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An assessment of the implementation of teleradiology in the Eastern Cape towards the enhanced utilisation of the system

Final Year Project Report

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Final year project presented in partial fulfilment of the requirements for the degree of Bachelors of Industrial Engineering at Stellenbosch University.

Study leader: Liezl van Dyk

December 2010

Declaration

I, the undersigned, hereby declare that the work contained in this final year project is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.

……………………….. ………………………

Charlotte Hauman Date

ECSA Exit level outcomes references

The following table include references to sections in this report where ECSA exit level outcomes are addressed.

Exit level outcome	Description	Section(s)	Page(s)
1. Problem solving	Problem Statement Methodology Comparing alternatives Analytic Hierarchy Process	Chapter 1 Section 2.3.2 Section 8.3 Section 7.4 Section 8.4	1-4 10 48-50 39-40 50-52
5. Engineering methods, skills & tools, incl. IT	Workflow analysis Engineering Economy Change Management Cause and Effect Analysis Innovation Management	Section 5.2 Section 8.3 Section 7.4 Section 6.3 Section 3.3 Chapter 3-7 Section 3.2	21 48-50 39-40 34 16 13-43 13-14
6. Professional & Technical communication	Entire document Interviews and emails Participation in SA Telemedicine Conference	Chapter 1-9 Chapter 4	 16-20
9. Independent learning ability	Entire Document Value to the student	 Section 9.2	 54-55
10. Engineering professionalism	Entire Document Future work	 Chapter 9	 53-56

Synopsis

Telemedicine is the use of communication and information technology (ICT) to enable the delivery of specialised health care services. In a developing country like South Africa where there is a shortage of medical specialists, telemedicine is an innovative tool that can contribute to the equitable distribution of resources such as specialist knowledge. The problem is that the past decade has seen numerous telemedicine initiatives being introduced in the country, with little sustainability and low utilisation rates. The initiatives being introduced need to be monitored and evaluated to ensure the sustained implementation and complete adoption of the telemedicine systems in the country.

This project focuses on a specific South African telemedicine initiative, the teleradiology system in the Eastern Cape province, with the purpose to provide an assessment of the implementation of the system and a framework towards the enhanced utilisation of the system. Literature is studied comprehensively to find a broad perspective on the factors involved when teleradiology is implemented. Four barriers to the sustained implementation of teleradiology are identified, namely technological, organisational, behavioural and economical barriers. These barriers are discussed with regard to the literature and then the broad perspective is narrowed by applying the literature to various aspects of the Eastern Cape system. This application follows a visit as part of a project team from the Medical Research Council of South Africa and the University of Stellenbosch in June 2010 to monitor and evaluate telemedicine in the Eastern Cape. Research was done using surveys, interviews and observations and valuable exposure to the system was obtained.

The four implementation barriers and examples of the Eastern Cape system are integrated into a discussion of the entire teleradiology system. The assessment of the system is concluded with an engineering view point of providing an alternative solution and the evaluation of alternatives. It is anticipated that the project will contribute to the available literature on the sustained implementation of teleradiology and telemedicine in a developing country such as South Africa and provide decision makers and managers of telemedicine in the Eastern Cape with an original view on the system and a framework towards the enhanced implementation of the teleradiology system.

Opsomming

Telegeneeskunde is die gebruik van inligtings- en kommunikasietegnologie om die eweredige verspreiding van gespesialiseerde gesondheidsdienste te bewerkstellig. In ‘n ontwikkelende land soos Suid-Afrika waar daar ‘n groot tekort aan mediese spesialiste is, is telegeneeskunde ‘n innoverende oplossing om die verspreiding van hulpbronne soos hierdie spesialis kennis te bevorder. Die probleem is dat daar verskeie projekte die afgelope dekade in die land geloods is, maar hierdie projekte is selde volhoubaar en het ‘n lae benuttings-graad. Projekte moet gemonitor en evalueer word om sodoende te verseker dat dit volhoubaar is en dat daar volkome aanneming van die stelsel in die verskeie organisasies is.

