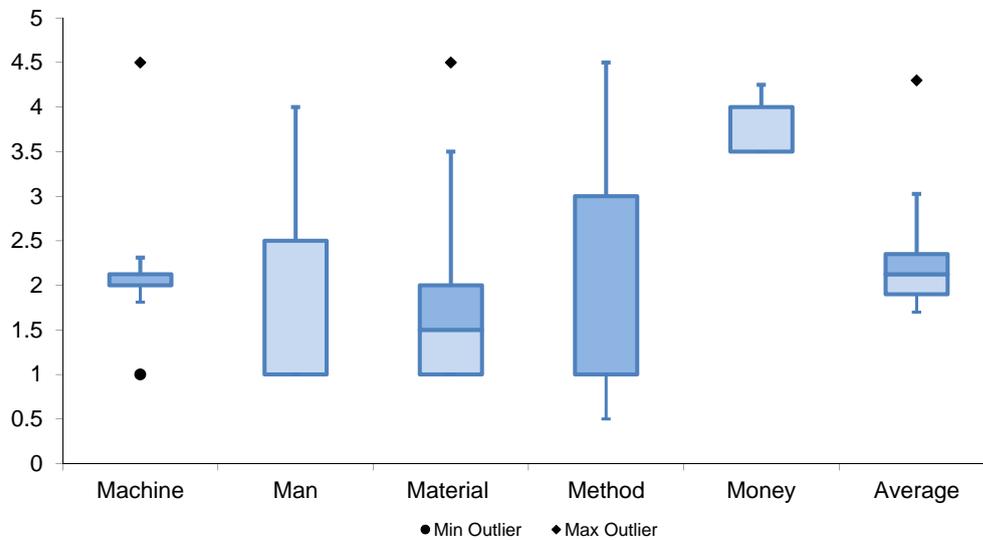


Figure 5.4.8: Box Plot summarising the TMSMM assessment data referring to the Capture process

medical officers or specialist physicians. Similarly, as with the ADR processes, the physician capturing medical data executes the process as an employee of the Western Cape DoH and therefore the money domain is ranked highly on the maturity scale.

The low method domain maturity of the capture process is the product of a lack of work protocols. The analysis of the TMSMM data conducted in Section 5.4.1 suggests that the majority of the Western Cape public health care telemedicine services are administered in a non-official capacity, utilising mobile devices. The medical officers and specialist physicians administering these telemedicine services do so at their own discretion, to provide their patients with the most effective and high quality health care as possible.

A closer look at the capture process box-and-whisker plots (see Figure 5.4.8) shows that the information obtained from Figure 5.4.5 alone does not provide a complete picture. As is visible in Figure 5.4.8, the method domain varies in maturity across the entire scale. Although the illustrated TMSMM data may seem to be complex, the explanation for the severe variance in maturity is provided by investigating type of services assessed during the study.

The services assessed range from official telemedicine services such as PACS,

which are fully matured, to non-official telemedicine services utilising mobile devices. The latter services are not designed for the particular purpose and are therefore not matured. The variety in telemedicine services explains the broad distribution of the method domain illustrated in Figure 5.4.8.

Summary Remarks:

The capture process suggests combining both the elements of the ADR processes and the transmit data process. Whilst the machine (2.3), man (2.1) and material (1.8) domains do not indicate any distinctive anomalies, the method and money domains attract all the attention.

As with the ADR processes, the telemedicine user performing the capture process does so as an employee of the DoH, which explains the qualitatively managed and controlled financial money domain (Maturity Level 4).

Whereas the method domain varies considerably, due to the fact that the TMSMM sample consists of a variety of services such as the MRC Telemedicine Workstations, which are governed by matured work protocols. The opposite extreme is the non-official mobile device services, which rely on the user's own discretion and lacks work protocols.

The failure to integrate telemedicine services into the health care system, induces a considerably lower maturity rating. All domains correlate with the method domain, some more strongly and others less so. Health care policies can be singled out as the key influential factor, with regard to the capture process.

5.4.4.4 Machine Domain: The Preferred Telemedicine Device

The previous section stated the mobile phone as the commonly preferred telemedicine device in the Western Cape public health care sector. The use of mobile phones, or more generally speaking any mobile devices, in health care is not governed by appropriate work protocols or guided by work procedures. Nonetheless the majority (68.6 percent) of the telemedicine services implemented in the Western Cape, utilise mobile phones or devices in a non-official capacity (see Figure 5.4.2).

The TMSMM assessment confirms that the most commonly used telemedicine device is not a Telemedicine Workstation designed to provide telemedicine services, but rather a simple mobile phone.

Having established that the device most utilised for telemedicine services is

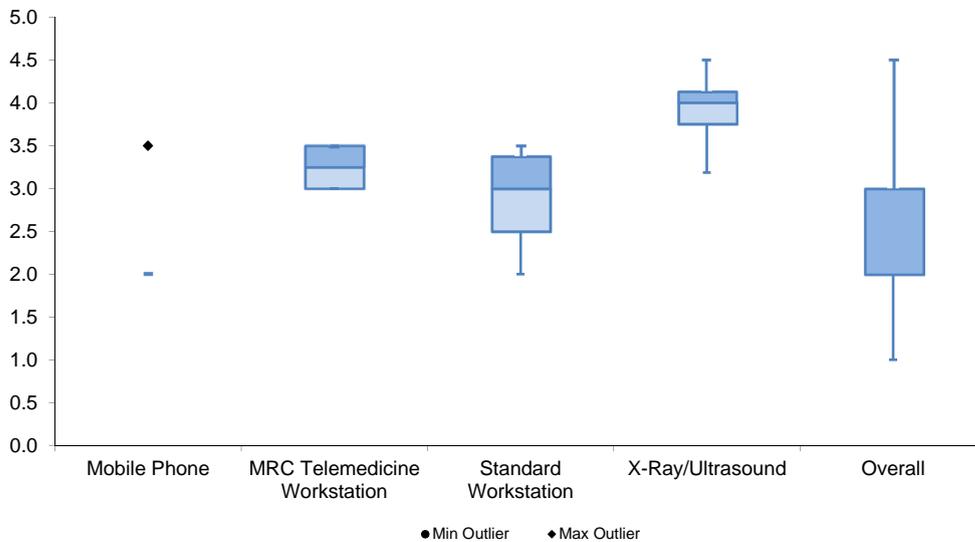


Figure 5.4.9: Box Plot summarising the TMSMM assessment data referring to the Machine domain

indeed the mobile phone, a box-and-whiskers plots is used to provide additional information (see Figure 5.4.9). An initial observation of the machine domain in Figure 5.4.9, indicates that there is an absence of a maturity variance regarding the mobile phone. It can therefore be argued that for each of the approximately 18 telemedicine services which utilise mobile phones, the mobile phone achieves a maturity rating of 2.0 (Managed).

According to the TMSMM capability statements (see Appendix C), a maturity rating of 2.0 means that the mobile phone is reliable, effective and available but lacks the design element. In other words, the device was not specifically designed for the purpose of or to perform telemedicine services and thus, according to the TMSMM capability statements, cannot achieve a higher maturity rating.

Nonetheless, the mobile phone remains the most effectively utilised device, compared to the other devices. It can thus be argued that the mobile phone is preferred due to the increased mobility and ease-of-use which the device provides. In comparison a workstation is stationary and requires a certain level of computer literacy to be operated effectively and efficiently. As opposed to the operating mobile device, especially mobile phones, which is to the most people second nature.

A further discovery which supports the previous argument, is the extremely low utilisation rate of the MRC Telemedicine Workstation (3.8 percent). The MRC Telemedicine Workstation was designed and developed to provide rural, public health care facilities with telemedicine service application, and as such the workstation achieves a considerably higher maturity rating. Even though the MRC Telemedicine Workstation is more mature than a mobile device, medical officers and specialist physicians who perform telemedicine services would rather utilise mobile devices, particularly because the devices fulfil the needs of the users.

Summary Remarks:

In conclusion, the analysis of the TMSMM data suggests that the preferred telemedicine services devices utilised are mobile devices, more particularly mobile phones. This observation is of interest due to the fact that the maturity rating of the mobile phone is the lowest of all the devices identified and yet it is utilised in 68.8 percent of the services.

The mobile phone is so popular because it satisfies the needs of the user and the service, while not increasing complexity and workload.

The mobile phone achieves a maximum maturity rating of 2.0 and can only achieve a higher rating if the device is taken into consideration during the design process. The argument can therefore be made that the mobile phone is the telemedicine services devices of choice due to the effectiveness, reliability and availability it provides, regardless of if it is designed for the intended purpose.

5.4.4.5 Man: The Average Domains

The prior discussion (Section 5.4.1), regarding the general overview of the telemedicine services implemented in the Western Cape public health care sector, already gave an indication of who the primary users of these services are. The majority of the telemedicine services are operated and utilised by medical officers, and on some occasions by nurses, situated at the rural district health care facilities. The application of telemedicine services allows the health care staff to request advice and support from specialist physicians at higher level health care facilities quicker, and unnecessary referrals are minimised.

Figure 5.4.10 illustrates a detailed summary box plot of the man domain TMSMM assessment data. It is limited to include only the primary telemedicine services users identified. Keeping the discussion regarding the ADR processes

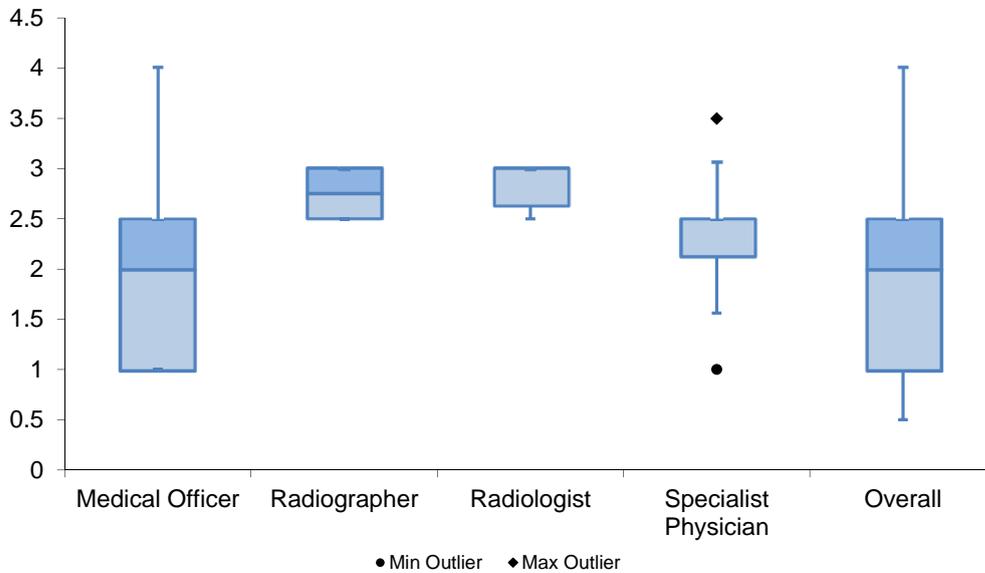


Figure 5.4.10: Box Plot summarising the TMSMM assessment data referring to the Man domain

(Section 5.4.4.2) in mind, the noticeably high and minimally varying maturity of the Radiographer, Radiologist and Specialist Physician are a result of the mature method domain.

The box-and-whiskers plot of interest is that which is referred to the maturity distribution and variance of the Medical Officer. In the majority of the cases, the Medical Officer conducts the react process (see Table 5.4.3), which is included in the highly matured ADR, as mentioned earlier. Contrary to the Radiographer, Radiologist and Specialist Physician the Medical Officer also conducts the less mature and not as strongly governed capture processes. The high variance in maturity is therefore explained.

Summary Remarks:

In conclusion it can be argued that the overall low maturity of the man domain is a result of the high maturity variance of the Medical Officer.

In other words, although the users of the Western Cape public health care telemedicine services are willing and able to execute the processes consistently, the fact that the telemedicine service as a whole is not governed by the appropriate policies, results in a low

maturity rating for the user executing the capture process.

5.4.5 A Brief Discussion of the Telemedicine Services Meso- and Macro-Levels

Systems engineering dictates that a complex system such as a telemedicine service or the health care system should be seen as systems of systems. Thus, the TMSMM not only assesses the internal telemedicine processes, but also accommodates the systems at the higher levels of the overall system hierarchy.

Telemedicine service meso- and macro-level systems are situated higher up in the overall hierarchy. Although the meso- and macro-level represent the provincial and national systems respectively and do not exclusively relate to the individual telemedicine services, these systems have a significant impact on the success of telemedicine services.

An initial analysis of the average maturity ratings for both the meso- and macro levels suggests that the processes at a provincial level are more mature than at the higher national level.

5.4.5.1 Meso-Level: A Managed Provincial Telemedicine System

The information listed in Table 5.4.6 gives an indication that the physical infrastructure utilised to administer services is appropriate and available. Telemedicine services are driven by self-appointed champions and used by the health care community. The services are even considered as a standard operating procedure.

Elements which negatively affect the progress of the Western Cape telemedicine services meso-level to maturity are the lack of institutional business models which enable sustainability, and the absence of electronic medical records.

It can therefore be concluded that, although telemedicine services at the meso-level achieve a considerably lower maturity rating than the telemedicine services themselves (macro-level), the higher level telemedicine system is managed.

5.4.5.2 Macro-Level: A Non-Existent National Telemedicine Level

The overall average achieved by of the macro-level is the lowest of the three telemedicine services levels. A more detailed inspection of the various TMSMM domains listed in Table 5.4.6 suggests that the macro-level barely achieves a maturity level of 1.0, especially the method and money domains.

Both the national and provincial policies and strategies concerning telemedicine, and the national business, score an extremely low maturity rating of 0.2 and 0.3 respectively. This means that telemedicine policies and financial structures are barely existent at a national level, and that where there are any policies or structures in place, these are ad-hoc or experimental at best.

Although the remaining three domains, namely machine, man and material have an above average maturity rating, the domains are still far less mature than the respective micro-level domains. This is a clear indication that the maturity of the macro-level services needs to be improved in order for the telemedicine services to evolve to a higher maturity level.

5.5 Chapter Conclusion

The purpose of the synthesis, analysis and discussion of the TMSMM assessment data presented in this chapter was to resolve research questions pertaining to research phase 5 (stated in Section 1.3).

A brief discussion of the synthesis and analysis tools used to manipulate and transform the TMSMM assessment data was followed by an overview of the Western Cape public health care telemedicine services. The overview analysis concluded that of the 26 telemedicine services assessed, including radiological, dermatological, CTG and ECG services, the majority of the services are administered by medical officers or specialist physicians by means of mobile phones.

The subsequent statistical correlation analysis of the TMSMM assessment data revealed relationships between the telemedicine service domains. The existence of links between the domains was therefore confirmed. The method domain which turned out to be the most influential of the five domains and linked to each of the other domains.

Having established an overview of the telemedicine services implemented in the Western Cape public health care sector, and having identified the inter-domain relationships, an analysis of the maturity TMSMM data concluded that the overall average maturity is 2.4. A more detailed investigation into the TMSMM assessment data entails the identification of the telemedicine processes and domains which exceed or fall below the average maturity rating of 2.4. The investigation concludes with an in-depth discussion of the factors which influence these considerable differences.

Chapter 6

TMSMM Assessment Validation

Chapter 6 serves the primary purpose of validating the outcomes and assumptions made in terms of the assessment of the telemedicine services conducted during the study. The aim of this chapter is to confirm the study's hypotheses, based on a sample volume of telemedicine services, which apply to the overall volume of telemedicine services implemented in the Western Cape. Chapter 6 discusses the method of collecting validation data by means of a questionnaire and how such a questionnaire is constructed. The crux of this chapter is the analysis and validation of the TMSMM assessment results.

Research Question 5.1

What methods can be utilised to validate the results of the TMSMM assessment?

Research Question 5.2

How is the validation process conducted?

Research Question 5.3

What are the outcomes of the validation process?

6.1 The Need for Validation

The purpose of the study is to conduct an assessment on telemedicine services implemented in the public health care sector of the Western Cape. Chapter 5 discussed the analysis of the TMSMM assessment data and established an understanding of the circumstances which affect the success or failure of telemedicine service, specifically those identified during the progress of the study.

The transformed telemedicine services information describes the 26 telemedicine services identified at the selected number of health care facilities listed in Table 5.1.1.

The aim of the study is to assess telemedicine services in the Western Cape public health care sector. Taking into consideration the fact that the Western Cape is considerably vast and provides care by means of multiple public health care facilities, the study was restricted to a the select number of facilities, as previously mentioned.

The purpose of the following sections was to validate the fact that the information obtained from the limited sites is indeed synonymous to the entire public health telemedicine industry of the Western Cape. The validation procedure was conducted independently the ETL and telemedicine services assessment discussed in Chapters 4 and 5. This ensured the authenticity of the validation data.

According to Global Harmonization Task Force (2004), act of validation is an assurance that a product, service, or system meets the needs of the customer. Cognisance is taken of the fact that the telemedicine services of the Western Cape were not assessed based on customer needs but rather on the maturity of the telemedicine services. The validation was by means of a questionnaire, which was set up to determine whether the specific telemedicine services implemented in the Western Cape conform to the maturity hypotheses defined in Chapter 5.

6.2 Questionnaire: A Research Tool

A questionnaire is a structured interview, which allows for the collection of information from individuals while avoiding a face-to-face interview. These features make the questionnaire the most appropriate research tool to aid and facilitate in the validation of the hypothesis concluded in Chapter 5. A higher cost effectiveness, and less time consumed, compared to personal face-to-face interviews, are the primary advantages of a questionnaire. The ease of ad-

ministering a questionnaire is an additional factor why it was decided that questionnaires would be made use of in this study.

Although the questionnaire has a number of advantages, there are a few disadvantages which need to be taken into account during the analysis of the data.

According to Nulty (2008), Eiselen and Uys (2005), the general response rate to a web-based questionnaire is likely to be considerably lower than that of a paper based questionnaire. A further issue which requires attention is the fact that no control over the sample population can be guaranteed (Eiselen and Uys, 2005). In other words, the composition of sample may be known, but the composition of the population which did not answer the questionnaire is unknown. There is therefore limited control.

A lower response rate and limited control over the questionnaire population, albeit negative aspects, are outweighed by the advantages of the research tool. In addition, the convenience of allowing the respondent to reply in a time frame of their own choosing is an important positive factor in encouraging responses. The "Use of Mobile Devices in Health Care" self-administered online questionnaire was therefore constructed and forwarded to the desired target population.

The following section discusses the process of constructing the questionnaire and the target population it is intended for.

6.2.1 Questionnaire: Research Questions

Constructing a questionnaire involves a certain procedure, which according to Eiselen and Uys (2005) is comprised of formulating research questions, defining a target population and finally formulating the questions.

The information contained in the responses to the questionnaire will be utilised for the validation process. The formulation and construction of a questionnaire requires an appropriate structure. It is therefore imperative to clearly define research questions and set the desired goals which the questionnaire aims to achieve.

The primary goal of the questionnaire is to validate the fact that the body of knowledge obtained in Chapter 5 applies to Western Cape telemedicine services in general. The research questions listed in Table 6.2.1 were defined to provide a foundation for the questionnaire.