Hierdie projek fokus op ‘n spesifieke telegeneeskunde projek in Suid-Afrika, die teleradiologie stelsel in die provinsie van die Oos-Kaap . Die doel is om die implementering van hierdie stelsel te assesseer en ‘n raamwerk te verskaf wat ‘n bydrae sal lewer tot die verhoogte benutting van die stelsel. Die metodologie wat gevolg word is ‘n omvattende literatuurstudie wat ‘n breë perspektief bied op verskeie faktore wat ‘n invloed het op die implementering van ‘n teleradiologie stelsel. Die projek identifiseer vier hindernisse wat volhoubare implementering en aanneming van die stelsels keer, naamlik: tegnologiese, organisatoriese, gedrags- en ekonomiese hindernisse.

Hierdie hindernisse word deur middel van die literatuur bespreek, en daar word dan in meer diepte gekyk na die hindernisse deur dit toe te pas op die stelsel in die Oos-Kaap. Hierdie toepassing volg na ‘n besoek aan die Oos-Kaap in Junie 2010 saam met ‘n projekspan van die Mediese Navorsingsraad en die Universiteit van Stellenbosch met die doel om telegeneeskunde in die provinsie te monitor en te evalueer. Tydens hierdie besoek is navorsing gedoen deur middel van vraelyste, onderhoude en waarnemings en waardevolle blootstelling aan die stelsel en die hospitaal-opset is verkry.

Die vier implementerings versperrings en Oos-Kaap voorbeelde word dan geïntegreer deur ‘n bespreking van die hele teleradiologie stelsel. Die assessering van die stelsel word afgesluit deur ‘n ingenieurs uitgangspunt aan te neem as daar na verskillende oplossings gekyk word en dit evalueer word.

Die hoop is dat hierdie projek ‘n bydrae sal lewer tot die beskikbare literatuur aangaande die volhoubare implementering van teleradiologie en telegeneeskunde in ‘n ontwikkelende land soos Suid Afrika en dat dit aan die besluitnemers en bestuurders in telegeneeskunde in die Oos-Kaap ‘n oorspronklike perspektief op en ‘n raamwerk vir die verbeterde implementering van die teleradiologie stelsel sal verskaf.

Acknowledgements

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- My parents, sisters and friends for continued emotional support and guidance throughout the four years of study.
- My Creator and Savior, for four years of many answered prayers, the ability to study, His grace and countless blessings in my life. All the glory to Him!

I am able to do all things through Him who strengthens me.

Phil. 4:13

Table of Contents

LIST OF FIGURES

LIST OF TABLES

Glossary

Telemedicine (Eastern Cape)	The system of services that use communications networks to ensure the equitable distribution of healthcare to the rural areas of the Eastern Cape; to address a shortage of infrastructural, monetary and human resources
Teleradiology	The transmission of radiographic images from a remote hospital to a specialist for diagnosis
GDP	Gross Domestic Product
ICT	Information Communications Technology
MRC	Medical Research Council of South Africa
PACS	Picture Archiving and Communication System – The technology that enables digital transfer of radiographic images

1. Introduction

1.1 Background

South Africa is ranked as one of the top countries when viewing the percentage of GDP (Gross Domestic Product) that is allocated to Health Care (NationMaster, 2010). Yet health care in the country remains a great challenge, and the burden of disease is ever increasing along with the population growth. Health care faces many challenges such as poor management, over-population of hospitals and most importantly a shortage of health-care professionals.

Telemedicine, the use of technology to optimise the use of these professionals poses a possible solution to these challenges. At the recent South African Telemedicine conference, the Minister of Health, Dr. Aaron Motsoaledi posed the challenge that the effectiveness of health systems need to be strengthened (Motsoaledi, 2010). This challenge is taken on with this project. He further proposed that telemedicine is a developmental tool that can serve as a solution in the above-mentioned challenge and in bridging the gap between rural and urban sectors in South Africa.