Table 6.2.1: Research Question 6.3 sub-questions devised to validate the results of the TMSMM assessment

Research Question	
Research Question 6.3.1:	Are mobile devices utilised within the context of public health care services?
Research Question 6.3.2:	Are mobile devices utilised as part of or to perform official and non-official telemedicine services?
Research Question 6.3.3:	Do health care policies accommodate the use of mobile phones as part of health care procedures?
Research Question 6.3.4:	What drives the use of mobile devices to perform telemedicine services?
Research Question 6.3.5:	Is the TMSMM assessment analysis conducted in terms of the machine domain reflected by the target population?
Research Question 6.3.6:	Are the hypotheses, documented with respect to the man domain, validated?
Research Question 6.3.7:	Does the TMSMM assessment of the material domain reflect the target population?
Research Question 6.3.8:	Are the conclusions, made in terms of the method domain, aligned with those of the target population?
Research Question 6.3.9:	Does the TMSMM analysis of the money domain align with those of the target population?

6.2.2 Questionnaire: Target Population

The listed research questions were designed to act as a guideline. They aimed to align the actual questions with the response-information required to validate the concluding hypothesis of the TMSMM assessment. The formulation and language used to compose the research questions aimed to aid in the validation process and needed to consider the intended target population of the validation process. The scope of the population affects the level and type of the extracted response information.

The questionnaire was constructed particularly for the purpose of validation, was therefore concentrated on a target population which consisted of health care workers and health care professionals employed or active in the public sector (i.e. Administrative Staff, Community Service Doctor, Intern, Managerial Staff, Medical Officer, - Specialist, - Student and Nurse). The region of interest is the Western Cape, although the responses are not necessarily restricted

to that specific region.

The definition of the target population, along with the formulation of the research questions determined the construction of the questionnaire.

6.2.3 Questionnaire: Ethical Clearance

As with any medical research, ethical approval is required before any medical information can be extracted. It was thus important to ensure that any rights to privacy and dignity was not violated and that the information obtained was handled ethically. An amendment of the original ethical approval granted by the Health Research Ethics Committee (HREC) was requested, in order to incorporate the "Use of Mobile Devices in Health Care" questionnaire (see Appendix A).

6.2.4 Questionnaire: Distribution Methodology

Due to time constraints and for reasons of convenience, it was decided that the existing relationship with Medical Officers at each of the visited facilities, would be utilised and that the questionnaires would be distributed amongst medical staff and colleagues. This enabled the collection of independent telemedicine service data, which had no link to and was not influenced by the TMSMM assessment. Although this particular method of distribution reduces the time of the validation, it increases the complexity of the analysis. The downside of the lack of control over who receives the questionnaire is that very little is known about the demographic of the population that receives the questionnaire.

6.2.5 Questionnaire: Conceptualisation

The final questionnaire was conceptualised utilising Google Drive, which provided both the means to construct and distribute a web based questionnaire. Furthermore, it supplied a subsequent web-based drive to which the response-data could be chronologically forwarded and stored. A complete copy of the questionnaire, as distributed to the target population, is attached in Appendix E.

6.3 The Validation Process

The previous section elaborated on the construction of a questionnaire which was utilised to obtain data pertaining to the use of mobile devices in health care. The purpose of the questionnaire and the following sections is to validate that the body of knowledge generated in Chapter 5 represents telemedicine services implemented in the Western Cape public health care sector.

As with the analysis of the TMSMM assessment data, a demographic overview of the questionnaire sample is established. A demographic overview of the sample is of high significance. This is due to the disadvantageous lack of control over the respondent population, synonymous with web-based questionnaires. In terms of this particular questionnaire the lack of knowledge pertaining to the composition of the general questionnaire, population complicated the analysis. It was therefore of importance to determine the exact composition of the target population, to assist the analysis and support the validation process.

The second phase of the analysis concentrated on the validation of the body of knowledge discussed in Chapter 5. The validation procedure was structured to align with the five domains (Man, Machine, Material, Method, Money) of the TMSMM.

6.3.1 Sample Demographics

The questionnaire was distributed between six Medical Officers allocated at the selected six health care facilities included in the initial ETL process. The Medical Officers were asked to distribute the questionnaires amongst their respective staff and colleagues. The composition of the questionnaire sample was therefore and unclear. What was clear was who responded to the questionnaire. This gave an indication of the general composition of the sample population. The questions in the questionnaire which referred to demographic information are listed in Table 6.3.1.

Table 6.3.1: Questions formulated to extract information pertaining to the demographics of the respondent population

#	Population Demographic
1	What is the job title for your current position?
2	What is your gender?
3	What is your age?
4	What is the highest level of education you have completed?
5	Number of years (health care sector) work experience?
6	What is the name of the Health Care Facility you are currently working at?
7	What type of Health Care Facility do you work at?

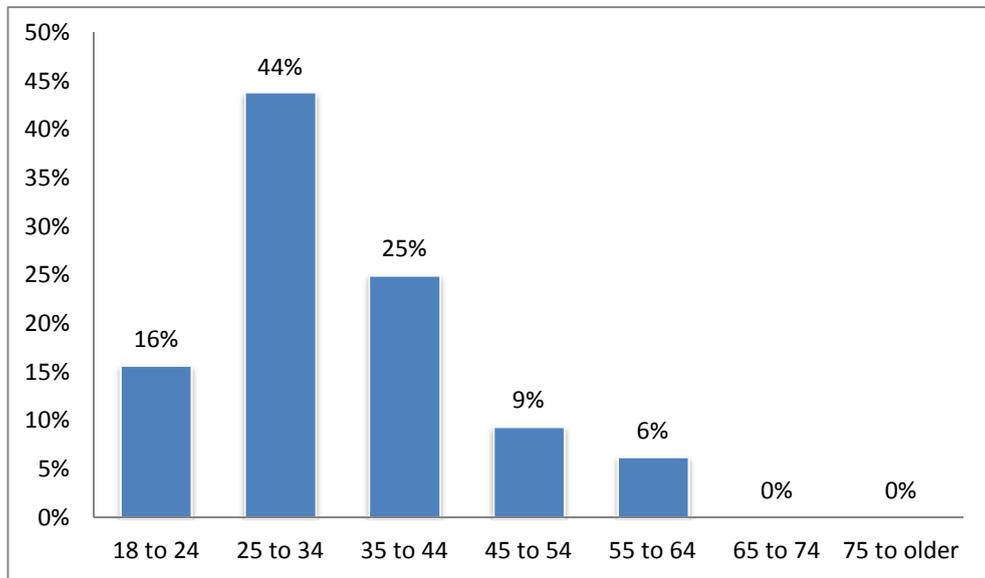


Figure 6.3.1: Age distribution of sample

6.3.1.1 Questionnaire Sample: Male/Female Composition

The analysis of the demographic data indicated the male/female distribution amongst the sample was approximately two thirds male (69 percent) and the remaining third female (31 percent).

The age group which is the most noticeable is the (Figure 6.3.1) health care workers of 25-to-34 years of age. Further information which can be deduced from the distribution in Figure 6.3.1 indicates that the age group of 65-and-older is not represented.

The demographic data of the age groups confirms that the intended target population, ranging from medical students to medical specialists active in the public health care sector, composes the sample.

The validation data obtained from the questionnaire is thus representative of a predominantly male health care workforce aged from 25-to-44.

6.3.1.2 Questionnaire Sample: Job Title Composition

It is important to take into consideration the job titles of target groups when establishing the demographics of the sample. Knowledge of the composition of the sample aids in the validation discussion.

The 26 telemedicine services assessed during the study were predominantly

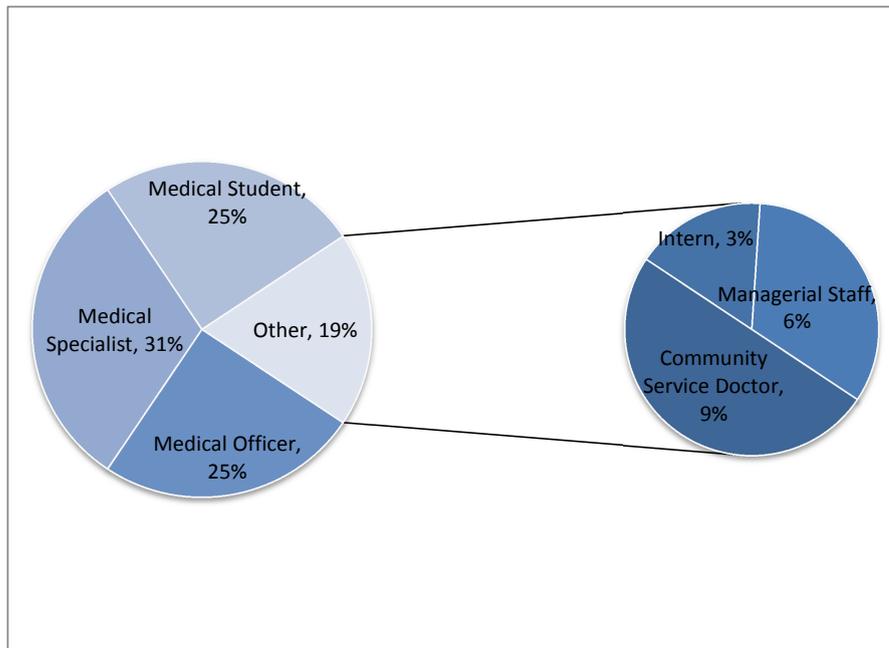


Figure 6.3.2: Job title distribution of sample

utilised by Medical Officers or Specialist Physicians to administer medical care. Administrative and Nursing staff showed less exposure to the particular type of telemedicine services included in the study. Taking note of the composition of the sample in terms of job title could possibly aid in the validation process.

As can be seen in Figure 6.3.2, the majority of the respondents were medical personnel, ranging from medical students or highly experienced physicians who have acquired a specialisation in a certain medical field. Only 6 percent of the sample was representative of managerial staff (non-medical personnel), the remainder of the sample (94 percent) was comprised of medical-orientated personnel.

As shown by the figure, visually illustrates neither Nurses nor Administrative staff are represented in the sample data. Of the 26 telemedicine services assessed during the study, the majority of the services were executed by medical personnel, specifically physicians. Thus for the questionnaire to validate the insight gained from the analysis of the TMSMM assessment data, the sample should be composed of medical personnel. The demographic data illustrated in Figure 6.3.2 confirms that the composition of the sample relates to that of the study, therefore providing a base for the validation process.

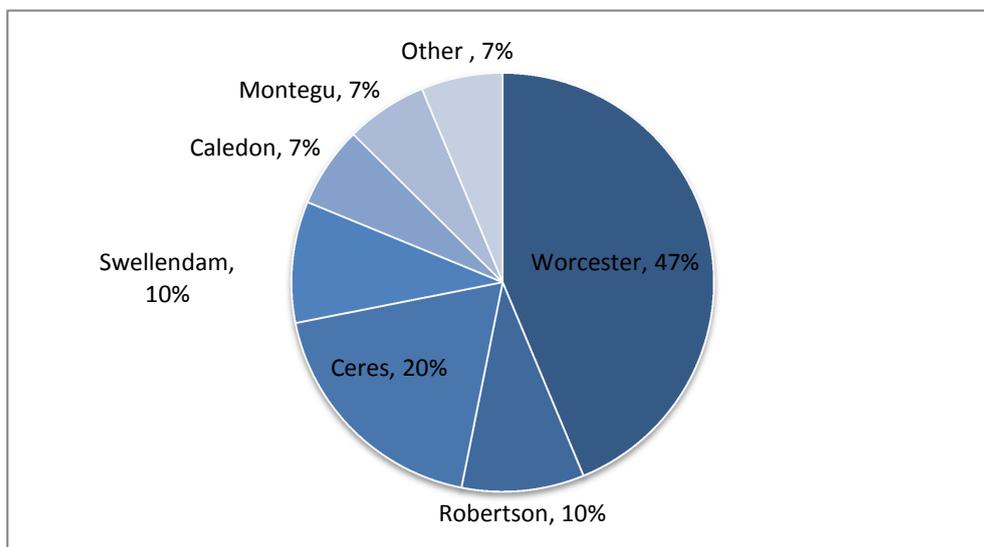


Figure 6.3.3: Western Cape regions and distribution among sample

6.3.1.3 Questionnaire Sample: Hospital Composition

The methodology implemented in distributing the questionnaire amongst the intended target population, resulted in a high representation of the Western Cape districts (see Figure 6.3.3) in the sample. Of the health care facilities represented, Worcester was considered a secondary-level hospital, which most of the District Hospitals in the surrounding regions are linked to and refer their patients too.

This is an indication that the sample is evenly represented by both Primary Health Care (District) facilities and Secondary Health Care facilities. It in turn provides an basis for the validation procedure, due to the fact that both facets of a telemedicine services assessed are represented in the sample (Level 1 - Primary Health Care Facilities (50 percent), Level 2 - District Health Care Facilities (47 percent), and even Level 3 - Tertiary Health Care Facilities (3 percent)).

The second part of the questionnaire focused on obtaining data which enabled the validation of the Western Cape telemedicine services body of knowledge generated in Chapter 5. The questions were therefore formulated to be aligned with the five telemedicine service domains defined by Van Dyk (2013). The subsequent sections discuss the validation of the five telemedicine service domains.

6.3.2 Domain: Machine

The following section focuses on validating the assumptions and body of knowledge obtained in Chapter 5 pertaining to the device used to administer telemedicine services.

The flow of the machine domain is supported by adapting the structure of the questionnaire to the analysis. All the questions which were formulated respective to the machine domain are listed in Table 6.3.3 along with the intended purpose of the respective question.

The analysis of the TMSMM data suggests that the devices which are predominantly used to perform telemedicine services are the mobile phones (68.6 percent), compared to other devices (31.4 percent) utilised by telemedicine services (see 5.4.2). Further analysis of the TMSMM data gave rise to the hypothesis that mobile devices (i.e. laptops, tablets and mobile phones) are the preferred telemedicine devices, owing to the fact that these devices grant mobility, accessibility and are easy to use.

According to the maturity assessment and the subsequent analysis of the TMSMM data, the mobile phone (hereinafter including all mobile devices) received the second lowest average rating (2.0) of all the devices utilised for the purpose of telemedicine (see Table 5.4.9). According to the TMSMM capability statement (see C.2), a maturity rating of 2.0 indicates that the mobile phones driven telemedicine services are repeatable. In other words, the mobile phone is an available and effective device which is utilised for telemedicine processes.

Although according to the analysis of the TMSMM assessment data the mobile phone is regarded an immature device in terms telemedicine, it is the most frequently used telemedicine device. It is argued that the high usage of mobile devices is a result of the accessibility, mobility and ease-of-use associated with the devices.

6.3.2.1 Machine Hypothesis Validation

According to the analysis of the machine domain discussed briefly above, the primary devices utilised within the context of Western Cape telemedicine services are mobile phones. Question 8, 14 and 17 documented in the questionnaire serve the purpose of validating the hypothesis that mobile devices, in particular mobile phones, are the primary devices used to execute telemedicine services in the Western Cape public health care sector.

Table 6.3.2: Extract of the questionnaire listing questions pertaining to the Machine domain

#	Questions	Confirmation / Determine?
8	Which type of themobile device are you currently using?	Confirm that mobile phone is the most commonly used telemedicine device. Determine which mobile devices are most commonly used.
9	Which operating system does your mobile device use?	Information intended for parallel study.
10	Which mobile service provider do you subscribe to?	
11	How would you rate your mobile device signal coverage?	Determine if the connectivity of the mobile device is adequate.
13	Did you purchase your mobile device with the intention of using it in the health care sector?	Determine if a mobile device is chosen regarding a set of standards/criteria, thus being more suitable for the use in the health care industry. This should achieve a higher capability rating, as it fulfils the criteria despite the device not being designed with the particular service in mind.
14	Do you use your mobile device to assist you in your work, by attaining information via the internet?	Determine if the mobile device used is an efficient and reliable source of information.
17	Do you use your mobile device to capture, document or transmit medical data?	Confirm the use of mobile devices to conduct telemedicine services. Capturing, documenting and transmitting patient information are defining aspects of Telemedicine.
23	Which of the following factors would motivates you to use mobile devices for Health Care purposes?	Determine what motivates people to use telemedicine services.
25	- Better quality mobile devices	Confirm that the quality of mobile devices does not have an extensive effect on the usability of telemedicine.

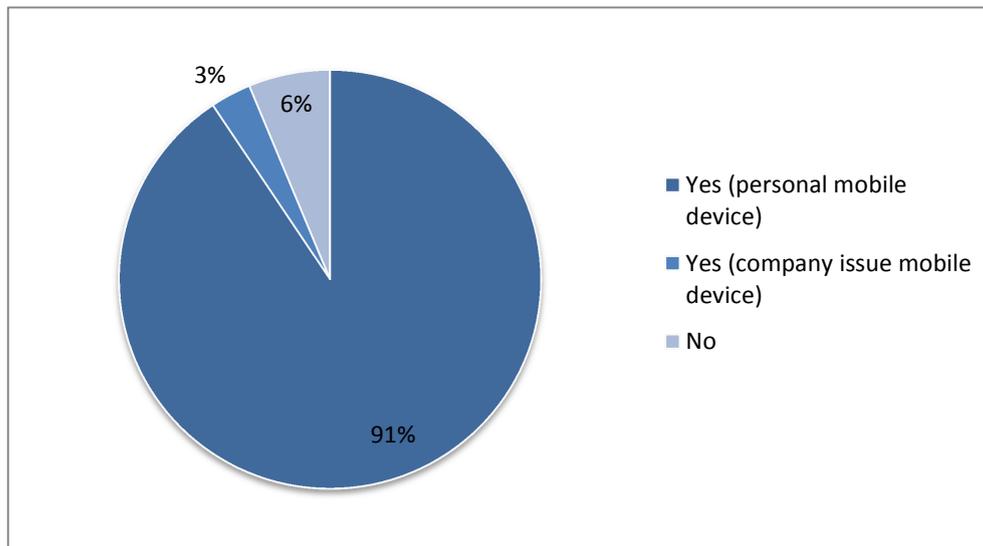


Figure 6.3.4: Percentage of sample population utilising mobile devices for health care purposes

To confirm the validity of the previously stated hypothesis, the sample data needs to be analysed to establish whether mobile phones are indeed utilised in the field of health care and if these devices are utilised to execute telemedicine services. An analysis of the sample data pertaining to these questions reveals that 94 percent of the sample population utilises mobile devices within the public health care sector for health care purposes (see Figure 6.3.4). Of the sample population, 64 percent use mobile phones.

The confirmation that mobile devices are utilised in health care is not conclusive in the validation of the use of mobile devices for telemedicine purposes. According to the sample data illustrated in Figure 6.3.5, 72 percent of the sample use mobile devices to capture, document and transmit medical information. The process of capturing, documenting and transmitting medical data defines a telemedicine service, thus validating the hypothesis stated earlier.

Furthermore, the sample data pertaining to question 13 aims to confirm the fact that mobile devices are in fact preferred over other telemedicine devices, despite not being specifically designed with telemedicine services in mind. The questionnaire data indicates that 41 percent (see Figure 6.3.6) of the sample purchased a mobile device with the intention of utilising the device in the health care environment. This confirms and validates the high usage of mobile phones (see Figure 5.4.2) in the health care sector of the Western Cape.

In addition, a resounding 91 percent take advantage of their mobile devices

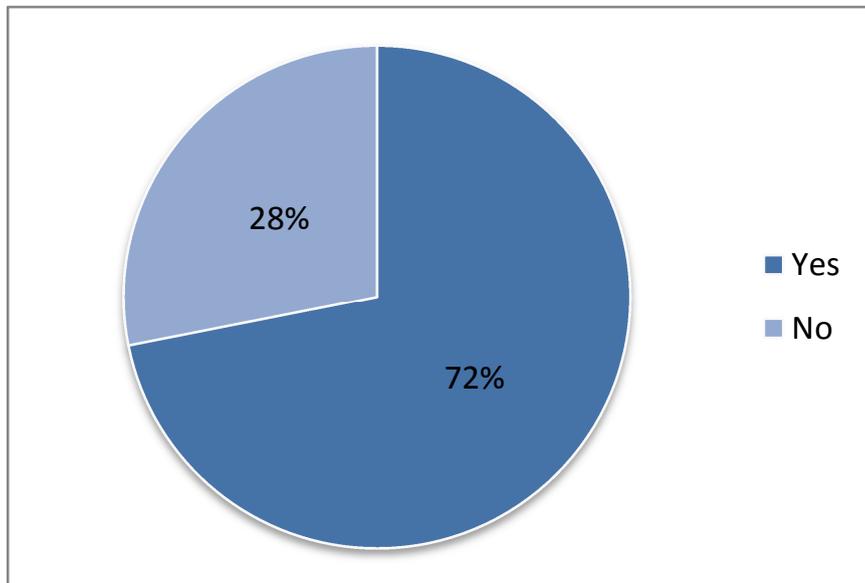


Figure 6.3.5: Percentage of sample population utilising mobile devices as part of telemedicine services

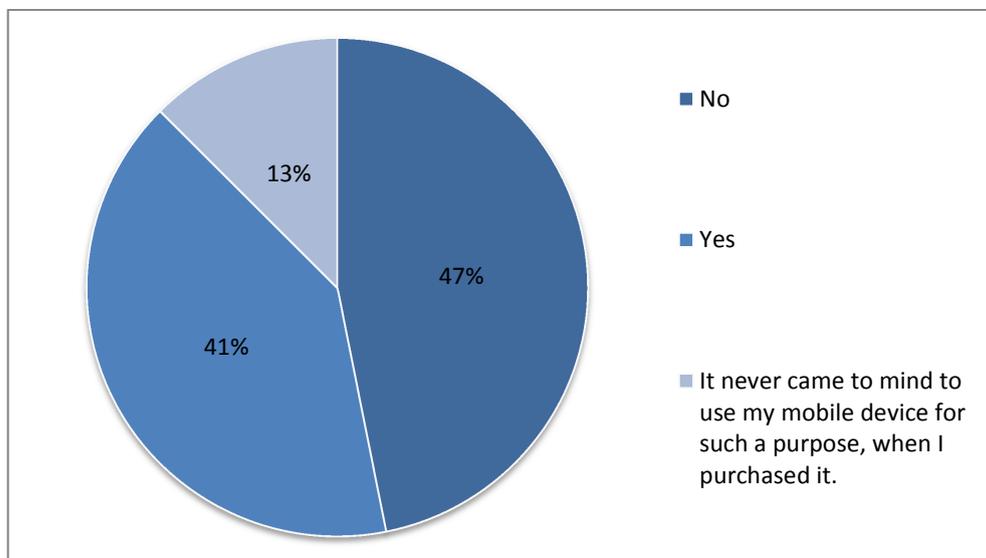


Figure 6.3.6: Do you [the user] use your mobile device for health care purposes at work?

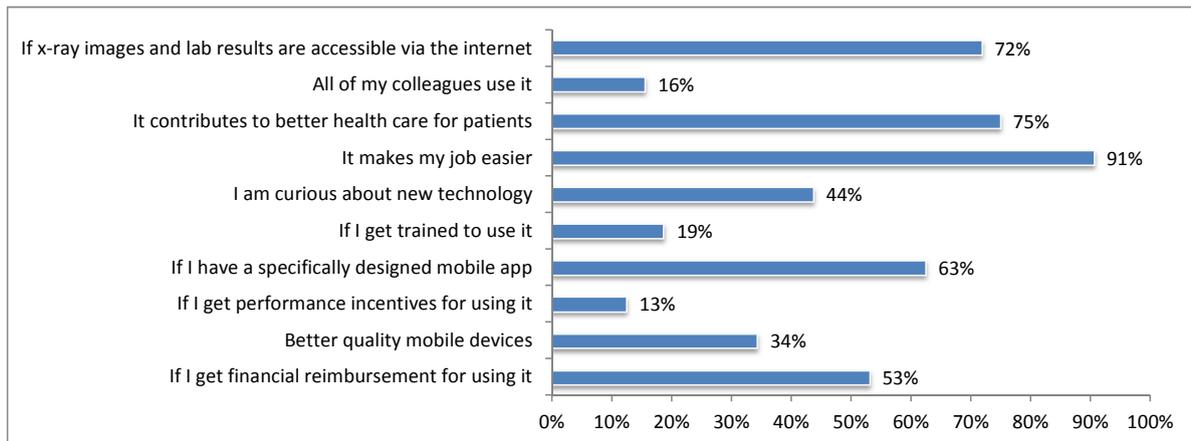


Figure 6.3.7: Do you [the user] use your mobile device for health care purposes at work?

connectivity and mobility to attain medical information via the internet, instead of consulting other sources of information. When asked what motivates the user of a mobile device to utilise it in conjunction with telemedicine services, 29 responses (91 percent) were that the ease of use is a key motivational factor (see Figure 6.3.7).

6.3.3 Domain: Man

Having confirmed the validity of the hypotheses pertaining to the machine domain, a similar approach is taken to validate the man domain. To provide a guide throughout the discussion, the questions concerning the man domain are listed in Table 6.3.3, along with the intended purpose of each respective question.

The TMSMM data analysis of the man domain gives rise to the following hypothesis: The considerably low average maturity rating (2.2) is not a consequence of a lack of availability of the services or the willingness of the user to perform telemedicine services, but rather a consequence of the lack of standardisation with respect to these type of services. This leads to the realisation that health care policies and methods are linked with the utilisation of telemedicine services (see Section 5.4.2).

The initial hypothesis suggested that the low maturity of the telemedicine

Table 6.3.3: Extract of the questionnaire listing questions pertaining to the Man domain

#	Questions	Confirmation / Determine?
23	Which of the following factors would motivate you to use mobile devices for Health Care purposes?	Determine what motivates people to use telemedicine services.
24	- If I get financial reimbursement for using it.	Determine whether health care policies and financial structures covering telemedicine services influence the use of these services.
27	- If I have a specifically designed mobile application.	Confirm that services which are standardised and regulated by health care policies promote the use of telemedicine services.
28	- If I get trained to use it.	Determine if continuous support and training has an impact on telemedicine service usability.
29	- I am curious about new technology.	
30	- It makes my job easier.	Confirm that the added mobility, connectivity and ease of use of mobile devices is a deciding factor. Confirm hypothesis that designing for the end-user is of great importance (bottom-up approach).
31	- It contributes to better health care for patients.	Confirm that if the service is potentially beneficial to the patient's health it is more likely to be utilised.
32	- All of my colleagues use it.	Confirm that telemedicine services require a champion who drives it.
33	- If x-ray images and lab results are accessible via the internet.	Confirm that overall connectivity and accessibility is important.

user is mainly attributed to a lack of interest or buy-in on behalf of the user. Furthermore, the complicated telemedicine applications and the coinciding increased work load demotivated physicians to utilise telemedicine services. These claims were quickly proven to be false. In reality, telemedicine services are frequently utilised by physicians and specialists within public health care sector of the Western Cape.

According to the TMSMM capability statements, and the analysis conducted in Section 5.4.4, the average physician or specialist utilising a telemedicine service assessed during the study is defined as willing and able to execute a telemedicine services. The analysis of the man domain draws attention to the fact that physicians and specialists execute non-official telemedicine services frequently even though they are not incorporated in the health care facility policies. This is an indication that ease-of-use, the health benefit provided by the service to the patients and the improved accessibility to medical data outweigh other factors such as requiring a telemedicine champion, training, or performance incentives to promote the service.

6.3.3.1 Man Hypothesis Validation

The subsequent section discusses the analysis of the questionnaire data referring to the questions listed in Table 6.3.3 and the results which are depicted in Figure 6.3.7. The purpose is to assess whether the hypotheses established in Chapter 5 are validated by the questionnaire sample.

The synthesis of the questionnaire data revealed that 29 of the 32 respondents (91 percent) state that ease-of-use is a key motivational factor or incentive to utilising mobile device telemedicine services. This partially confirms the assumptions previously stated.

75 percent of the sample is of the opinion that the health care benefits accompanied by the implementation of telemedicine services contribute largely to the preferred use of telemedicine services. Likewise, 72 percent of the respondents highlight the importance of connectivity and accessibility of medical data with respect to telemedicine services.

Question 27 of the questionnaire was included with the intent to determine whether the implementation of telemedicine services as standard procedure would motivate users to utilise these services more often. A response of 63 percent confirms the initial assumptions. For a telemedicine service to mature to level 3 of the TMSMM scale, it must be implemented as a defined standard procedure, thus instilling confidence in the user to execute such services.

The analysis of the questionnaire data confirms the validity of the hypothesis made regarding the Western Cape telemedicine services user (man domain).

The information obtained via the TMSMM assessment and analysis of the 26 telemedicine services is thus representative of telemedicine service in the entire Western Cape.

6.3.4 Domain: Material

In Chapter 5, the similarities between the domains became apparent. Both the machine and man domains have comparably low maturity ratings. The material domain achieved a noticeably low maturity rating. According to the analysis of the TMSMM assessment data in Section 5.4.4, the maturity rating of the material domain fall somewhere between 1.5 and 3.0 for 50 percent of the telemedicine services. The average maturity rating (2.1) of the material domain, suggests that the material domain is the most immature of the five domains.

According to the TMSMM capability statements (see Appendix C.3), a maturity of 2.1 corresponds to the 'Standard' maturity level as defined by Van Dyk (2013), and is associated with consistency, acceptable quality and secure transmission of the material.

The average material which is captured, analysed and transmitted in conjunction with a telemedicine service, is captured consistently at a acceptable quality even if the service is not specifically designed for such a purpose. Secondly the data transmission is conducted on a secure level, which does not jeopardise the integrity and security of the data.

A high positive correlation between the machine and material indicates that an improvement in maturity of one of the domains subsequently has a positive effect on the linked domain. Furthermore, the preferred use of mobile devices, confirmed in the previous section, is singled out as the reason for the low maturity of the material domain. Mobile devices are not specifically designed for the purpose of telemedicine services and therefore neither the machine nor the material domain can achieve a higher maturity rating than 2.0 according to the capability statements defined by the TMSMM.

6.3.4.1 Material Hypothesis Validation

The stated hypotheses are based on the telemedicine service body of knowledge established in Chapter 5 and refers to the 26 telemedicine services assessed. The section which follows aims to validate the assumptions made, based on the questionnaire sample, which ensures that the information is applicable to the general population of telemedicine services implemented in the Western Cape. The questions listed in Table 6.3.4 provide a guideline throughout the

validation discussion.

Table 6.3.4: Extract of the questionnaire listing questions pertaining to the Material domain

#	Questions	Confirmation / Determine?
18	How do you capture or document medical data with your mobile device?	Confirmation that the quality of the material is linked to the device utilised.
19	How do you transmit/receive medical information/data via your mobile device?	Determine which methods of transmission are mostly used and whether they are regarded as secure.
20	Do you consider transmitting/receiving medical information/data via mobile device	Confirm that transmitting patient information via mobile networks is presumed to be secure.
21	Medical information/data captured using the mobile device camera is	Confirm that the quality of the material is of higher/acceptable grade.
23	Which of the following factors would motivate you to use mobile devices for Health Care purposes?	Determine what motivates people to use telemedicine services.
25	- Better quality mobile devices.	Confirm that a high quality device, incorporates the required standards.
33	- If x-ray images and lab results were accessible via the internet.	Confirm that overall connectivity and accessibility were important.

The purpose of question 18 (see Table 6.3.4) is to determine which method of capturing medical data is preferred and primarily executed in the sample. The method or application utilised dictates the quality and consistency of the material captured.

According to the information obtained from the questionnaire, 72 percent of the sample utilise, a mobile device to capture, document and transmit medical data. The overwhelming majority (96 percent) captures medical material by means of a mobile device camera. This confirms the strong correlation and causal relationship between the device and the quality of the material emphasised previously.

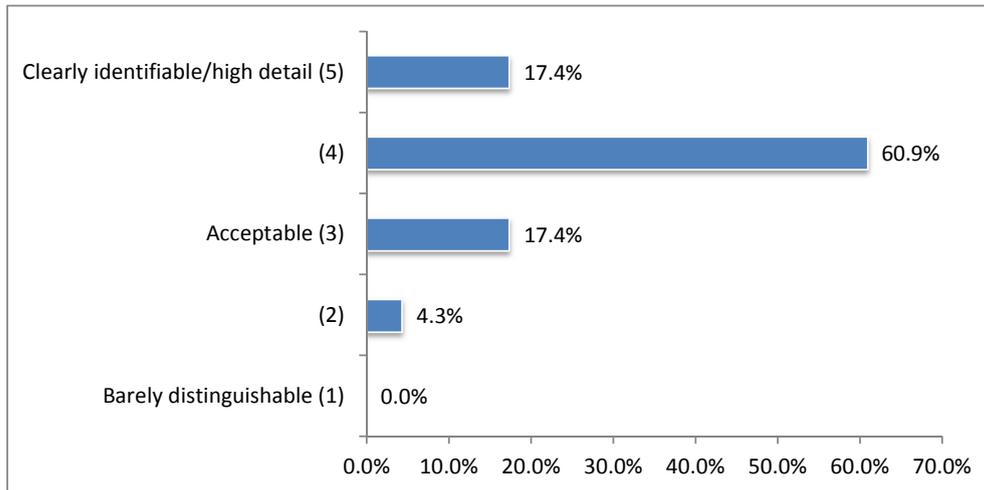


Figure 6.3.8: Do you use your mobile device to capture, document and transmit medical data?

A maturity rating of 2.0 for the capture, analyse and diagnose processes indicates the quality of the medical data captured and transmitted should be of acceptable quality. The questionnaire sample was asked to rate the quality of medical data captured and transmitted via mobile devices, according to a scale ranging from 'Barely distinguishable' (1) to 'Clearly identifiable/high detail' (5). A majority of 60.3 percent considered the medical material captured and transmitted via these means to be more than acceptable. The results of question 21 are depicted in Figure 6.3.8.

The purpose of questions 19 and 20 is to confirm the validity referring to the security of the transmitted medical data. The responses of the sample confirms the hypothesis, that medical data are transmitted safely by means of standard mobile data transmission protocols, see Figure 6.3.9.

The sample data also confirms that these modes of transmission are perceived as secure and safe. The majority of the respondents (69 percent) rate the transmission of medical data via mobile devices as 'fairly secure'. Only 4.3 percent consider the transmission of medical information to be 'un-secure' and 13 percent regard it as 'questionable' (see Figure 6.3.9).

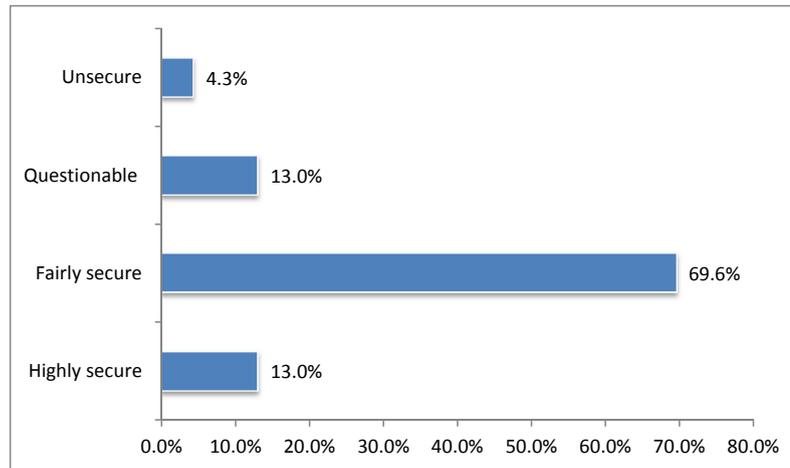


Figure 6.3.9: Do you use your mobile device to capture, document and transmit medical data?

6.3.5 Domain: Method

The majority of the telemedicine services assessed during the study were services executed in a unofficial capacity. This already suggested a lack of proper methods and work protocols. Telemedicine services utilised in the public health care sector are a product of necessity, simplification of the work process and an improvement in the quality of health care provided.

The entire maturity distribution, with respect to the methods domain, ranges from a maturity of as low as 1.5 to the maximum maturity level of 5.0. The high variation in maturity can be attributed to the variety of telemedicine services implemented and the processes involved in such a service.

On the one hand there are official telemedicine services, specifically developed and intended for telemedicine. They are accompanied by the proper work protocols and methods. Even unofficial services consist of processes which are governed by prescribed work ethics and protocols. For example, a diagnose or analysis process conducted by a medical specialist physician is performed at a high maturity level, due to the fact that the specialist physician applies common medical standards.

On the other hand, there are telemedicine services ranging between maturity levels of 1.5 and 2.0, which are representative of the processes which lack adequate work policies. These processes are commonly associated with mobile device driven, unofficial telemedicine services. Excluding outliers, the lowest rating of the method domain maturity is 1.5. According to the TMSMM capability statements, these processes are repeatable and executed by a specific service provider.

Telemedicine service processes which are the focus of attention are the capture and transmission of data processes which are unable to progress beyond a maturity of 2.0 due to the lack of appropriate work methodologies.

The analysis of the TMSMM assessment data suggests that these issues often occur in telemedicine services which are utilised in an unofficial capacity, such as mobile device incorporated telemedicine services.

A further observation lead to the hypothesis that even though these unofficial telemedicine services lack appropriate work protocols and have non-existent funding structures, they are more frequently utilised than other more mature telemedicine services.

6.3.5.1 Method Hypothesis Validation

The questions listed in Table 6.3.5 provide the structure for the following section. The aim of the method hypothesis validation is to corroborate the assumptions made, in terms of the method domain. This is based on the 26 services assessed during the study which are transferable to the entire telemedicine services community of the Western Cape.

A financial reimbursement structure implies that there are policies governing and methods of measuring the usage of telemedicine services. According to the responses to question 22 of the questionnaire, the majority (92 percent) of the respondents do not receive any financial support for utilising mobile devices in order to administer medical care. The previously discussed assumption that mobile devices driven telemedicine services lack appropriate work protocols is therefore confirmed.

Only 7 percent of the health care facilities included in the sample are known to be equipped with health care policies which accommodate the use of mobile devices in health care. This information, coupled with the validated fact that mobile phones are the primary devices utilised for the provision of telemedicine services, substantiates the claim that telemedicine service are implemented even in the absence of proper policies.