This project aims to contribute to this solution by assessing the implementation of teleradiology in the Eastern Cape. The project undertaken by the student involves the implementation of telemedicine, but more specifically teleradiology in the Eastern Cape province; and an assessment of the reason for the low utilisation rates of the system. The project aims to provide a framework that can be used to enhance the utilisation rates of the system.

The formal title is as follows:

An assessment of the implementation of teleradiology in the Eastern Cape towards the enhanced utilisation of the system.

1.2 Problem Statement

In 1998 a National Telemedicine Task Team was formed with the task to implement a national telemedicine strategy in South Africa. Phase one of this strategic plan was implemented early in

2000, and 28 telemedicine sites were established in six of the nine provinces, including six hospitals in the Eastern Cape (Mars, 2008). However, these initiatives are in need of monitoring and evaluation; to determine whether they were successful, and if unsuccessful, what the reasons are for this.

This final year project commenced with the problem under consideration that certain telemedicine initiatives deployed by the Department of Health in the Eastern Cape are not fully implemented and the problems and the impact of the equipment on clinical aspects, finances, operations, efficiency and effectiveness of health care service delivery have to be evaluated.

A field study project was executed as part of a joint team of the Medical Research Council and Stellenbosch University in June 2010 with this problem statement in mind. However, after this visit to the Eastern Cape it was found that most of the telemedicine initiatives were not being used at all and an evaluation thereof is deemed extraneous. Even so, the teleradiology system does have the potential to be a successful telemedicine initiative, but the lack of coordination and the general operational management of the system need to be improved.

Teleradiology in the Eastern Cape is the focus of this study. However, the factors involved in the unsuccessful adaption of the system constitute the problem faced by most telemedicine projects in South Africa. The original problem statement was revisited accordingly; telemedicine initiatives are launched in South Africa without proper preparation and the necessary operational models being in place. Although everything seems to be in place for successful teleradiology, the number of successful consultations and referrals remains low.

It is proposed that there exist certain implementation barriers with regard to the technology, economics, organisational impact and how to handle the behavioural changes associated with the implementation of teleradiology and these need to be addressed.

1.3 Objectives

This project's intent is to assess the implementation of the Eastern Cape teleradiology system within context of the implementation barriers and to propose an alternative towards the successful sustained implementation and higher utilisation thereof.

To accomplish this, the following objectives are set:

- Determine the context of the project through a thorough study of the literature.
- Determine the state of the teleradiology system by physically visiting the different hospitals in the Eastern Cape and interviewing key stakeholders of the system.
- Develop a framework according to which the implementation of the system can be assessed.
- Apply this framework to the system and assess the system by means of any implementation barriers present.
- Propose and verify alternatives to the current mode of service delivery.
- Contribute to the development of the draft telemedicine strategy for South Africa.

1.4 Methodology

The project roadmap is shown in Figure 1.