The majority (91 percent) of the sample is considered the ease-of-use, associated with a mobile device, to motivate the use of telemedicine services. Only 63 percent and less (53 percent) are motivated by a specifically designed telemedicine application and financial reimbursement, respectively. The combination of the these facts confirms the assumptions made in terms of the method domain.

Table 6.3.5: Extract of the questionnaire listing questions referring to the Method domain

#	Questions	Confirmation / Determine?
22	Do you receive any reimbursements for the use of mobile devices to you in your work?	Confirm that no policies are in place which address the funding of telemedicine services.
23	Which of the following factors would motivates you to use mobile devices for Health Care purposes?	Determine what motivates people to use telemedicine services.
26	If I get performance incentives for using it.	Determine whether providing incentives for the proper use of telemedicine services (in other words measuring the telemedicine user) promotes the service.
27	If I have a specifically designed mobile application.	Confirm that a specifically designed service with prescribed work protocols positively effects the use of such services.
30	It makes my job easier.	Confirm that telemedicine services are executed whether or not they are governed by appropriate work ethics and methods, if the service simplifies the procedure.
34	Does the Health Care Facility you work at have a mobile device policy?	Confirm that mobile device policies are non-existent in the public health care industry.

6.4 Chapter Conclusion

In Chapter 6, a questionnaire is utilised as a research tool in the validation of the hypotheses drawn from the TMSMM assessment and analysis, documented in Chapter 5. The purpose of the study is to assess telemedicine services implemented in the public health care sector of the Western Cape.

The questionnaire distributed amongst public health care practitioners and personnel of the Western Cape, aimed at focusing on the use of mobile devices in public health care sector. The focus on mobile devices is a result of the analysis of the 26 telemedicine services, which suggests a considerably high percentage of mobile devices being used in accordance with telemedicine ser-

vices. The questions in the questionnaire were constructed to harmonise the five domains of the TMSMM and formulate the purpose of obtaining information. This was in turn utilised to confirm the validity of the Western Cape telemedicine services assessment.

In conclusion, Chapter 6 confirmed that by means of the 'Mobile Devices in Health Care' questionnaire and the subsequent validation analysis, the telemedicine services insight, with respect to a limited sample of 26 telemedicine services, applies to the telemedicine services of similar design in the entire Western Cape.

Chapter 7

strengths, weaknesses, opportunities and threats (SWOT) Analysis

The primary purpose of the study is to assess telemedicine services implemented in the Western Cape public health care sector. The product of the assessment and subsequent analysis of the services is a comprehensive insight with regard to telemedicine services implemented in the Western Cape public health care sector.

The purpose of Chapter 7 is to utilise, translate and transform the insight gained from the analysis and validation (Chapter 5 and 6, respectively), pertaining to elements of the Western Cape telemedicine services affecting the success or failure of said services. The resultant outcome of the SWOT analysis is a set of recommendations which can be utilised by the Western Cape DoH to improve the current and future status of telemedicine services implemented in the Western Cape.

Research Question 6.1

What business management tool can be utilised to interpret the results documented in Chapters 5 and 6?

Research Question 6.2

How can a business analysis technique be utilised to interpret the TMSMM data obtained during the study?

7.1 Translating the Telemedicine Services Insight

The aim of the Western Cape public health care telemedicine services assessment was to conduct a thorough investigation of the telemedicine services currently implemented and utilised, to establish what influences these services.

The result of the TMSMM assessment is a collection of raw telemedicine services data stored in the TMSMM multidimensional database. This data were deciphered and analysed utilising various engineering techniques as discussed in Chapter 5.

The final outcomes of the TMSMM assessment, analysis and validation, discussed in Chapter 6, is a comprehensive insight pertaining to the actively utilised telemedicine services implemented in the public health care sector of the Western Cape. Thus establishing an extensive understanding of the current status and factors which influence the success or failure of telemedicine services in the public health care sector of the Western Cape.

From an industrial engineering point of view, the telemedicine services acumen acquired contains all the information needed to facilitate the improvement of the current status of telemedicine services in the Western Cape. The main advantage of the engineering level insight provides telemedicine users, policy-makers and institutional stakeholders with an overview of the current status of telemedicine services implemented in the Western Cape public health care sector.

A further objective of the study is to translate the telemedicine services obtained telemedicine service insight into a set of recommendations which will enable telemedicine service stakeholders to utilise the information. The following sections elaborate on the methodology and implemented engineering management tools, to translate the telemedicine services data and discusses the set of recommendations defined.

7.2 SWOT Analysis: A Market and Business Management Tool

A SWOT analysis is a structured planning method used to identify the Strengths, Weaknesses, Opportunities and Threats of an organisation or a project. The utilisation of the SWOT analysis is common in the marketing and business environment. Although the application of SWOT analyses is not limited to the marketing and business environment, a SWOT matrix (see Figure 7.2.1)

	Helpful To achieving the objectives	Harmful To achieving the objectives
Internal Origin (attributes of the organisation)	S Strengths	W Weaknesses
External Origin (attributes of the organisation)	O Opportunities	T Threats

Figure 7.2.1: SWOT Matrix with its four elements

can be applied to a product, place, industry, person or, in the case of this study, a medical service (Humphrey, 2005; Dyson, 2004).

The purpose of a SWOT analysis is to exploit the strengths and weaknesses of an organisation, and identify the opportunities and threats of the organisational environment. This assists the development and formulation of strategies which capitalise on the strengths, weaknesses, opportunities and threats illustrated by the analysis (Dyson, 2004).

According to Pickton and Wright (1998), "...as a framework, SWOT analysis is highly commended for its simplicity and value in focusing attention on key issues which affect business development and growth".

7.3 Applying a SWOT to Analyse a Health Care Service

The application of a SWOT analysis is not limited to profit-seeking corporations and enterprises seeking to find a new venture or gain a larger market share. A SWOT analysis may be used in any decision-making process where a desired objective is defined. For example, the improvement of Western Cape public health care telemedicine services maturity level.

Within the context of the study, the SWOT analysis technique is used to identify possible factors within the Western Cape public health care telemedicine service industry which are perceived to positively and negatively affect the maturity of these services. Based on the analysis of the TMSMM micro-, meso- and macro-level services, presented in Sections 5.4.4 and 5.4.5, the maturity distribution across the domains is noticeably unbalanced.

The purpose of the SWOT assessment is to determine which elements of the telemedicine services are considered strengths (positive factors) and which are perceived to be weaknesses (negative factors). Most importantly, the aim is to exploit the resulting insight and improve the status of telemedicine services in the Western Cape public health care sector.

The SWOT analysis relies on the four elements (strengths, weakness, opportunities and threats). It is conducted by interpreting the information attained in the preceding chapters and identifying the strengths, weaknesses, opportunities and threats. The respective SWOT categories as defined for the assessment of telemedicine services are listed below.

Strengths: The characteristics which positively influence the maturity status of telemedicine services.

Weaknesses: The elements which negatively affect the maturity status of telemedicine services implemented in the public health care sector.

Opportunities: Capability areas which could be exploited to advance Western Cape telemedicine services to higher maturity.

Threats: Elements in the health care environment which could be of disadvantage to the progress of telemedicine services.

The first two elements (strengths and weaknesses) refer to the internal factors of telemedicine services, in other words the processes which compose the micro-level of the assessed telemedicine services.

The external factors, referred to by the latter two elements (opportunities and

threats) of the acronym, which affect the telemedicine services implemented in the public health care sector of the Western Cape are obtained by interpreting the capability areas of the meso- and macro-level.

7.4 Western Cape Telemedicine Service SWOT Analysis

The aim of the SWOT analysis is to identify negative and positive factors which affect the internal elements of the telemedicine services implemented in the Western Cape public health care sector.

To establish a proper SWOT analysis, an objective for the analysed services needs to be defined.

The visual review of the internal telemedicine services maturity data illustrated in Figure 5.4.5 indicates a high variance in maturity across the various domains and services types of the Western Cape telemedicine services.

The objective of the implementation of the telemedicine services is to balance the maturity across the five domains and services types and to establish a level playing field. It is strongly argued that once the current below average telemedicine services domains have reached a maturity level of 2.5, is it worthwhile to invest further time and money in improving telemedicine services in the Western Cape.

The process of identifying the perceived strengths and weaknesses of the telemedicine services implemented in the Western Cape public health care sector was assisted by employing the following methodology.

The capability areas representing the micro-level elements of telemedicine services, implemented in the Western Cape public health care sector, illustrated in Table 5.4.5 are split into two groups (cells, marked in light and dark blue) by means of the average micro-level maturity (2.4). The capability areas located above the average are the strengths of the telemedicine services (see Table 7.4.1). The telemedicine services elements which fall below the average micro-level maturity are considered to be weaknesses (see Table 7.4.2).

A similar methodology was implemented to separate the external telemedicine services elements, represented by the capability areas of the meso-level and macro-level listed in Table 5.4.6. Contrary to splitting the meso- and macro-level telemedicine elements according to their respective averages, the capability areas are split based on the average maturity of the micro-level (2.4) telemedicine processes.

Table 7.4.1: Western Cape Public Health Care Sector Telemedicine Services STRENGTHS

#	Technical Definition	Colloquial Definition	Reference
1	The analyse, diagnose and react process has well defined, performance controlled work procedures, which guide the execution of the service.	The analysis and diagnostic processes conducted by a physician or specialist within the context of a telemedicine service is defined and controlled by health care policies and procedures. Similarly the process of reacting to an analysis or diagnosis is guided by standard health care policies.	Section 5.4.4.2 and Figure 5.4.7
2	The operational costs of the analyse, diagnose, react and capture processes are a reporting item of the health care facility accounting system.	The labour costs regarding the analysis or diagnosis of a medical case, as well as the cost of capturing medical data and reacting to an analysis or diagnosis are covered by the individual hospital accounting structure.	Sections 5.4.4.2 and 5.4.4.3

The particular methodology for splitting the meso- and macro-level was implemented, because the primary focus of a SWOT analysis is the internal elements of the telemedicine services. The appropriate maturity margin used to separate the external elements should therefore be biased towards the micro-level.

The opportunities are the elements of the meso- and macro-level which achieved a maturity rating above that of the average micro-level maturity (2.4). The opposite applies to identifying the respective external threats which the telemedicine services are facing.

The SWOT analysis concludes that the majority of the telemedicine services elements listed in Tables 5.4.5 and 5.4.6 are internal weaknesses and external threats which the telemedicine services of the Western Cape face. Table 7.4.6 summarises the strengths, weaknesses, opportunities and threats identified during the analysis.

The following section will utilise the information obtained from the SWOT analysis to aid in the formulation of recommendations which will support the improvement of the overall telemedicine services maturity of telemedicine services implemented in the Western Cape.

Table 7.4.2: Western Cape Public Health Care Sector Telemedicine Services WEAKNESSES

#	Technical Definition	Colloquial Definition	Reference
1	Their is a lack of financial sustainability with regard to the transmission of data process and operational costs are only covered on a short term basis.	The cost of transmitting medical information via a network service provider (i.e.MTN, Telkom) is not accommodated by the accounting system of the health care facility. The transmission costs are covered by the telemedicine services user personally.	Section 5.4.4.1 and Figure 5.4.6
2	The capture and transmit data processes lack standardised work policies and defined service level agreements respectively.	The telemedicine process involved in acquiring electronic medical information is not defined or governed by adequate health care guidelines. Likewise the electronic transmission of medical information is not supported by well defined service level agreements with the service provider.	Sections 5.4.4.3 and 5.4.4.1
3	The utilisation of an effective, reliable and available, but immature telemedicine devices such as mobile phone which is lacking appropriate standardisation.	The most commonly utilised telemedicine device (mobile phone) is effective, reliable and available, but is utilised in a non-official capacity and thus is not specifically designed for the purpose of administering telemedicine services.	Section 5.4.4.4 and 6.3.2
4	Medical data is created consistently and not lost during transmission, but lacks standardisation ensuring the quality and safety of the material.	Although risk of losing electronic medical information during transmission is considerably low, the security and quality of the information transmitted is not enforced standard transmission protocols.	Section 6.3.4
5	The average health care professional is willing to execute the services but is reluctant to use the service due to the absence of the appropriate health care policies.	The average Western Cape health care worker acknowledges the benefits of telemedicine services but is resistant to utilise the service, due to the absence of appropriate health care procedures and policies incorporating telemedicine services into the health care system.	Section 5.4.4.5 and 6.3.3

Table 7.4.3: Western Cape Public Health Care Sector Telemedicine Services OPPORTUNITIES

#	Technical Definition	Colloquial Definition	References
1	The Western Cape community of health care professionals uses telemedicine services.	The entire health care community of the Western Cape appreciates the benefits of telemedicine services and utilises telemedicine services.	Section 5.4.5.1 and Figure 5.4.6

7.5 Recommendations to Improve the Status of Western Cape Public Health Care Telemedicine Services

The purpose of the study is to assess telemedicine services implemented in the public health care sector of the Western Cape. Full filling the purpose produced a fully validated insight regarding the elements of telemedicine services which affect the success or failure of telemedicine services (see Chapters 5 and 6).

The secondary phase of the study is to translate the telemedicine services insight and formulate a set of recommendations aimed at a specific audience of decision- and policy-makers within the Western Cape Government DoH.

The information and data contained in the Chapters 5 and 6 provides insight at an engineering level, with regards to the telemedicine services implemented in the Western Cape public health care sector. Individuals (i.e. policy-makers) and institutions (i.e. Department of Health) which are in a position to implement change in the telemedicine services industry of the Western Cape, require the telemedicine services information obtained to be translated into a set of recommendations.

This is where the SWOT analysis (Section 7.3) was used to assess the micro-, meso- and macro-level telemedicine services capability elements in terms of the positive (strengths and opportunities) and negative (weaknesses and threats) influences which affect the overall maturity of the Western Cape telemedicine services. A summary of the SWOT analysis is presented in Table 7.4.6, in which the strengths, weaknesses, opportunities and threats of Western Cape public health care sector telemedicine services are listed. An initial observation of Table 7.4.6 indicates an imbalance between the positive (3) and negative (14) elements of the SWOT analysis coinciding with the low average maturity identified in analysis.

Table 7.4.4: Western Cape Public Health Care Sector Telemedicine Services THREATS

#	Technical Definition	Colloquial Definition	Reference
1	Although the physical infrastructure is mostly appropriate and available, it is not specifically set up for telemedicine services.	The distribution of telemedicine capable devices within the health care facilities is apt and the availability is acceptable, but no devices are specifically provided for the purpose of telemedicine.	Section 5.4.5.1 and Figure 5.4.6
2	Electronic medical records (EMRs) are only temporarily stored while the telemedicine service is in progress and not integrated with the Hospital Information System (HIS).	A patient's electronic medical information, generated during a telemedicine procedure, is only stored for the duration of the procedure. The information is not stored in a central health care database over a prolonged time period.	Section 5.4.5.1 and Figure 5.4.6
3	The institutional business model relies to heavily on donor and seed funds, leading too a lack of sustainability.	The dependency of telemedicine services on seed and donor funding, results in a unsustainable business model for telemedicine services.	Section 5.4.5.1 and Figure 5.4.6
4	Change management processes are driven by self-appointed entrepreneurs, lacking institutionalisation.	The integration and promotion of telemedicine services is currently driven by self-appointed individuals. This should be governed by an individual who is permanently appointed for this purpose.	Section 5.4.5.1 and Figure 5.4.6
5	The national technology infrastructure is dependent on the manual interaction between the telemedicine sub-systems.	The lack of a nationwide technological infrastructure, connecting the various telemedicine services, results in a manual or non-existent interaction between the different systems.	Section 5.4.5.2 and Figure 5.4.6

Continued in Table 7.4.5

Table 7.4.5: Western Cape Public Health Care Sector Telemedicine Services THREATS cont.

6	Society is unaware of the existence of telemedicine services and no effort is made to improve awareness.	The general population of the Western Cape is informed or made aware of the existence of telemedicine services which can improve the provision and quality of health care.	Section 5.4.5.2 and Figure 5.4.6
7	The absence or partial existence of a Electronic Health Record (EHR).	There exists no electronic database which enables the long term storage of digitalised patient information.	Section 5.4.5.2 and Figure 5.4.6
8	There is an absence of provincial and national health care policies incorporating telemedicine services.	On the provincial and national level, the telemedicine sector is not governed by health care policies which enable the basic application of telemedicine services.	Section 5.4.5.2 and Figure 5.4.6
9	The national business case does not consider provincial ICT funding structures.	Telemedicine services are not considered or accommodated in the national health care budget.	Section 5.4.5.2 and Figure 5.4.6

Table 7.4.6: SWOT Summary

Strengths	2
Weaknesses	5
Opportunities	1
Threats	9

The most basic and important factor which needs to be kept in mind during the process of formulating recommendations, is to exploit the strengths and opportunities and utilise knowledge regarding the weaknesses and threats listed in Tables 7.4.1, 7.4.2, 7.4.3 and 7.4.4 to the advantage of the Western Cape telemedicine services. The formulation of the Western Cape telemedicine services improvement recommendations is split into sections, internal (micro-level) and external (meso- and macro-level) telemedicine services recommendations.

7.5.1 Western Cape Telemedicine Services: Internal Improvement Recommendations

The recommendations formulated in the following section of Chapter 7 focus on exploiting the strengths and eliminating and converting the weaknesses of the Western Cape telemedicine services internal processes and domains into strengths.

According to Table 7.4.1, the strengths of the Western Cape telemedicine services are limited to health care policies, work procedures and financial structures governing the analysis, diagnosis and administration of health care processes. The strengths of the implemented telemedicine services are therefore related to health and work policies, as well as operational cost structures.

Keeping the strengths in mind, the five weaknesses of the Western Cape telemedicine services (Table 7.4.2) revolve around three common elements: (i) the lack of financial sustainability; (ii) an absence of standardisation; and (iii) a scarcity of work procedures. These observations seem to contradict each other, as a strength cannot at the same time be a weakness. However on further inspection, it becomes clear that only certain strengths and weaknesses refer to specific internal telemedicine service processes.

The strengths and weakness identified by means of the SWOT analysis resemble commonalities. It was therefore possible to assign each strength and weakness to one of the three core categories, namely Telemedicine Service Policies, Operational Cost Structures and Standardisation.

7.5.2 Telemedicine Service Policies

Throughout the analysis of the TMSMM assessment data, the methodology employed to provide health care by means of telemedicine is a recurring point of interest. This point is identified as both a positive and as a negative factor which influences the maturity of telemedicine service, implemented in the

public health care sector of the Western Cape. The SWOT analysis highlights the health care policies and work procedures utilised in conjunction with telemedicine services, or in certain cases the lack thereof, as both the primary strength and weakness of the Western Cape telemedicine services.

According to the TMSMM assessment and SWOT analysis, the methodology governing the telemedicine services of the Western Cape is arguably the primary and most influential factor affecting the success or failure of these telemedicine services. These noticeable influence (see Section 5.4.2) of the methodology on the telemedicine users, the devices utilised to perform telemedicine services, the type and quality of medical information utilised and most importantly the operational costs structures implemented.

The the following conclusion can therefore be drawn, to improve the current poor status of telemedicine service implemented in the Western Cape public health care sector. Focus needs to shift towards establishing of health care policies, work protocols and procedures which govern and incorporate the provision of health care via telemedicine services in the current public health care system.

The MRC Telemedicine Workstation provides the required confirmation that the appropriate methodology does indeed effectively influence the operational cost structures and standardisation of the telemedicine device, but does not affect the willingness of the user to implement the service.

The outcomes of the study recommended the primary focus of decision- and policy-makers employed by the Western Cape Government DoH, to be directed at establishing health care policies and work procedures which govern the use of telemedicine services in the public health care sector. Special attention should be given to the use of mobile device orientated telemedicine services.

7.5.3 Operational Cost Structures

The preceding section indicates the extensive influence telemedicine services policies have on the maturity of Western Cape telemedicine services. The operational cost structures financing telemedicine services, are strongly linked to the methodology employed to provide the same services. As with the previously discussed work procedures and health care policies, the operational cost structures of the Western Cape telemedicine services are both a weakness and strength. Depending on the internal telemedicine process.

The positive relationship between the telemedicine methodologies and operational cost structures of telemedicine services supports the recommendation formulated in Section 7.5.2. The incorporation of telemedicine services in the

standard health policies of public health care facilities will automatically result in more sustainable implementation of telemedicine services.

7.5.4 Standardisation

Similar to the lack of sustainability resulting in immature telemedicine service being implemented in the Western Cape public health care sector, the lack of standardisation is a result of poor telemedicine services policies.

It is argued that the standardisation of telemedicine services procedures and devices is hindered due to the lack of appropriate work procedures which govern the provision of telemedicine services in the Western Cape. The results of the TMSMM analysis confirm these suspicion. Mobile phones which are utilised by the majority of the Western Cape telemedicine services, are considered less mature telemedicine devices because they have not been developed or designed specifically for the purpose of administering telemedicine services. On the other hand, a service such as the MRC Telemedicine Workstation, which is regulated by proper work procedures and policies, utilises standardised devices and procedures, but is minimally utilised in practice.

Standardisation of telemedicine devices implemented in the Western Cape is a two prong issue: (i) Telemedicine services primarily executed in the public health care sector of the Western Cape are unofficial service utilising sub-standard devices and work procedures and (ii) official telemedicine services regulated by the appropriate policies and administered by means of standardised devices are less frequently utilised.

The observations mentioned above conclude that telemedicine service standardisation is dependent on the policies governing the public health care sector, more specifically telemedicine services. However, a highly standardised telemedicine service does not necessarily guarantee the success of the telemedicine service. The recommendation is to acknowledge the superior use of mobile technology in the health care industry and incorporate mobile devices and the telemedicine services in the health care policies and procedures.

7.5.5 Western Cape Telemedicine Services: External Improvement Recommendations

The SWOT analysis principally focuses on the internal elements of the Western Cape telemedicine services, but also takes into account external factors. More specifically these external factors are represented by the meso- and macro-levels, in other words the general health care society and Provincial/National governing bodies respectively.

Due to the fact that the TMSMM assessment, analysis and SWOT analysis of the Western Cape telemedicine services is primarily concerned with the assessment of the telemedicine services at the point of care, the external environmental factors affecting the success or failure of telemedicine services are brief.

Based on Table 7.4.3, the only element of the external telemedicine services which provides an opportunity for the Western Cape telemedicine services, is the fact that the health care professional community utilises telemedicine services. The use of telemedicine services by health care professional community is a considerable advantage, considering that the majority (69.6 percent) of the telemedicine services administered in the Western Cape are unofficial and mobile devices orientated.

The support of the health care community is the sole opportunity according to the SWOT analysis conducted in Section 7.3. Table 7.4.4 on the other hand lists a total of 9 external elements which threaten the success of telemedicine services implemented in the Western Cape. The threats illustrated in Table 7.4.4 includes elements such as: absence of appropriate ICT infrastructures; lack of telemedicine awareness; lack of financial sustainability; the absence of national policies incorporating telemedicine services in the South African health care system and many more. The common denominator of all these threats is methodology.

Methodology, refers to the health care Policies, Procedures and Protocols (3P) which are put in place to regulate and control the health care system, in terms of telemedicine services on a national, provincial and district level. The reason for such a high number of threats is that there are no policies, protocols or procedures which govern the provision of telemedicine on a national or provincial level. There are, however, national strategies, for instance the eHealth Strategy of South Africa, which aim to facilitate the establishment of the much needed 3P. The primary issue is that the eHealth Strategy aims to regulate eHealth, of which telemedicine is merely one of many facets. The needs particular to telemedicine services are therefore overlooked.

The concluding recommendation is as follows. For telemedicine services to succeed in providing quality health care to the South African population, national and provincial strategies need to be formulated which focus on the specific needs and requirements of telemedicine services.

7.6 Confirmation of Use

The recommendations provided in the previous section are directed at an audience of decision- and policy-makers situated within the DoH of the Western Cape Provincial Government. The study is addressed to a larger group of people due to fact that the individuals or institutions within the Western Cape DoH which have the authority and ability to utilise the recommendations provided have not yet been identified.

To confirm that the advice contained in the set of recommendations presented in Sections 7.5.1 and 7.5.5 previously are of value and use to the intended readers, the set of recommendations was reviewed by a high ranking official of the Western Cape DoH to confirm the usefulness information contained. The outcome of the interview was that although the information presented provides the Western Cape DoH with an in-depth and detailed insight into the telemedicine service, implemented in the Western Cape, recommended improvements to the practical implementation remains questionable. The primary reason why the implementation of the previously presented recommendations is questionable, is because the individuals within the Western Cape DoH with the appropriate authority to execute the recommended changes are unknown and need to be identified.

7.7 Chapter Conclusion

Chapters 5 and 6 fulfil the primary purpose of the study, namely (i) the assessment and analysis of telemedicine services implemented in the public health care sector of the Western Cape; (ii) establishing an insight with regard to the elements which influence the success or failure of telemedicine services; and (iii) providing validation of the information obtained from the TMSMM analysis represents Western Cape telemedicine services.

The purpose of the this Chapter is to utilise the Western Cape telemedicine services insight attained in Chapters 5 and 6, and devise a set of recommendations which enable the Western Cape DoH to improve the current status of telemedicine services implemented in the public health care sector.

It could therefore be concluded by means of a SWOT analysis in which the strengths, weaknesses, opportunities and threats to the success of the Western Cape telemedicine services are considered. The positive (strengths and opportunities) and negative (weaknesses and threats) elements were interpreted and enabled the formulation of internal and external telemedicine service recommendations.

The summary conclusion of the SWOT analysis and the interpretation of the telemedicine services implemented in the Western Cape public health care sector are primarily failing due to a lack or absence of the 3P, which regulate the technology, users, financial structures, medical material and methods employed by telemedicine services on district, provincial and national level.

Chapter 8

Conclusion

In this study: (i) the TeleMedicine Services Maturity Model (TMSMM) was utilised to assess telemedicine services implemented in the Western Cape public health care sector; (ii) the elements of a telemedicine services which affect the success or failure of these services were established; and (iii) the strengths, weaknesses, opportunities and threats (SWOT) analysis was utilised as the point of departure for a Strategic Telemedicine Services Framework.

This conclusion provides a reflection on the methodologies implemented and utilised to solve the research problem (Section 1.2.2) and fulfil the research purpose (Section 1.2.3). The chapter also presents a summary of the study conclusion, along with suggestions of possible future projects.

Reflection

Which research methodologies were used during the course of the study?
What has been done?

Taking Stock

What has been established by this study? What are the outcomes of the study?

Future Work

What possibilities of future projects have emerged during the research progress?

8.1 Reflection

The initial first world problem which led to the execution of the study was the lack of insight pertaining to telemedicine services implemented in the public health care sector of the Western Cape, and the elements which affect the success or failure of such services.

The purpose of the study was to assess telemedicine services implemented in the Western Cape public health care sector. The purpose was also to provide recommendations for the improvement of current and future telemedicine services implemented in the Western Cape.

The methodologies and tools utilised to resolve the stated problem and fulfil the research purpose, by identifying the strengths and weaknesses of telemedicine services, are reflected upon in this section.

The research overview depicted in Figure 8.1.1 illustrates the methodologies employed to conduct the study. The state of the art review pertains to the methodologies and includes the review of the: (i) South African health care system (Chapter 2); (ii) telemedicine landscape in South Africa (Chapter 3); and (iii) the TMSMM (Chapter 4). The review provides the required background information to establish the context within which the study was conducted.

The review indicated that, South Africa is not only facing many burdens in form of disease, but it also lacks human resources. South Africa is therefore struggling to administer quality medical care to a large rural population characterized by an economical imbalance. The state of the art review also established that telemedicine services could benefit the current health care status of South Africa, despite these services being prone to failure. The audit pertaining to the TMSMM depicts the literary state of the art review and therefore completes the research phases 1,2, and 3. Furthermore, the review resolves the respective research questions defined in Table 1.3.1.

The telemedicine services data gathering process, or Extract, Transform and Load (ETL) process, incorporated the TMSMM as part of the transformation and loading phases. The analysis of the TMSMM assessment data provided an in-depth insight into the elements which affect the success or failure of telemedicine services. Throughout the study it was clear that the methodologies (protocols, procedures and policies) employed to regulate and govern telemedicine services constituted the primary element to the success or failure of telemedicine services.

The insight obtained by means of the analysis conducted in Chapter 5 was based on telemedicine service data extracted from a sample of 26 telemedicine

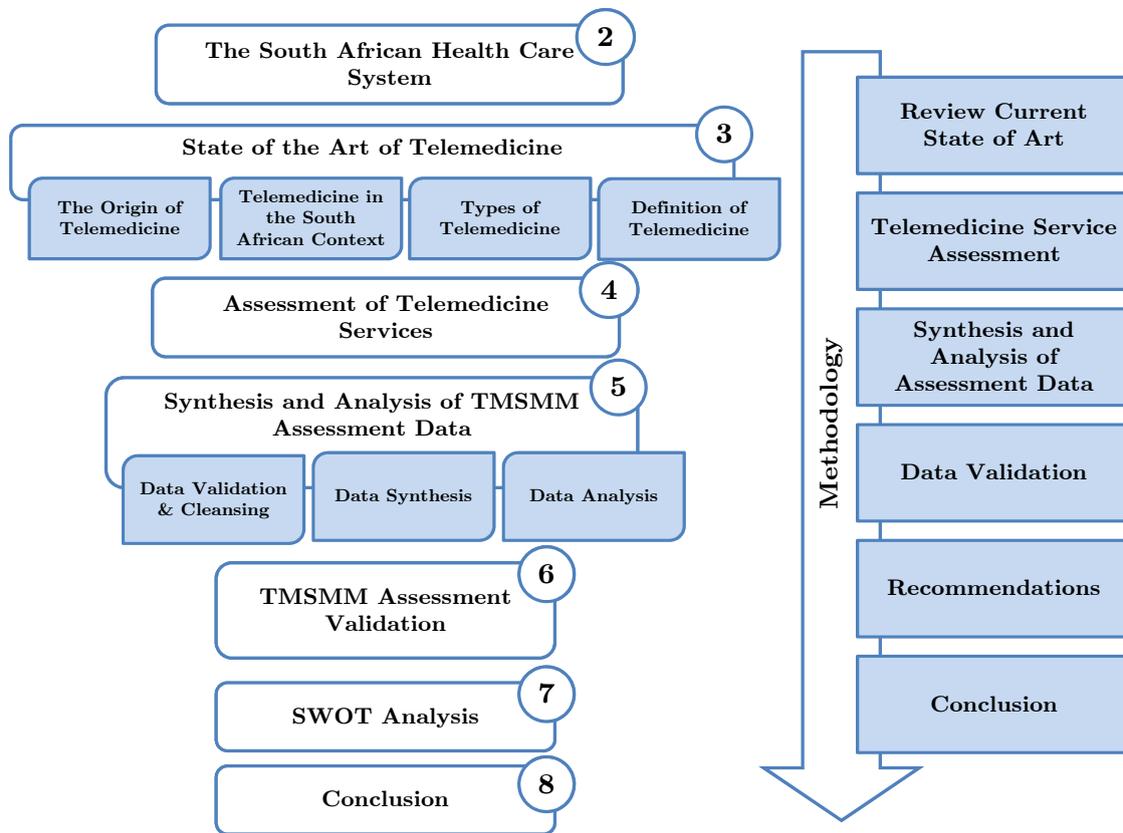


Figure 8.1.1: Research Overview and Methodology

services. A questionnaire was thus constructed and distributed amongst medical practitioners in the Western Cape. This confirms the validity of the analysis, with respect to the entire Western Cape telemedicine services.

The execution of the validation procedure (Chapter 6) resolved the research questions regarding research phase 3. It also partially fulfils the purpose of the study, which was the assessment of the Western Cape public health care telemedicine services.

Chapter 7 utilised the SWOT analysis and identified the strengths, weaknesses, opportunities and threats of the Western Cape telemedicine services. This analysis was conducted based on the insight gained from the preceding TMSMM assessment and analyses. The research questions defined in research phase 6 were therefore addressed. Based on the outcomes of the SWOT analysis, a set of internal and external (provincial, national) telemedicine service recommendations were formulated for an intended audience of policy- and decision-makers. The purpose of the study, which was to generate a set of rec-

ommendations for the facilitation of the improvement of telemedicine services implemented in the Western Cape.

The SWOT analysis also substantiates the assumptions initially stated in the conclusion to the TMSMM assessment analysis. The success or failure of telemedicine services implemented in the Western Cape public health care sector is principally dependent on the methodologies (policies, protocols and procedures) regulating and governing these services.

In conclusion, it can thus be stated that the success or failure of telemedicine services implemented in the Western Cape public health care sector is primarily dependent on the telemedicine service policies, protocols and procedures at the point of care at a district, provincial and national level. Improving the status of telemedicine services in the Western Cape relies on the implementation of health care Policies, Procedures and Protocols (3P) telemedicine services, and utilises the insight contained in the Western Cape telemedicine services body of knowledge.

8.2 Future Work

Due to primarily logistical and time considerations, the scope of the study was restricted to public health care telemedicine services, implemented in of the Western Cape. Thus future work could include the expansion of the research scope to include: (i) a larger volume of health care facilities in the Western Cape; (ii) telemedicine services implemented in the private health care sector; (iii) telemedicine services implemented in other provinces; (iv) identify the individuals and institutions within the Western Cape Government Department of Health (DoH) which are in a position to implement changes to telemedicine in the Western Cape; and (v) and construct a telemedicine services strategic framework which provides a strategy to improve the maturity status of telemedicine services implemented in the Western Cape public health care sector.

8.3 Taking Stock

The lack of information about the circumstances which affect the success or failure of telemedicine services implemented in the public health care sector of South Africa has provoked the execution of the study presented in this document. The aim of this study was to assess the telemedicine services implemented in the public health care sector and to gain a detailed and in-depth insight into the internal elements of telemedicine services implemented in rural public health care facilities. In addition, the aim was to establish which of

these elements influenced the success or failure of telemedicine services. This information was then intended to be utilised to exploit the elements which are known to promote success and mitigate or improve the elements which have a negative affect on telemedicine services.

By taking stock of what has been accomplished by this study, it can be stated that the issues of a lack of information on telemedicine services implemented in the Western Cape, has been resolved. During the study it was proven that the utilisation of the TMSMM as part of a ETL process enables the collection and assessment of telemedicine services data. This telemedicine services data pertains to the lower level capability areas of the services, as well as the higher levels of the telemedicine services hierarchy. The analysis of the telemedicine services data provides the reader with an detailed insight and understanding of the circumstances which influence the success or failure of telemedicine services. The formulation of a set of recommendations aimed at improving the current status of telemedicine services implemented in the public health care sector of the Western Cape, resolves the initial research problem by supplying decision- and policy-makers with the previously lacking insight.

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Appendix A

Ethical Clearance

A.1 Research Study Ethical Approval Notice



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Approval Notice New Application

23-Nov-2012
Van Dyk, Liezl L

Ethics Reference #: S12/11/277

Title: An investigation on the factors that influence the success rate of telemedicine services in the public health sector of South Africa.

Dear Mrs. Liezl Van Dyk,

The **New Application** received on **05-Nov-2012**, was reviewed by members of **Health Research Ethics Committee 1** via Expedited review procedures on **23-Nov-2012** and was approved.

Please note the following information about your approved research protocol:

Protocol Approval Period: **23-Nov-2012 -23-Nov-2013**

Please remember to use your **protocol number (S12/11/277)** on any documents or correspondence with the HREC concerning your research protocol.

Please note that the HREC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

After Ethical Review:

Please note a template of the progress report is obtainable on www.sun.ac.za/rds and should be submitted to the Committee before the year has expired. The Committee will then consider the continuation of the project for a further year (if necessary). Annually a number of projects may be selected randomly for an external audit.

Translation of the consent document to the language applicable to the study participants should be submitted.

Federal Wide Assurance Number: 00001372
Institutional Review Board (IRB) Number: IRB0005239

The Health Research Ethics Committee complies with the SA National Health Act No.61 2003 as it pertains to health research and the United States Code of Federal Regulations Title 45 Part 46. This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki, the South African Medical Research Council Guidelines as well as the Guidelines for Ethical Research: Principles Structures and Processes 2004 (Department of Health).

Provincial and City of Cape Town Approval

Please note that for research at a primary or secondary healthcare facility permission must still be obtained from the relevant authorities (Western Cape Department of Health and/or City Health) to conduct the research as stated in the protocol. Contact persons are Ms Claudette Abrahams at Western Cape Department of Health (healthres@pgwc.gov.za Tel: +27 21 483 9907) and Dr Helene Visser at City Health (Helene.Visser@capetown.gov.za Tel: +27 21 400 3981). Research that will be conducted at any tertiary academic institution requires approval from the relevant hospital manager. Ethics approval is required BEFORE approval can be obtained from these health authorities.

We wish you the best as you conduct your research.
For standard HREC forms and documents please visit: www.sun.ac.za/rds

If you have any questions or need further assistance, please contact the HREC office at 0219389657.

Included Documents:

Consent Form
Synopsis
Application Form
Checklist
Investigators declaration
Protocol

Sincerely,

Franklin Weber

A.2 Questionnaire Ethical Approval Notice



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Ethics Letter

16-Jul-2013

Ethics Reference #: S12/11/277

Title: An investigation on the factors that influence the success rate of telemedicine services in the public health sector of South Africa.

Dear Mrs. Liezl Van Dyk,

Your letter dated 29 May 2013 refers.

The Chairperson of the Health Research Ethics Committee approved the amended documentation in accordance with the authority given to him by the Committee.

The following amendments were approved:

1. Survey to access mobile device usage of health care applications.

It is recommended that the following short paragraph could be inserted to the beginning of the survey: "Completion of this survey implies that you have given consent to be enrolled into this study."

If you have any queries or need further help, please contact the REC Office 0219389207.

Sincerely,

REC Coordinator
Mertrude Davids
Health Research Ethics Committee 2

A.3 Blank TeleMedicine Services Maturity Model (TMSMM) Assessment Informed Consent Form

PARTICIPANT INFORMATION LEAFLET AND CONSENT FORM

TITLE OF THE RESEARCH PROJECT:

An investigation on the factors that influence the success rate of telemedicine services in the public health sector of South Africa

REFERENCE NUMBER:

PRINCIPAL INVESTIGATOR: Liezl van Dyk CONTACT NUMBER: 021 808 3733

ADDRESS:

Health Systems Engineering Research Group
Industrial Engineering Department
Stellenbosch University

You are being invited to take part in a research project. Please take some time to read the information presented here, which will explain the details of this project. Please ask the study staff or doctor any questions about any part of this project that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research entails and how you could be involved. Also, your participation is **entirely voluntary** and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part.