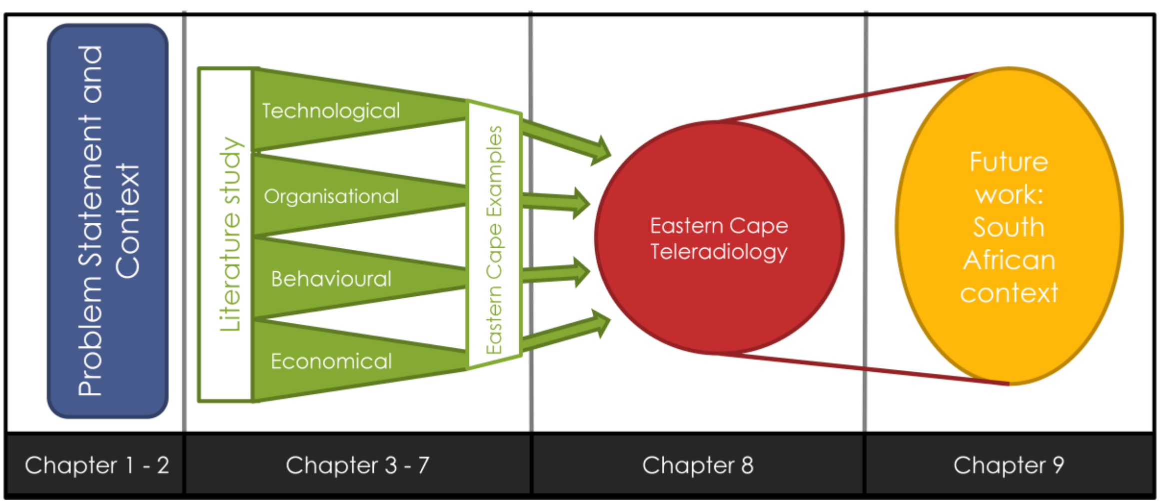


Figure 1 Project roadmap

The project starts with an overview of the literature to give a brief background and provide context for the rest of the project, especially with regard to telemedicine in South Africa. The problem statement's development was discussed in the previous section.

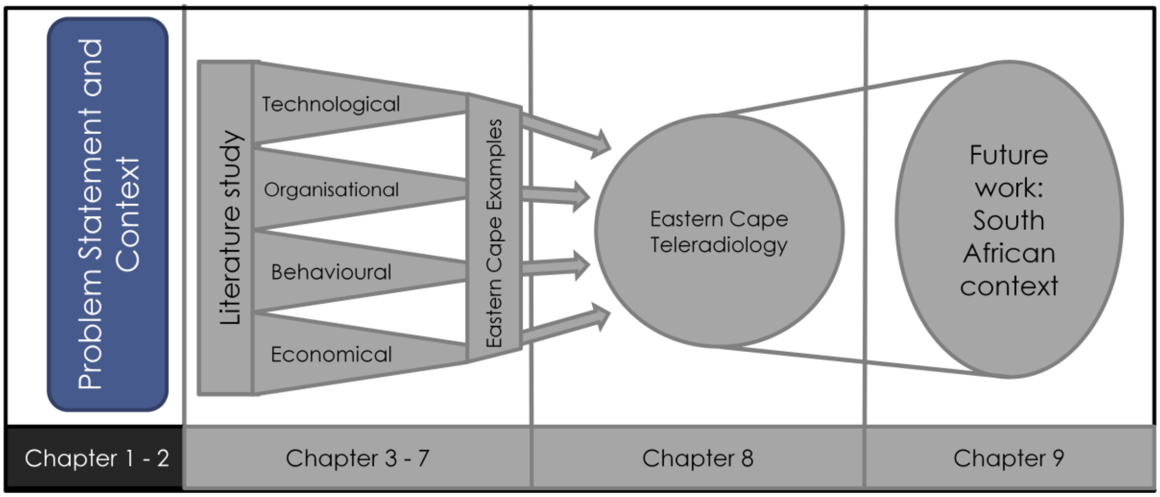
A visit to the hospitals in the Eastern Cape consisting of observations, surveys and interviews further provide context and an overview of the system.

The study of the literature is continued and four barriers that hinder the sustained implementation of teleradiology are identified. The four chapters that follow focus on the different implementation barriers respectively. In each of these chapters, observations from the Eastern Cape study is put into context of lessons learned from literature in order to inform decisions regarding the future implementation of teleradiology and telemedicine. This serves as a further analysis of the problem statement and contributes to the design of solutions.

The individual examples and implementation barriers is then extrapolated and integrated to the entire Eastern Cape in Chapter 8. An alternative to the current methods are proposed and evaluated.

The project concludes by discussing future work and the application of the project to the rest of South Africa.

2. Context of the Project



2.1 Telemedicine

The field of telemedicine is constantly evolving, and over the years a number of definitions have been formalised. When looking at the word in itself, "tele-" meaning over a long distance and "medicine"; the study and treatment of diseases and injuries (Oxford Advanced Learner's Dictionary, 2000) the basic idea of telemedicine is conveyed, but a lot of aspects are excluded. After a systematic review of 104 perspectives on telemedicine, Sood *et al*. (2007) defines telemedicine as follows:

Telemedicine being a subset of telehealth, uses communications networks for delivery of healthcare services and medical education from one geographical location to another, primarily to address challenges like uneven distribution and shortage of infrastructural and human resources.