This study has been approved by the **Health Research Ethics Committee at Stellenbosch University** and will be conducted according to the ethical guidelines and principles of the international Declaration of Helsinki, South African Guidelines for Good Clinical Practice and the Medical Research Council (MRC) Ethical Guidelines for Research.

What is Telemedicine?

If the word *telemedicine* is considered semantically, telemedicine can be defined as the delivery of healthcare services (*medicine*) where distance is an issue (*tele*). The ability to deliver telemedicine services is mainly accredited to the advances and use of information and communication technology (ICT).

Most of the time telemedicine services are being applied without the service being specifically mentioned. Take for example (1) the picture archiving and communication system (PACS) used by radiographers. PACS is used to store X-Ray images on a central server accessible from different sites (hospital, clinic, general practitioner) and the different role players involved in the process. Nowadays prescriptions are sent via e-mail to the patient in need.

In 1998, the South African National Department of Health (DoH) published a telemedicine strategy in which they recognised the potential of telemedicine, to give previously isolated communities access to healthcare. Since then, many telemedicine services have been deployed in the public health sector of South Africa. Although it is not clear if these services are really working as intended and which factors influence the success of such services.

What is this research study all about?

- *The purpose of this study is to determine the factors that influence the success of telemedicine service (although they might not be known as such) deployment in the public health sector of South Africa.*

Why have you been invited to participate?

- *The hospital or clinic at which you are currently working was considered for this study due to the fact that this institution is part of a telemedicine services pilot study. Specifically the MRC-MTN telemedicine workstation. This study is not limited to the MRC-MTN workstation, the idea is to focus on any telemedicine services which can be identified.*
- *You were identified as someone who is in one way or another influenced by or participating in a telemedicine service.*

What procedure will be conducted in this research?

- *Two researchers from the University Stellenbosch will conduct a site visit at your hospital/clinic. It would be highly appreciated if you could spare 2½ hours of your time to take part in this structured workshop together with 2,3 or 4 of your colleagues. At this workshop the researchers will facilitate a session during which a number of telemedicine services will be identified, described and evaluated.*

Will results be communicated to you? How will your confidentiality be protected?

- *Within 5 working days after conclusion of the workshop, a confidential report will be sent to the participants (only the participants) of the workshop. In the case of a comment regarding the information in the report on your behalf, the information will be taken into account and considered during the overall analysis.*
- *After all the institutions in initially considered have been visited, a full report will be published in one or two academic journals regarding trends which may be of value to future telemedicine services. No information will be published which could be tracked back to individuals or individual hospitals, clinics or departments.*

What is the value of this study for me and my colleagues?

- *Firstly, the your participation in this study, along with the report which will be written up specifically for the hospital / clinic / department, will give you the chance to deliver insight regarding the factors which influence the use of telemedicine services.*
- *Secondly, the information gathered through this study can be useful to policymakers and project-managers in order to ensure the correct / effective use and implementation of new technology and existing telemedicine services.*

Declaration by participant

By signing below, I agree to take part in a research study entitled *(insert title of study)*.

I declare that:

- I have read or had read to me this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- I may be asked to leave the study before it has finished, if the study doctor or researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at *(place)* on *(date)* 2012.

.....
Signature of participant

.....
Signature of witness

Declaration by investigator

I *(name)* declare that:

- I explained the information in this document to
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use a interpreter. *(If a interpreter is used then the interpreter must sign the declaration below.*

Signed at *(place)* on *(date)* 2005.

.....
Signature of investigator

.....
Signature of witness

A.4 Signed TMSMM Assessment Informed Consent Forms

Will results be communicated to you? How will your confidentiality be protected?

- Within 5 working days after conclusion of the workshop, a confidential report will be sent to the participants (only the participants) of the workshop. In the case of a comment regarding the information in the report on your behalf, the information will be taken into account and considered during the overall analysis.
- After all the institutions in initially considered have been visited, a full report will be published in one or two academic journals regarding trends which may be of value to future telemedicine services. No information will be published which could be tracked back to individuals or individual hospitals, clinics or departments.

What is the value of this study for me and my colleagues?

- Firstly, the your participation in this study, along with the report which will be written up specifically for the hospital / clinic / department, will give you the chance to deliver insight regarding the factors which influence the use of telemedicine services.
- Secondly, the information gathered through this study can be useful to policymakers and project-managers in order to ensure the correct / effective use and implementation of new technology and existing telemedicine services.

Declaration by participant

By signing below, I RYAN MANTHEU agree to take part in a research study entitled (insert title of study).

I declare that:

- I have read or had read to me this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- I may be asked to leave the study before it has finished, if the study doctor or researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at (place) Roburke on (date) 19/04/2013

Signature of participant [Handwritten Signature]

Signature of witness [Handwritten Signature]

Declaration by investigator

I (name) A. Hartman declare that:

- I explained the information in this document to
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use a interpreter. (If a interpreter is used then the interpreter must sign the declaration below.

Signed at (place) Robertsen on (date) 19/04/2013

Signature of investigator [Handwritten Signature]

Signature of witness [Handwritten Signature]

Will results be communicated to you? How will your confidentiality be protected?

- Within 5 working days after conclusion of the workshop, a confidential report will be sent to the participants (only the participants) of the workshop. In the case of a comment regarding the information in the report on your behalf, the information will be taken into account and considered during the overall analysis.
- After all the institutions in initially considered have been visited, a full report will be published in one or two academic journals regarding trends which may be of value to future telemedicine services. No information will be published which could be tracked back to individuals or individual hospitals, clinics or departments.

What is the value of this study for me and my colleagues?

- Firstly, the your participation in this study, along with the report which will be written up specifically for the hospital / clinic / department, will give you the chance to deliver insight regarding the factors which influence the use of telemedicine services.
- Secondly, the information gathered through this study can be useful to policymakers and project-managers in order to ensure the correct / effective use and implementation of new technology and existing telemedicine services.

Declaration by participant

By signing below, I Sonia vd Spuy agree to take part in a research study entitled (insert title of study).

I declare that:

- I have read or had read to me this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- I may be asked to leave the study before it has finished, if the study doctor or researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at (place) Robertson on (date) 19-04-2013

Signature of participant [Signature]

Signature of witness [Signature]

Declaration by investigator

I (name) A. Hartmann declare that:

- I explained the information in this document to
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use a interpreter. (If a interpreter is used then the interpreter must sign the declaration below.

Signed at (place) Robertson on (date) 19/04/2013

Signature of investigator [Signature]

Signature of witness [Signature]

Will results be communicated to you? How will your confidentiality be protected?

- Within 5 working days after conclusion of the workshop, a confidential report will be sent to the participants (only the participants) of the workshop. In the case of a comment regarding the information in the report on your behalf, the information will be taken into account and considered during the overall analysis.
- After all the institutions in initially considered have been visited, a full report will be published in one or two academic journals regarding trends which may be of value to future telemedicine services. No information will be published which could be tracked back to individuals or individual hospitals, clinics or departments.

What is the value of this study for me and my colleagues?

- Firstly, your participation in this study, along with the report which will be written up specifically for the hospital / clinic / department, will give you the chance to deliver insight regarding the factors which influence the use of telemedicine services.
- Secondly, the information gathered through this study can be useful to policymakers and project-managers in order to ensure the correct / effective use and implementation of new technology and existing telemedicine services.

Declaration by participant

By signing below, I L. Baha agree to take part in a research study entitled (insert title of study).

I declare that:

- I have read or had read to me this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- I may be asked to leave the study before it has finished, if the study doctor or researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at (place) Robertson on (date) 19/04/13

[Signature]

Signature of participant

[Signature]

Signature of witness

Declaration by investigator

I (name) A. Hatman declare that:

- I explained the information in this document to
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use a interpreter. (If a interpreter is used then the interpreter must sign the declaration below.

Signed at (place) Robertson on (date) 19/04/2013

[Signature]

Signature of investigator

[Signature]

Signature of witness

Will results be communicated to you? How will your confidentiality be protected?

- Within 5 working days after conclusion of the workshop, a confidential report will be sent to the participants (only the participants) of the workshop. In the case of a comment regarding the information in the report on your behalf, the information will be taken into account and considered during the overall analysis.
- After all the institutions in initially considered have been visited, a full report will be published in one or two academic journals regarding trends which may be of value to future telemedicine services. No information will be published which could be tracked back to individuals or individual hospitals, clinics or departments.

What is the value of this study for me and my colleagues?

- Firstly, the your participation in this study, along with the report which will be written up specifically for the hospital / clinic / department, will give you the chance to deliver insight regarding the factors which influence the use of telemedicine services.
- Secondly, the information gathered through this study can be useful to policymakers and project-managers in order to ensure the correct / effective use and implementation of new technology and existing telemedicine services.

Declaration by participant

By signing below, I K. Brinkman agree to take part in a research study entitled (insert title of study).

I declare that:

- I have read or had read to me this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- I may be asked to leave the study before it has finished, if the study doctor or researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at (place) Robertson on (date) 19/04/2017.

K. Brinkman
Signature of participant

[Signature]
Signature of witness

Declaration by investigator

I (name) A. Hartmann declare that:

- I explained the information in this document to
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use a interpreter. (If a interpreter is used then the interpreter must sign the declaration below.

Signed at (place) Robertson on (date) 19/04/2017

[Signature]
Signature of investigator

[Signature]
Signature of witness

Will results be communicated to you? How will your confidentiality be protected?

- Within 5 working days after conclusion of the workshop, a confidential report will be sent to the participants (only the participants) of the workshop. In the case of a comment regarding the information in the report on your behalf, the information will be taken into account and considered during the overall analysis.
- After all the institutions in initially considered have been visited, a full report will be published in one or two academic journals regarding trends which may be of value to future telemedicine services. No information will be published which could be tracked back to individuals or individual hospitals, clinics or departments.

What is the value of this study for me and my colleagues?

- Firstly, the your participation in this study, along with the report which will be written up specifically for the hospital / clinic / department, will give you the chance to deliver insight regarding the factors which influence the use of telemedicine services.
- Secondly, the information gathered through this study can be useful to policymakers and project-managers in order to ensure the correct / effective use and implementation of new technology and existing telemedicine services.

Declaration by participant

By signing below, I Andreas Homball agree to take part in a research study entitled (insert title of study).

I declare that:

- I have read or had read to me this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- I may be asked to leave the study before it has finished, if the study doctor or researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at (place) Robertson on (date) 19/04/2013
.....
Signature of participant **Signature of witness**

Declaration by investigator

I (name) A. Hartmann declare that:

- I explained the information in this document to
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use a interpreter. (If a interpreter is used then the interpreter must sign the declaration below.

Signed at (place) Robertson on (date) 19/04/2013
.....
Signature of investigator **Signature of witness**

Will results be communicated to you? How will your confidentiality be protected?

- Within 5 working days after conclusion of the workshop, a confidential report will be sent to the participants (only the participants) of the workshop. In the case of a comment regarding the information in the report on your behalf, the information will be taken into account and considered during the overall analysis.
- After all the institutions in initially considered have been visited, a full report will be published in one or two academic journals regarding trends which may be of value to future telemedicine services. No information will be published which could be tracked back to individuals or individual hospitals, clinics or departments.

What is the value of this study for me and my colleagues?

- Firstly, your participation in this study, along with the report which will be written up specifically for the hospital / clinic / department, will give you the chance to deliver insight regarding the factors which influence the use of telemedicine services.
- Secondly, the information gathered through this study can be useful to policymakers and project-managers in order to ensure the correct / effective use and implementation of new technology and existing telemedicine services.

Declaration by participant

By signing below, I Francisca de Wet Dowling agree to take part in a research study entitled (insert title of study).

I declare that:

- I have read or had read to me this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- I may be asked to leave the study before it has finished, if the study doctor or researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at (place) Robertson on (date) 2013/04/19

Francisca de Wet Dowling
Signature of participant

[Signature]
Signature of witness

Declaration by investigator

I (name) A. Hartmann declare that:

- I explained the information in this document to
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use a interpreter. (If a interpreter is used then the interpreter must sign the declaration below.

Signed at (place) Robertson on (date) 19/04/2013

[Signature]
Signature of investigator

.....
Signature of witness

Will results be communicated to you? How will your confidentiality be protected?

- > Within 5 working days after conclusion of the workshop, a confidential report will be sent to the participants (only the participants) of the workshop. In the case of a comment regarding the information in the report on your behalf, the information will be taken into account and considered during the overall analysis.
- > After all the institutions in initially considered have been visited, a full report will be published in one or two academic journals regarding trends which may be of value to future telemedicine services. No information will be published which could be tracked back to individuals or individual hospitals, clinics or departments.

What is the value of this study for me and my colleagues?

- > Firstly, the your participation in this study, along with the report which will be written up specifically for the hospital / clinic / department, will give you the chance to deliver insight regarding the factors which influence the use of telemedicine services.
- > Secondly, the information gathered through this study can be useful to policymakers and project-managers in order to ensure the correct / effective use and implementation of new technology and existing telemedicine services.

Declaration by participant

By signing below, I Dr. S. Perdd agree to take part in a research study entitled (insert title of study).

I declare that:

- I have read or had read to me this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- I may be asked to leave the study before it has finished, if the study doctor or researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at (place) Hermanus on (date) 04/04/13 ~~2012~~


Signature of participant


Signature of witness

Declaration by investigator

I (name) A. Hartmann declare that:

- I explained the information in this document to Dr. S. Perdd
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use a interpreter. (If a interpreter is used then the interpreter must sign the declaration below.

Signed at (place) Hermanus on (date) 04/04/13 ~~2005~~


Signature of investigator


Signature of witness

Will results be communicated to you? How will your confidentiality be protected?

- Within 5 working days after conclusion of the workshop, a confidential report will be sent to the participants (only the participants) of the workshop. In the case of a comment regarding the information in the report on your behalf, the information will be taken into account and considered during the overall analysis.
- After all the institutions in initially considered have been visited, a full report will be published in one or two academic journals regarding trends which may be of value to future telemedicine services. No information will be published which could be tracked back to individuals or individual hospitals, clinics or departments.

What is the value of this study for me and my colleagues?

- Firstly, the your participation in this study, along with the report which will be written up specifically for the hospital / clinic / department, will give you the chance to deliver insight regarding the factors which influence the use of telemedicine services.
- Secondly, the information gathered through this study can be useful to policymakers and project-managers in order to ensure the correct / effective use and implementation of new technology and existing telemedicine services.

Declaration by participant

By signing below, I agree to take part in a research study entitled (insert title of study).

I declare that:

- I have read or had read to me this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- I may be asked to leave the study before it has finished, if the study doctor or researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at (place) Ceres on (date) 28/05/13


.....
Signature of participant

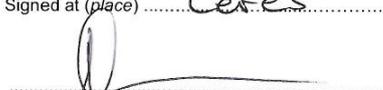
.....
Signature of witness

Declaration by investigator

I (name) declare that:

- I explained the information in this document to
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use a interpreter. (If a interpreter is used then the interpreter must sign the declaration below.

Signed at (place) Ceres on (date) 28/05/13


.....
Signature of investigator

.....
Signature of witness

Will results be communicated to you? How will your confidentiality be protected?

- Within 5 working days after conclusion of the workshop, a confidential report will be sent to the participants (only the participants) of the workshop. In the case of a comment regarding the information in the report on your behalf, the information will be taken into account and considered during the overall analysis.
- After all the institutions in initially considered have been visited, a full report will be published in one or two academic journals regarding trends which may be of value to future telemedicine services. No information will be published which could be tracked back to individuals or individual hospitals, clinics or departments.

What is the value of this study for me and my colleagues?

- Firstly, the your participation in this study, along with the report which will be written up specifically for the hospital / clinic / department, will give you the chance to deliver insight regarding the factors which influence the use of telemedicine services.
- Secondly, the information gathered through this study can be useful to policymakers and project-managers in order to ensure the correct / effective use and implementation of new technology and existing telemedicine services.

Declaration by participant

By signing below, I Dr. A. Hess agree to take part in a research study entitled (insert title of study).

I declare that:

- I have read or had read to me this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- I may be asked to leave the study before it has finished, if the study doctor or researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at (place) Caledon on (date) 28/05/13

Signature of participant

Signature of witness

Declaration by investigator

I (name) A. Hartman declare that:

- I explained the information in this document to
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use a interpreter. (If a interpreter is used then the interpreter must sign the declaration below.

Signed at (place) Caledon on (date) 28/05/13

Signature of investigator

Signature of witness

A.5 Blank Result Validation Informed Consent Forms

PARTICIPANT INFORMATION LEAFLET AND CONSENT FORM

TITLE OF THE RESEARCH PROJECT:

An Assessment of the Telemedicine Services within the Western Cape Public Health Care System

PRINCIPAL INVESTIGATOR: André

CONTACT NUMBER: 073 681 4894

ADDRESS:

Health Systems Engineering Research Group
Industrial Engineering Department
Stellenbosch University

You are being invited to take part in a research project. Please take some time to read the information presented here, which will explain the details of this project. Please ask the study staff or doctor any questions about any part of this project that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research entails and how you could be involved. Also, your participation is **entirely voluntary** and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part.

This study has been approved by the **Health Research Ethics Committee at Stellenbosch University** and will be conducted according to the ethical guidelines and principles of the international Declaration of Helsinki, South African Guidelines for Good Clinical Practice and the Medical Research Council (MRC) Ethical Guidelines for Research.

What is this research study all about?

- *The purpose of this study is to determine the factors which influence the success of telemedicine service (although they might not be known as such) deployment in the public health sector of the Western Cape.*
- *And utilising the body of knowledge obtained to provide recommendations on how to improve the overall status of telemedicine services implemented in the Western Cape public health sector.*

Why have you been invited to participate?

- *The institution which you represent was considered for the validation of the study due to the fact that the scope of the study focuses on the public health sector of the Western Cape.*
- *You were identified as someone who is in one way or another influenced by or participating in a telemedicine service.*

What procedure will be conducted in this research?

- *The researcher from the University of Stellenbosch will discuss the results of the study and conduct structured interview.*

How will your confidentiality be protected?

- *After the study has been validated and concluded, a full report will be published in one or two academic journals regarding trends which may be of value to future telemedicine services. No information will be published which could be tracked back to individuals or individual hospitals, clinics or departments.*

What is the value of this study for me and my colleagues?

- *Your participation in this study will give you the chance to deliver insight regarding the improvement recommendations pertaining to the improvement of telemedicine services suggested by the study. And provide insight to whether these recommendations are conceivable and of use to policy-makers.*
- *The information gathered through this study can be useful to policymakers and project-managers in order to ensure the correct / effective use and implementation of new technology and existing telemedicine services.*

A.6 Signed Result Validation Informed Consent Forms

Declaration by participant

By signing below, I Helène Rossouw agree to take part in a research study entitled, An Assessment of the Telemedicine Services within the Western Cape Public Health Care System.

I declare that:

- I have read or had read to me this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be penalised or prejudiced in any way.
- I may be asked to leave the study before it has finished, if the study doctor or researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at (place) Cape Town on (date) 21/11/2013.

Helène Rossouw
Signature of participant

[Signature]
Signature of witness

Declaration by investigator

I (name) André Hartmann declare that:

- I explained the information in this document to Helène Rossouw
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use a interpreter. (If a interpreter is used then the interpreter must sign the declaration below.

Signed at (place) Cape Town on 21/11/2013.

[Signature]
Signature of investigator

[Signature]
Signature of witness

Appendix B

Extraction, Transformation and Loading of Telemedicine Services Data

B.1 Extraction: Structured Interview

Western Cape Telemedicine Services Interview Methodology

André Hartmann
Department of Industrial Engineering,
University of Stellenbosch

March 2013

B.2 Extraction: Structured Interview

1 Methodology

Interview with Case Study participant (2 to 3 hours), subject to availability of the participant and pre-meeting arrangements.

1. Ask study participant for permission to record the entire session. The purpose of the recording is to archive the information exchanged during the interview, for use in the assessment report.

- Start the recording for the session.

2. Explain the reason of the interview and what the research is about to the study participant.

The purpose of the interview is to determine which official and non-official telemedicine services exist in the public health sector of the Western Cape - as well as which factors influence these services.

- Read through the Informed Consent Form and have it signed by the study participant.

3. Pre-assessment

- What is your experience with respect to telemedicine services?
- Which telemedicine services are you involved with, either as a participant or as developer? (Any telemedicine service - official or non-official, functional or non-functional)
- What is your role within this service?
- Are any standard frameworks or guidelines being used to help with the implementation, operationalisation and optimisation of the telemedicine service?

During this procedure functional and/or non-functional, official and/or non-official telemedicine services are identified and noted, to be evaluated during the Telemedicine Services Maturity Model (TMSMM) assessment.

B.3 Extraction: Structured Interview

4. Assessment

- Describe each previously identified telemedicine service with the help of the TMSMM tool.
 - (a) Identify the processes which take place within the telemedicine service.
 - (b) Complete the description of the five domains (man, machine, material, method and money) for each process.
- Assess the maturity level of each instance of the service, aided by the use of the predefined capability statements.

5. Post-assessment

- What is the study participants view on the current telemedicine services environment in South Africa, specifically the Western Cape.
- Which improvements could be made to strengthen telemedicine services in the Western Cape, South Africa?
- Compile a data flow diagram (DFD) for each of the telemedicine services identified and evaluated.
- Align both the TMSMM and DFD, so that both coincide.
- Generate an assessment report, for the study participant. The assessment report includes a description of each of the telemedicine services identified and evaluate. Along with the DFD and TMSMM maturity dashboard for these services. And finally the assessment conclusion.

Appendix C

Telemedicine Services Maturity Model

C.1 Man Domain Capability Statements

telemedicine device/ mobile phone ect.		Micro-level processes		infra-structure		Meso-level processes		Macro-level processes	
		Capture, Diagnose/ Analyze, React processes	Data Transmission processes			physical infrastructure	national technology infrastructure		
Level 0	nothing	nothing	telemedicine device/ mobile phone ect. internet service, mobile phone network etc.	Level 0	no	none	does not exist.	does not exist.	
Level 1	experiment	is used on ad hoc/ experimental basis.	is assumed to be available.	Level 1	initial	insufficient	is neither appropriate nor available.	manual interface between subsystems	
Level 2	prototype/ pilot	is used on experimental basis and the safety thereof is established.	is confirmed to be available.	Level 2	repeatable	appropriate	is either not appropriate or not available.	manual interface between subsystems	
Level 3	standards and inter-operability	is effective and available, but still undergoes frequent modifications.	transmits data effectively.	Level 3	defined	standard	is appropriate and mostly available.	technical interoperability	
Level 4	monitored	is effective, reliable and available	transmits data effectivity and an acceptable speed.	Level 4	quantitatively managed	maintained	is appropriate and always available.	technical interoperability	
Level 5	maintenace and upgrades	is the defined as standard.	capacity (bandwidth) was considered in the design of the service.	Level 5	optimizing	continuous improvement	is set up specifically for this service and is always available.	limited human interaction	
		conforms to the interoperability standards.	's interoperability is considered in the system's standards design.				is set up specifically for this service according to defined design standards.	limited human interaction	
		's availability is monitored.	's reliability and availability can be measured.				's availability is monitored.	automatic monitoring	
		'availability, reliability and maintainability are monitored.	's reliability and availability are monitored.				'availability, reliability and maintainability are monitored.	automatic monitoring	
		's corrective maintenance is executed effectively and timely.	: Deviations from acceptable levels of availability and reliability is continuously addressed.				is continuously maintained and upgraded whenever needed.	continuous improvement	
		's preventative maintenance and upgrades is executed effectively and timely.	's capability, reliability and availability is continuously improved.				is scalable (can easily be expanded to accommodate more instances of this service).	continuous improvement	

C.2 Machine Domain Capability Statements

telemedicine device/ mobile phone ect.		Micro-level processes		infra-structure		Meso-level processes		Macro-level processes	
		Capture, Diagnose/ Analyze, React processes	Data Transmission processes internet service, mobile phone network etc.			physical infrastructure	national technology infrastructure		
Level 0	nothing	does not exist.	does not exist.	no	none	does not exist.	does not exist.		
Level 1	experiment	is used on ad hoc/ experimental basis.	is assumed to be available.	initial	insufficient	is neither appropriate nor available.	manual interface between subsystems		
Level 2	prototype/ pilot	is used on experimental basis and the safety thereof is established.	is confirmed to be available.	Level 1		is either not appropriate or not available.	manual interface between subsystems		
Level 3	standards and inter-operability	is effective and available, but still undergoes frequent modifications.	transmits data effectively.	Level 2	appropriate	is appropriate and mostly available.	technical interoperability		
Level 4	monitored	is effective, reliable and available	transmits data effectivity and an acceptable speed.	Level 3	standard	is appropriate and always available.	technical interoperability		
Level 5	maintenance and upgrades	is the defined as standard.	capacity (bandwidth) was considered in the design of the service.	Level 4	maintained	is set up specifically for this service and is always available.	limited human interaction		
Level 5	optimizing	conforms to the interoperability standards.	's interoperability is considered in the system's standards design.	Level 5	optimizing	is set up specifically for this service according to defined design standards.	limited human interaction		
Level 5	optimizing	's availability is monitored.	's reliability and availability can be measured.	Level 5	continuous improvement	's availability is monitored.	automatic monitoring		
Level 5	optimizing	'availability, reliability and maintainability are monitored.	's reliability and availability are monitored.	Level 5	continuous improvement	'availability, reliability and maintainability are monitored.	automatic monitoring		
Level 5	optimizing	's corrective maintenance is executed effectively and timely.	: Deviations from acceptable levels of availability and reliability is continuously addressed.	Level 5	continuous improvement	is continuously maintained and upgraded whenever needed.	continuous improvement		
Level 5	optimizing	's preventative maintenance and upgrades is executed effectively and timely.	's capability, reliability and availability is continuously improved.	Level 5	continuous improvement	is scalable (can easily be expanded to accommodate more instances of this service).	continuous improvement		

C.3 Material Domain Capability Statements

data/ images/ video ect.		Micro-level processes		record management	Meso-level processes		Macro-level processes	
		Capture, Diagnose/ Analyze, React processes	Data Transmission processes		electronic medical record (EMR)	electronic health record (EHR)		
Level 0	no data	do not exist.	data/ images/ video ect.	Level 0	no records	does not exist.	does not exist.	
Level 1	uncertain quality	are of varying and most often unacceptable quality.	sometimes get lost.	Level 1	limited	only exists on paper.	only exists on paper.	
Level 2	consistent quality	are of varying but most often acceptable quality.	can possible be viewed by an unauthorized person.	Level 2	repeatable	is kept and stored by user while telemedicine process is in progress.	is partially available on a/ some system(s).	
Level 3	quality standards	are created consistently.	does not get lost.	Level 3	integrated	is kept on telemedicine device.	of telemedicine service is centrally accessible to all insitutions involved in service.	
Level 4	quality control	are created consistently at an acceptable physical quality.	are transmitted securely.	Level 4	managed	is kept with databasis specific to telemedicine service.	of telemedicine service is centrally accessible to all insitutions involved in service.	
Level 5	quality improvement	's physical quality standards are defined within context of this service.	are transmitted according to a standard transmissions protocol.	Level 5	business optimization	is linked with hospital information system (HIS).	of telemedicine service is centrally accessible to all insitutions involved..	
Level 4	quantatively managed	's physical quality / clinical effectiveness are defined.	are encrypted and decrypted according to a standard transmissions protocol.	Level 4	business optimization	is integrated with hospital information system.	: telemedicine service data is seamlessly added to EHR.	
Level 5	quantatively managed	's physical quality are measured as part of the standard process.	can be tracked throughout the telemedicine service.	Level 5	business optimization	: Aggregated reports can be generated.	: Aggregated reports can be generated.	
Level 5	quantatively managed	's physical quality effectiveness measures are effectively reported.	and identities of persons who viewed and edited it, can be tracked.	Level 5	business optimization	: Aggregated reports are routinely analyzed.	: Aggregated reports are routinely analyzed.	
Level 5	quantatively managed	: Causes for unacceptable quality are continuously identified.	: Causes for delays and incorrectly transmitted data are identified.	Level 5	business optimization	: Ad hoc management decisions related to telemedicine services are based on this information.	: Ad hoc management decisions related to telemedicine services are based on this information.	
Level 5	quantatively managed	: Causes for unacceptable are continuously and effectively addressed.	: Causes for delays and incorrectly transmitted EHRs are continuously addressed.	Level 5	business optimization	: Continuous management decisions related to telemedicine services are based on this information.	: Continuous management decisions related to telemedicine services are based on this information.	

C.5 Money Domain Capability Statements

operational costs		Micro-level processes				business models			Meso-level processes		Macro-level processes	
		Capture, Diagnose/ Analyze, React processes	Data Transmission processes	operational costs	cost of transmission service							
Level 0	no	is not available yet/anytime	is not available yet/anytime	no	no m	is not available yet/anytime	is not available yet/anytime	national business case	is not available yet/anytime			
Level 1	initial	are not considered by developers/ entrepreneur.	are not considered by developers/ entrepreneur.	initial	research and development	are considered and covered by seed funds whilst service is in development phase.	are considered and covered by seed funds whilst service is in development phase.		:only research and development			
Level 2	repeatable	will be covered on short term by seed funds.	will be covered on short term by seed funds.	Level 2	seed funding	will be covered on long term by seed funds.	will be covered on long term by seed funds.		:only pilots			
Level 3	consistent and permanent	are included partially as a standard budget item.	are included partially as a standard budget item.	Level 3	defined	are included fully as a standard budget item.	are included fully as a standard budget item.		:pockets of organized funding.		:national ICT and telecommunications funding structures are in place.	
Level 4	account-ability	are a reporting item of the accounting system.	are a reporting item of the accounting system.	Level 4	quantitatively managed	's reports are routinely scrutinized to ensure optimal use of funds.	's reports are routinely scrutinized to ensure optimal use of funds.		:nationally organized funding		: processes for the reimbursement of telemedicine services are in place.	
Level 5	cost optimization	Non-value adding activities are continuously identified.	Non-value adding activities are continuously identified.	Level 5	optimizing	are routinely scrutinized to ensure optimal use of funds.	are routinely scrutinized to ensure optimal use of funds.		: The health economic impact of the service are measured.		: Health economics metrics are used as decision input to health systems strengthening.	
	optimizing	Non-value adding activities are continuously eliminated.	Non-value adding activities are continuously eliminated.		value				: The service has a significant impact on the socio-economic well-being of the nation.		: The impact of the service on the socio-economic well-being of the nation is continuously expanded.	

Appendix D

Telemedicine Services Maturity Model Additional Information

D.1 TMSMM Data Consistency and Uniformity Tables

D.1.1 Man Domain Consistency and Uniformity

Table D.1.1: Definition and Grouping of Man Domain Descriptors

Man Domain	
Health Care Administrator	Plans, organises, directs, controls and coordinates medical programs and clinical services in a hospital or health service facility.
Medical Officer	Registered medical practitioner employed by a hospital who does not practice at specialist or consultant level.
Nurse	Supports, cares for and treats a health care user to attain, maintain, or recover optimal health and quality of life.
Radiographer	Take x-rays and apply radioactive substances or ultrasound to patients for diagnostic and therapeutic purposes. Working at the request of a qualified physician or specialist (Radiologist)
Radiologist	Medical physician specialising in diagnosing and treating diseases and injuries using medical imaging techniques.
Specialist Physician	Physician practising medicine at a referral or specialist hospital (tier 2 or 3). Physician who further their medical education in a specific speciality of medicine.

D.1.2 Machine Domain Consistency and Uniformity

Table D.1.2: Definition and Grouping of Machine Domain Descriptors

Machine Domain	
Fax Machine	Device with capability to send & receive pictures & text via a land-line connection.
Mobile Phone	Communication device with built-in digital voice services, internet access, short message services (SMS), multimedia messaging services (MMS), instant messaging (IM), e-mail, web browsing, still & video camera.
Telemedicine Workstation	Workstation supplied by Donor [MRC] as a complete telemedicine service package, including touch-screen PC, video conferencing capabilities, internet connectivity (3G) and a scanner.
Workstation [e-mail]	Basic computer set-up enabling the user to access patient medical data via e-mail.
Workstation [PACS]	Basic computer set-up enabling the user to access patient medical data via PACS software/server.
Workstation [scanner]	Basic computer set-up enabling the user to capture patient medical data via scanner.
X-Ray/Ultrasound	X-ray and/or Ultrasound device generating paper-based (hard-copy) outputs.
X-Ray/Ultrasound [digital]	X-ray and/or Ultrasound device generating digital outputs.

D.1.3 Material Domain Consistency and Uniformity

Table D.1.3: Definition and Grouping of Material Domain Descriptors

Material Domain	
Patient medical data	Information regarding the patients medical condition.
Referral acknowledgement	Patient referral confirmed based on medical patient data.
Treatment recommendation	Analysis/Diagnosis of medical patient data and subsequent issue of treatment recommendation by Specialist/Medical Officer
CTG printout [digital image]	Digital image (taken via a mobile phone camera) of a CTG printout.
Dermatological disorder [digital image]	Digital image (taken via a mobile phone camera) of a skin, scalp, hair or nail related disease or disorder.
X-Ray/Ultrasound [digital image]	Digital image (taken via mobile phone camera) of a x-ray film or ultrasound printout.
X-Ray/Ultrasound [film/printout]	Traditional x-ray film or ultrasound printout.
ECG printout [digital image]	Digital image (taken via a mobile phone camera) of a ECG printout.
Patient/CTG data	Patient file - containing all the relevant medical data, including the CTG data.
Patient/ECG data	Patient file - containing all the relevant medical data, including the ECG data.
Patient/Dermatology data	Patient file - containing all the relevant medical data, including the dermatology data.
Patient/Radiology data	Patient file - containing all the relevant medical data, including the radiology data.

D.1.4 Method Domain Consistency and Uniformity

Table D.1.4: Definition and Grouping of Method Domain Descriptors

Method Domain	
Mobile phone service protocol	Technical standard for data transmission via mobile phone.
Own discretion	The ability or power of the user to decide responsibly, judge on one's own.
PACS protocol	Technical standard for data transmission via PACS.
Standard referral protocol	Procedure followed upon the referral of a patient between health care facilities.
Internet service provider protocol	Technical standard for data transmission via the internet.
Standard medical protocol	Systematically developed statements to assist physician decisions about appropriate health care for specific clinical circumstances
Standard radiography protocol	Systematically developed statements to assist the radiography decision making process.
Land-line service protocol	Technical standard for data transmission via the land-line.

D.1.5 Money Domain Consistency and Uniformity

Table D.1.5: Definition and Grouping of Money Domain Descriptors

Money Domain	
DoH (employing institution)	The service is financed by the institution employing the user of the service. (Department of Health)
Donor Funding	The funding of the service is secured by an donor.
Medical Officer	Medical Officer covers the cost of the service personally.
Nurse	Nurse covers the cost of the service personally.
Specialist Physician	Specialist Physician covers the cost of the service personally.

D.2 Micro-Level Telemedicine Services Maturity Raw Data

Table D.2.1: TMSMM analyse process maturity ratings

Process description	Machine	Man	Material	Method	Money
Administrator analyses the patient medical data for referral	2.5	0.5	1.5	3.0	4.0
Medical Officer/Specialist use personal mobile phone to analyse and suggest further treatment	2.0	3.0	1.0	4.5	4.0
Radiologist analyses the radiological case stored on internal server.	3.0	3.0	3.0	4.5	4.0
Radiologist uses departmental workstation at his/her disposal to analyse the patient record	3.5	2.5	2.5	4.5	3.5
Specialist analyses the CTG data and concludes treatment recommendation	1.0	2.5	1.0	4.5	4.0
Specialist analyses the image on mobile phone and concludes treatment recommendation	1.5	2.5	1.0	4.5	4.0
Specialist analyses the patient Electronic Health Record (EHR)	3.0	2.5	3.0	4.0	3.5
Specialist uses mobile phone to analyse the Cardiotocography (CTG) data	2.0	2.5	1.0	4.3	4.3
Specialist uses mobile phone to analyse the Electrocardiography (ECG) case	1.0	2.5	1.0	4.5	4.0
Grand Total	2.1	2.5	1.5	4.3	4.0

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Table D.2.2: TMSMM diagnose process maturity ratings

Process description	Machine	Man	Material	Method	Money
Make recommendation based on patient data transferred	2.5	2.5	2.0	4.5	4.0
Medical Officer (@ Caledon) diagnoses dermatological case	2.0	2.5	1.5	4.5	3.5
Radiologist analysis the radiological case and diagnosis	3.5	3.0	3.0	4.5	4.0
Specialist determines treatment recommendation / diagnosis.	3.0	3.0	3.0	4.5	3.5
Specialist diagnoses the condition via the digital image	2.0	2.5	2.0	4.0	4.0
Specialist diagnoses the data transmitted	2.0	3.0	1.0	4.5	4.0
Specialist diagnoses the electronic health record transmitted	2.0	2.5	2.0	4.5	4.0
Specialist diagnoses the medical case using mobile phone	2.0	1.0	2.0	4.0	3.5
Specialist diagnoses the medical case via mobile phone	2.0	2.0	2.0	4.0	3.5
Specialist diagnoses the medical case	3.0	2.5	3.0	4.0	3.5
Specialist diagnoses the medical data and recommends proper treatment	2.5	3.5	2.0	4.0	4.0
Specialist diagnoses the radiological data transmitted	2.0	2.5	2.0	4.0	4.0
Specialist diagnoses the radiological case and recommends appropriate treatment	3.5	2.5	2.5	4.5	4.0
Specialist diagnosis and recommends treatment based on the patient data transmitted	2.0	3.5	2.0	4.0	4.0
Specialist makes use of personal mobile phone to perform diagnosis	2.0	2.5	1.0	4.0	4.0
Specialist makes use of workstation to perform diagnosis	3.5	2.5	2.0	4.0	4.0
Specialist receives patient data and is enabled to make a diagnoses based on data at hand	3.5	2.5	1.0	4.0	4.0
Specialist transmits treatment recommendation data via mobile phone	2.0	2.5	1.0	4.0	4.0
Specialist uses dept. workstation to diagnose the orthopaedic case data transmitted	3.0	2.5	2.5	4.0	3.5
Specialist uses his/her personal mobile phone to diagnose the orthopaedic case data transmitted	2.0	2.0	2.5	4.0	3.5
Specialist uses the medical information transmitted to diagnose and recommend treatment method	2.5	2.5	2.0	4.0	3.5