From an Industrial Engineering systems perspective, it is interesting to note that one of the earliest definitions of telemedicine refers to it as a "system of care" (Sood *et al.*, 2007). Bashshur (2002) states that one of the primary reasons for the existence of telemedicine is to provide "a more equitable distribution system of clinical services". The definition of health systems engineering is applicable to this project on telemedicine as it states: "Health systems engineering is an academic discipline where researchers and practitioners treat health care industry as complex systems, and further identify and apply engineering applications in health care systems.” (Wikipedia, 2010)

For the purpose of this document, telemedicine refers to the system of services that use communications networks to ensure the equitable distribution of healthcare to the rural areas of the Eastern Cape; to address a shortage of infrastructural, monetary and human resources.

2.2 Teleradiology through Pre-recorded Telemedicine

This project is focused on the implementation and operation of teleradiology that is practiced in a pre-recorded mode. Context to the project is provided through a discussion of these two terms.

Pre-recorded Telemedicine

Pre-recorded telemedicine is a form of telemedicine where the information that is shared between two different sites are recorded and stored in a specific format, before or after it is transmitted (Della Mea, 2005). This form of telemedicine is common in South Africa as the general bandwidth of the internet is too small to enable adequate live video-conferencing and as no simultaneous scheduling of the specialist and patient is needed. The telemedicine application that will be evaluated in this project is briefly explained in the following section.

Teleradiology

Teleradiology is the electronic transmission of radiological images from one site to another (Della Mea V, 2005). Radiological images can include X-rays and CT scans. According to Kaylanpur, Weinberg, Neklesa, Brink and Forman (2003) radiology is the one mode of healthcare that is susceptible to the use of telemedicine, following the introduction of Picture Archiving and Communication Systems (PACS) that enable the storage and transmission of radiological images. In addition to this, the development of the internet means that a radiologist can access images anywhere in the world to diagnose a patient.

2.3 South African Healthcare and Telemedicine

South Africa embodies a unique combination of a developing and a developed country; while some of its citizens are extremely poor, others live in relative wealth. The healthcare systems further exhibit this unique relationship as the South African Healthcare consist of a public and a private sector. The public sector and services are fully funded by the government, but the private healthcare sector is funded by the patients and their medical aid schemes. Both the public and the private health sector can benefit from the ICT (Information Communication Technology) infrastructure of a developed world.

South Africa is faced with a shortage of health-care professionals, in addition to a skewed distribution of these resources. Table 1 provides an overview of the number of specialists available in the public sector of South Africa (Health Systems Trust South Africa, s.a.).

Table 1 Number of medical specialists per 100 000 population in the Public Sector, South Africa.

	EC	FS	GP	KZN	LP	MP	NC	NW	WC	ZA
2000	2.6	10.9	32.4	7.4	1.0	1.2	2.0	1.5	42.7	11.2
2001	2.6	9.3	24.6	6.5	0.8	0.6	2.4	1.7	44.5	10.3
2002	2.3	9.2	25.0	6.3	0.7	0.7	2.2	1.5	39.3	9.8
2003	2.3	9.2	19.7	6.0	1.0	0.7	2.7	1.5	32.7	8.9
2005	2.3	13.8	18.3	6.2	1.5	0.5	2.5	1.9	29.1	8.8
2006	2.2	13.3	20.8	6.2	1.4	1.3	3.1	1.9	31.3	9.2
2007	2.4	14.2	21.9	6.3	1.6	1.8	2.7	1.7	33.2	9.8
2008	2.5	14.7	22.3	6.2	1.7	1.6	2.9	1.3	31.9	9.8

EC: Eastern Cape **FS:** Free State **GP:** Gauteng **KZN:** KwaZulu-Natal **LP:** Limpopo **MP:** Mpumalanga **NC:** Northern Cape **NW:** Western Cape **ZA:** South Africa

From these figures it is clear that there is a definite need for a solution to ensure equitable distribution and effective application of specialist services. Telemedicine has the potential of being such a solution.