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Table D.2.3: TMSMM react process maturity ratings

Process description	Machine	Man	Material	Method	Money
Medical Officer administers the recommended specialist treatment.	3.5	1.0	3.0	4.0	3.5
Medical Officer administers treatment	2.0	2.5	2.3	4.3	4.3
Medical Officer administers treatment.	2.0	3.0	2.5	4.0	3.5
Medical Officer pulls the Specialist diagnosis and administers the recommended treatment.	3.0	1.5	2.5	4.5	4.0
Medical Officer pulls the treatment recommendation and administers treatment	2.0	2.5	2.0	4.0	3.5
Medical Officer pulls the treatment recommendation / diagnosis, and administers treatment.	2.5	2.0	2.5	4.0	4.0
Medical Officer pulls the treatment recommendation /diagnosis and administers treatment.	2.5	2.0	3.5	4.0	4.0
Medical Officer reacts to referral acknowledgement	2.0	1.5	1.0	3.0	4.0
Medical Officer reacts to the treatment recommendation	2.0	2.5	2.5	4.5	4.0
Medical Officer reacts to treatment recommendation	2.0	2.5	2.0	4.0	4.0
Medical Officer reacts to treatment recommendation sent via mobile phone	2.0	2.0	2.0	4.0	4.0
Medical Officer reacts to treatment recommendation.	2.0	2.5	2.0	4.5	4.0
Medical Officer retrieves the data using a mobile phone and reacts accordingly	2.0	2.5	3.0	4.0	4.0
Medical Officer uses mobile phone to pull the Specialist diagnosis and treatment recommendation.	2.0	1.5	2.0	3.5	4.0
Medical Officer uses mobile phone to retrieve treatment recommendation	2.0	2.5	2.0	4.5	4.0
Medical reacts to treatment recommendation sent via mobile phone	2.0	2.5	2.0	4.0	4.0
Medical uses the treatment recommendation/diagnoses transmitted to treat patient	2.0	2.0	3.0	4.5	4.0
MO pulls the treatment recommendation via mobile phone to administer required treatment.	2.0	2.0	2.0	4.0	3.5
MO pulls treatment recommendation and administers the treatment	2.0	2.0	1.5	4.0	3.5
Mobile Nurse pulls treatment recommendation and administers treatment.	2.0	2.5	2.5	4.5	3.5
Mobile Nurse reacts to feedback	2.0	2.0	2.5	4.5	4.0
Nurse or Medical Officer pull the recommendation and administer treatment	2.0	2.0	2.0	4.0	3.5
Nurse pulls the treatment recommendation/diagnosis and administers treatment.	3.0	3.0	4.0	4.5	3.5
Uses personal mobile phone to pull treatment recommendation	2.0	2.5	2.0	4.5	4.0

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Table D.2.4: TMSMM capture process maturity ratings

Process description	Machine	Man	Material	Method	Money
Capture	2.3	2.1	1.8	1.8	3.8
Create a digital image of the dermatological condition with personal mobile phone.	2.0	1.0	2.0	1.0	3.5
Make a digital image copy of the paper based x-ray	2.0	2.5	2.0	1.0	4.0
Medical Officer captures CTG printout via mobile phone camera	2.0	2.5	1.0	1.0	4.3
Medical officer captures CTG printout with mobile phone camera	1.0	2.5	1.0	1.0	4.0
Medical Officer collects patient medical data for referral	2.0	1.5	1.0	3.0	4.0
Medical Officer dermatological condition with digital camera	2.0	2.5	2.0	1.0	4.0
Medical Officer takes a digital image of the dermatological condition with personal phone.	2.0	1.0	2.0	1.5	4.0
Medical Officer uses a mobile phone to take a picture of a ECG printout	2.0	2.5	1.0	1.0	3.5
Medical Officer uses a personal mobile phone to capture a picture of CTG printout	2.0	2.5	1.0	1.0	4.0
Medical Officer uses a traditional x-ray machine to create a x-ray	4.5	4.0	4.5	4.5	4.0
Medical Officer uses mobile phone camera to capture digital image of x-ray	2.0	2.5	2.0	1.0	4.0
Medical Officer uses personal mobile phone to capture dermatological case	2.0	2.0	2.0	1.5	4.0
Medical Officer uses personal mobile phone to make an image of ECG printout	2.0	2.5	1.0	1.0	3.8
Medical Officer uses scanner to convert x-ray to digital format.	2.5	1.0	2.0	3.0	4.0
Medical officer uses personal mobile phone to capture digital image of ECG printout	2.0	2.5	1.0	1.0	4.0
Medical Officer captures patient medical data using the Telemedicine Workstation.	3.5	1.0	3.0	4.0	3.5
MO takes a digital image of CTG readout.	2.0	1.0	1.0	1.0	3.5
MO uses mobile phone to take a digital image of the ECG readout.	2.0	1.0	1.0	1.0	3.5
Mobile Nurse captures medical condition with personal mobile phone	1.0	2.0	1.0	1.0	4.0
Mobile Nurse takes a digital image of dermatological condition.	2.0	2.5	1.0	0.5	3.5
Radiographer captures patient data via x-ray or ultrasound.	4.0	2.5	4.0	4.0	3.5
Radiographer takes a traditional x-ray in a digital format.	4.0	3.0	3.5	4.5	4.0
Radiographer takes a x-ray/ultrasound in digital format.	3.0	3.0	3.0	3.5	3.5
Take a digital picture of x-ray from light-box.	2.0	1.0	1.0	1.0	3.5

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Table D.2.5: TMSMM transmit data process maturity ratings

Process description	Machine	Man	Material	Method	Money
Transmit Data	2.4	2.1	2.3	1.2	1.5
Administrator send feedback of referral acknowledgement	2.0	0.5	1.0	2.0	4.0
Call Specialist (Level 2) to request a recommendation and convey patient information.	2.0	1.0	1.5	0.5	0.5
Medical Officer makes use of e-mail to transmit the medical data to the Specialist.	3.0	1.0	3.5	2.0	4.0
Medical Officer transmits image to Specialist at Tier 2 hospital	2.5	2.0	3.0	1.0	0.5
Medical Officer pulls the specialist recommendation and administers treatment.	3.0	3.0	4.0	2.5	4.0
Medical Officer request a treatment recommendation via mobile phone	2.0	2.5	3.0	1.0	0.5
Medical Officer request consolation and sends the patient EHR to Specialist via e-mail.	3.5	1.0	3.5	1.5	3.5
Medical Officer sends image of traditional x-ray to Specialist via e-mail	2.0	1.0	3.5	0.5	0.5
Medical Officer sends image of traditional x-ray to Specialist via SMS/IM	2.0	1.0	1.5	0.5	0.5
Medical Officer sends patient data to Specialist via verbal communication.	2.0	1.0	2.0	0.5	0.5
Medical Officer sends the medical data to referral hospital	3.0	1.5	2.5	2.0	4.0
Medical Officer sends treatment recommendation via SMS/IM.	2.0	2.5	1.5	1.0	0.5
Medical Officer transmits radiography data via mobile phone	3.0	2.5	2.0	1.0	0.5
Medical Officer transmits the image to a Specialist via SMS/IM	2.0	2.5	2.0	1.0	0.5
Medical Officer transmits the image to Specialist via SMS/IM	2.3	2.5	1.5	0.8	0.5
Medical Officer transmits the digital image to Specialist	2.0	2.5	2.0	1.0	0.5
Medical Officer uses fax machine to transmit the x-ray copy	2.0	2.0	1.0	1.0	2.5
Medical Officer uses personal mobile phone to transmit (e-mail/SMS/IM) image of CTG printout	2.0	2.5	1.0	1.0	0.5
Medical Officer uses personal mobile phone to convey important patient information to Specialist	3.5	2.5	3.0	1.0	0.5
Medical Officer/Specialist send feedback, suggested treatment and further actions	2.0	2.0	2.5	0.5	0.5

Continues on the next page . . .

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Process description	Machine	Man	Material	Method	Money
Medical officer transmits the CTG data via mobile phone	2.0	2.5	1.0	0.5	0.5
Medical Officer uses the Telemedicine Workstation video conf. tech. to consult with Specialist.	3.0	1.0	3.5	1.5	3.5
MO sends digital image of CTG readout via SMS/IM.	2.0	1.0	1.5	0.5	0.5
MO verbally communicates patient medical data to specialist and request recommendation	2.0	1.0	1.5	0.5	0.5
Mobile Nurse request assistance from Medical Officer via mobile phone.	2.0	2.5	1.5	1.0	0.5
Mobile Nurse sends image to Specialist/Medical Officer via SMS/IM for diagnosis.	2.0	2.5	1.5	1.0	0.5
Mobile Nurse sends the medical data to Medical Officer/Specialist	1.5	2.0	1.0	0.5	0.5
Mobile phone is used to request a recommendation verbally.	2.0	1.0	3.5	0.5	0.5
Mobile phone is used to transmit digital image of ECG via MMS/IM.	2.0	1.0	1.5	0.5	0.5
Nurse or Medical Officer send the digital image of the dermatological condition to the Specialist via e-mail.	3.0	1.0	2.5	0.5	0.5
Nurse or Medical Officer send the digital image of the dermatological condition to the Specialist via SMS/IM.	2.0	1.0	1.5	0.5	0.5
Patient record (x-ray/ultrasound) is sent to Radiologist.	3.0	2.5	3.0	1.0	2.0
Radiographer stores the data on internal server.	3.5	3.0	4.0	2.0	3.0
Radiographer stores the x-ray/ultrasound (digital format) on an internal server (PACS).	3.0	2.5	3.5	3.0	3.5
Radiologist saves analysis of radiological case on the server.	3.0	3.0	3.5	3.0	3.5
Radiologist sends the analysis to a Radiological Specialist.	3.5	2.5	3.0	2.0	3.5
Radiologist stores the treatment recommendation / diagnosis on server.	3.5	3.0	3.5	3.0	3.0
Recommendation is transmitted to the requesting MO via SMS/IM.	2.0	2.0	1.5	1.0	0.5
Send digital photo via service provider	2.5	2.0	4.0	1.0	0.5
Send image of dermatological condition to Specialist.	2.0	1.0	2.0	1.0	0.5
Send patient data (Verbal Communication) via service provider	2.5	2.0	4.0	1.0	0.5
Send recommendation via service provider	3.0	1.5	3.0	1.0	0.5

Continues on the next page . . .

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Process description	Machine	Man	Material	Method	Money
Specialist send CTG data feedback	2.0	2.5	2.5	0.5	0.5
Specialist sends recommendation to Medical Officer/Nurse	2.5	2.3	1.5	1.0	2.0
Specialist sends the diagnoses and treatment recommendation to Medical Officer.	3.5	2.5	3.0	2.0	3.5
Specialist sends treatment recommendation / diagnosis to Medical Officer.	2.5	1.0	3.5	2.0	4.0
Specialist sends treatment recommendation via personal mobile phone	2.0	2.5	1.5	0.5	4.0
Specialist sends treatment recommendation via workstation	3.5	2.5	3.0	2.0	4.0
Specialist sends treatment recommendation via SMS/IM.	2.0	2.0	1.5	1.0	0.5
Specialist sends treatment recommendation to Medical Officer via e-mail.	3.0	2.5	3.5	1.0	3.5
Specialist sends treatment recommendation to Medical Officer via personal mobile phone.	2.0	2.0	1.5	1.0	0.5
Specialist stores treatment recommendation / diagnosis on server.	3.0	3.0	4.0	3.0	3.5
Specialist transmits treatment recommendation via PC (e-mail)	3.0	2.5	2.5	2.0	4.0
Specialist transmits treatment recommendation data via mobile phone	2.0	2.5	2.5	1.0	0.5
Specialist transmits diagnoses /treatment recommendation to Medical Officer	2.0	2.5	2.0	1.0	0.5
Specialist uses fax machine to transmit diagnoses and treatment recommendation	1.5	2.0	1.0	1.0	4.0
Specialist uses mobile phone to transmit diagnoses/treatment recommendation	3.0	2.5	2.0	1.0	0.5
Specialist uses mobile phone to transmit the treatment recommendation	2.0	2.8	1.8	1.0	0.8
Specialist uses personal mobile phone to send feedback to Medical Officer	2.0	2.5	1.5	0.8	0.5
Specialist uses personal mobile phone to transmit diagnosis and recommended treatment.	2.0	1.0	2.0	1.0	0.5
Specialist uses personal mobile phone to convey treatment recommendation	2.5	2.0	2.0	1.0	0.5
Transmit feedback to Medical officer	2.0	2.5	1.0	1.0	0.5
Transmit the CTG data to Specialist	2.0	2.5	1.8	1.0	0.8
Transmit the digital image via mobile services to Specialist	2.0	2.5	1.0	1.0	0.5

Appendix E

Questionnaire: Use of Mobile Devices in Health Care

11/14/13

Use of Mobile Devices in Health Care - Google Drive

Use of Mobile Devices in Health Care

At the moment there is a lack of research data regarding the use of mobile devices in the health care sector. The data collected by this survey will provide useful information regarding the use of mobile phones for health purposes in the public health care sector of the Western Cape.

Mobile devices such as cellphones or tablets are used within the health care community to access, communicate and/or transmit medical information. Examples range from calling a medical specialist for a second opinion, to capturing and transmitting medical information between mobile devices.

The survey consists of 4 pages and will take less than 6 min.

* Required

Demographics

1. What is the job title for your current position? *

Tick the option which closest represents your job title.

Mark only one oval.

- Medical Officer
- Medical Specialist
- Medical Student
- Nurses
- Administrative Staff
- Managerial Staff
- Intern
- Community Service Doctor

2. What is your gender? *

Mark only one oval.

- Female
- Male

3. What is your age? *

Mark only one oval.

- 18 to 24
- 25 to 34
- 35 to 44
- 45 to 54
- 55 to 64
- 65 to 74
- 75 to older

APPENDIX E. QUESTIONNAIRE: USE OF MOBILE DEVICES IN HEALTH CARE

11/14/13

Use of Mobile Devices in Health Care - Google Drive

4. What is the highest level of education you have completed? *

Mark only one oval.

- Matric
- Diploma
- Degree
- Masters
- Doctorate
- Other:

5. Number of years (health care sector) work experience? *

.....

6. What is the name of the Health Care Facility you are currently working at? *

.....

7. What type of Health Care Facility do you work at? *

Mark only one oval.

- Primary (District Hospital and/or CHC/Clinic)
- Secondary (Regional Hospital)
- Tertiary
- Other:

Mobile Devices in Health Care

Part 1

8. Which type of mobile device are you currently using? *

More than one option available.

Check all that apply.

- Basic mobile phone (voice & SMS only)
- Feature mobile phone (internet & camera capabilities)
- Smart phone (internet, camera & application capabilities)
- Tablet (internet, camera & application capabilities)
- Laptop

APPENDIX E. QUESTIONNAIRE: USE OF MOBILE DEVICES IN HEALTH CARE

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Use of Mobile Devices in Health Care - Google Drive

9. Which operating system does your mobile device use? *

Mark only one oval.

- Blackberry (Blackberry OS)
- Nokia (Symbia or Windows Mobile OS)
- iPhone (iOS)
- Samsung, HTC (Android OS)
- Other:

10. Which mobile service provider do you subscribe to? *

Mark only one oval.

- MTN
- Vodacom
- CellC
- 8ta
- Virgin Mobile
- Other:

11. How would you rate your mobile device signal coverage? *

Mark only one oval.

	1	2	3	4	5	
(No signal most of the time)	<input type="radio"/>	(Good signal, Always available)				

12. Do you use your mobile device for health care purposes at work? *

Mark only one oval.

- Yes (personal mobile device)
- Yes (company issue mobile device)
- No

13. Did you purchase your mobile device with the intention of using it in the health care sector? *

Mark only one oval.

- Yes
- No
- It never came to mind to use my mobile device for such a purpose, when I purchased it.

APPENDIX E. QUESTIONNAIRE: USE OF MOBILE DEVICES IN HEALTH CARE

11/14/13

Use of Mobile Devices in Health Care - Google Drive

14. **Do you use your mobile device to assist you in your work, by attaining information via the internet?**

Mark only one oval.

- Yes
 No

15. **Do you use any medical applications on your mobile device? ***

If YES, please specify the medical application which you use.

Mark only one oval.

- No
 Yes

16. If YES, please specify the medical application which you use.

.....

17. **Have you purchased any kind of medical application for your mobile device? ***

More than one option can be selected.

Check all that apply.

- Yes, but it was only freeware
 Yes, and I paid for it
 Yes, and I convinced (some of) my colleague(s) to do the same
 Yes, but I am not using it for work purposes
 Yes, and I am using it for work purposes
 No, but I would not mind doing so
 No, I do not know how to
 No, I will never download medical apps to my mobile device
 Other:

18. If YES, please specify the price of the application.

.....

19. **Do you use your mobile device to capture, document or transmit medical data? ***

Mark only one oval.

- Yes Skip to question 20.
 No Skip to question 25.

Mobile Devices in Health Care

Part 2

APPENDIX E. QUESTIONNAIRE: USE OF MOBILE DEVICES IN HEALTH CARE

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Use of Mobile Devices in Health Care - Google Drive

20. **How do you capture or document medical data with your mobile device? ***

More than one option can be selected.

Check all that apply.

- Digital camera
- Text (SMS based)
- Voice recording
- Other:

21. **How do you transmit/receive medical information/data via your mobile device? ***

More than one option can be selected.

Check all that apply.

- SMS
- MMS (Multimedia Messaging Service)
- IM (Instant Messaging Service i.e. Whatsap or Mixlt)
- E-mail
- WiFi
- Other:

22. **Do you consider transmitting/receiving medical information/data via mobile device.... ***

Mark only one oval.

- Highly secure
- Fairly secure
- Questionable
- Unsecure

23. **Medical information/data captured using the mobile device camera is.... ***

Mark only one oval.

	1	2	3	4	5	
(barley distinguishable)	<input type="radio"/>	(clearly identifiable/high detail)				

24. **Do you receive any reimbursement for the use of mobile devices to you in your work? ***

Mark only one oval.

- Yes, and it covers all my mobile device expenses
- Yes, and it covers most of my mobile device expenses
- Yes, but it barley covers my mobile device expenses
- No

Mobile Devices in Health Care

Part 3

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25. Which of the following factors would motivate you to use mobile devices for Health Care purposes? *

More than one option can be selected.

Check all that apply.

- If I get financial reimbursement for using it
- Better quality mobile devices
- If I get performance incentives for using it
- If I have a specifically designed mobile app
- If I get trained to use it
- I am curious about new technology
- It makes my job easier
- It contributes to better health care for patients
- All of my colleagues use it
- If x-ray images and lab results are accessible via the internet

26. Does the Health Care Facility you work at have a mobile device policy? *

Mark only one oval.

- Yes
- I do not know
- No

27. If YES, please describe in short the Health Care Facility's policy on mobile devices

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