Notable is the difference between the Eastern Cape (2.5 in 2008), the Western Cape (31.9 in 2008) and Gauteng (22.3 in 2008), explaining the logic behind the collaboration between these provinces in the current teleradiology system.

The National Health Information Systems Committee of South Africa formed a National Telemedicine Task Team in 1998, with the goal to implement a national telemedicine strategy in the country (Mars, 2009). This strategy planned three phases for the development of telemedicine, but only Phase One was implemented, and after evaluation, this was discontinued. A renewed interest in Telemedicine resulted in a new strategic plan for 2008-2013 being developed by the Department of Health (Mars, 2009). This plan is being drafted at the moment and the outcomes of this project will be presented as input to such a draft.

With regard to the National Telemedicine Programme, the following statements were made by the National Health Information System:

> **"Telemedicine will only be adopted as an acceptable modality of health care delivery, if it efficiently and effectively enhances the accessibility of the scarce centralised specialist resources."** *(NHIS, 2001)*

It further states that it was envisaged that the Telemedicine Pilot Project would provide a cost-effective solution, with a particular focus on the distribution of Specialist Health Care in the rural and previously disadvantaged areas. (NHIS, 2001)

The project hopes to assess teleradiology in the rural areas of South Africa and specifically the Eastern Cape and to contribute to the field in such a way that the system enhances the accessibility of specialist resources in a cost-effective way.

2.3.1 Eastern Cape Situation

The Eastern Cape hosts approximately 14.4% of the South African population and is the fourth richest province when measuring the total current income, but in *per capita* income terms, the province is ranked eighth (SSA, 2003). The province further exhibits unique characteristics as the major economic centres are situated to the west of the province (Port Elizabeth and East London) while the northern parts consist of agricultural communities and the east of rural traditional communities. The infrastructure also markedly weakens as the distance from the economic centres increases. It is these characteristics - the per capita income and the unique geographical distribution - that support the idea that telemedicine could be an important component to ensure healthcare distribution in the province where the transport infrastructure is not supportive.

Telemedicine projects in the Eastern Cape were initially driven by the Walter Sisulu University, and this resulted in an active telemedicine committee within the province's Department of Health (Mars, 2009). This is part of the South African National Telemedicine Strategy that seeks to integrate the healthcare system by connecting and giving support to remote and rural medical centres of South Africa and most importantly, strengthening the referral systems.

The hospitals with active telemedicine programs during 2009 are: (Fortuin-Abrahams, 2010)

1) Uitenhage Hospital
2) Settlers Hospital
3) St Patricks Hospital
4) Madzikane Ka Zulu Hospital
5) Cradock District Hospital
6) Frontier Hospital

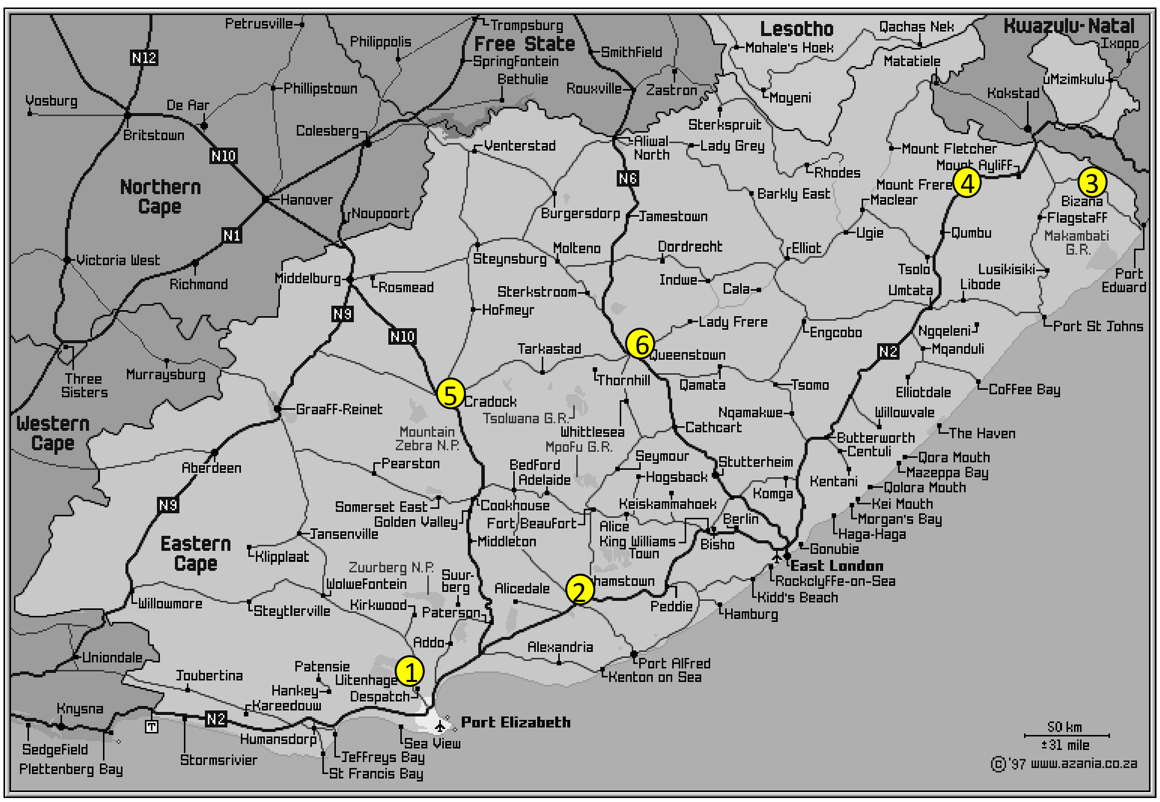


Figure 2 A map of the Eastern Cape and visited Telemedicine sites (Eastern Cape Tourism – Map, 2010)

2.3.2 Medical Research Council Monitoring and Evaluation of Telemedicine in the Eastern Cape

With regard to the need to monitor and evaluate telemedicine initiatives, a joint team of the Medical Research Council and the University of Stellenbosch embarked on a field study to the Eastern Cape in June 2010 to commence a project named the Monitoring and Evaluation of Telemedicine in the Eastern Cape.

The monitoring and evaluation consisted of: a set of surveys that was developed by the MRC-SU team and completed by the health professionals, patients and technicians at each of the 6 sites; observations of the systems (where applicable); and interviews with management at most of the hospitals. For the purpose of this study, the feedback provided by 34 clinicians who indicated that they are actively involved in teleradiology is considered, as summarized by Table 2. The relative figures are correlated to the implementation barriers that will be discussed in the following chapters. These figures do not include the specialists that constitute the other participants of the teleradiology system.

Table 2 Summary of feedback of clinicians in the Eastern Cape involved in teleradiology

	Feedback	Implementation Barrier
How often does the connection fail?	Never – 0 % Seldom – 42 % 50% of the time – 35% Mostly – 19% Almost always – 3%	Technological
Reason for teleradiology system not being utilized to full potential	Feedback – 50% Connectivity – 26 % Other – 20%	Organisational Technological
Driving need to address a problem that could be met by telehealth	Strongly agree – 45% Agree – 32% Neutral – 16%	Behavioural
Willing to make initial extra investment of time required	Strongly agree – 52% Agree – 32% Neutral – 16%	Behavioural
Access to consultation network	Strongly agree – 19% Agree – 37% Neutral – 29%	Organisational

	Feedback	Implementation Barrier
Provided with reliable clinical content	Strongly disagree – 26% Disagree – 30% Neutral – 19%	Organisational Behavioural

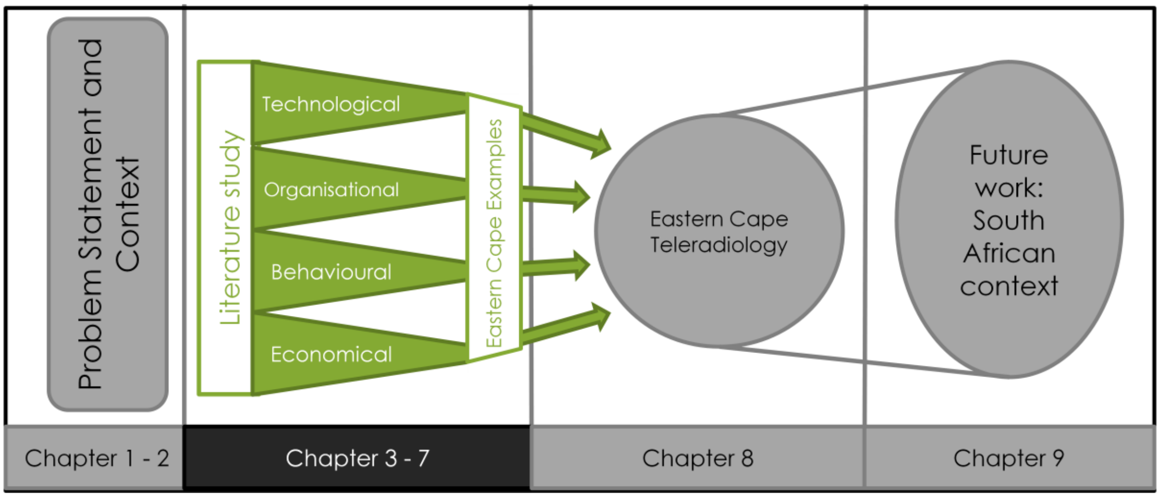
It was found that the literature and even the people involved in telemedicine at a high level did not adequately describe the state of telemedicine implementation in the province. It was valuable to witness, firstly the need that exists in the province for adequate health care, but more importantly, the attitudes of the clinicians towards the system, the obstacles that governmental hospitals face and general misconceptions and failed introductions of telemedicine as such.

Although the project initially commenced with the idea to monitor five different applications of telemedicine (telespirometry, tele-ECG, teledermatology, teleradiology and tele-consultation) it was found that in the majority of hospitals the applications were not being used at all, either due to training issues, technical issues or the lack of incentive (some of the applications deemed unnecessary). Teleradiology was however to a large extent being used, and it was clear that there is a definite need for this system to be functional. As explained in Chapter 1, this resulted in a new problem statement and indirectly a new project as the focus shifted to the assessment of teleradiology.

2.4 Conclusion

The chapter provided a brief literature overview to define telemedicine in a South-African and Eastern Cape context. It is clear that the strategies to support telemedicine are in place and that there is a need for telemedicine to be implemented in a sustainable way and to be integrated into the everyday health care of the country. However, telemedicine initiatives rarely proceed past the initial introductory stage. The next chapter investigates the obstacles that prevent telemedicine, and more importantly teleradiology, from becoming a sustained innovation.

3. Implementation Barriers



3.1 Introduction

In the previous chapters the problem statement and the context of the project was defined. This chapter considers the implementation barriers that are present in telemedicine. Telemedicine is in principle a technological innovation, and researchers tend to look at the technology and its use when developing implementation plans. With the exception of connectivity, the technology enablers of teleradiology proved to be successful and in working condition. This supports the idea that there are other issues in teleradiology in the Eastern Cape that has lead to its low utilisation rates.

3.2 Telemedicine as an Innovation

The classification of telemedicine as an innovation or invention should be discussed. An invention becomes an innovation after the successful market launch. Invention is connected to a research process and innovation to an economic process (Du Preez, Essman, Louw, Schutte, & Marais, 2009). What is notable for the case of telemedicine as an innovation is the explanation of Du Preez *et al.* (2009) that public services also need creative improvements (innovations) to ensure that organisations adapt to delivering services during a given time. Despite a lower degree of economic and market implications, telemedicine is still classified as an innovation as it is a creative improvement that allows the organisation to adapt.

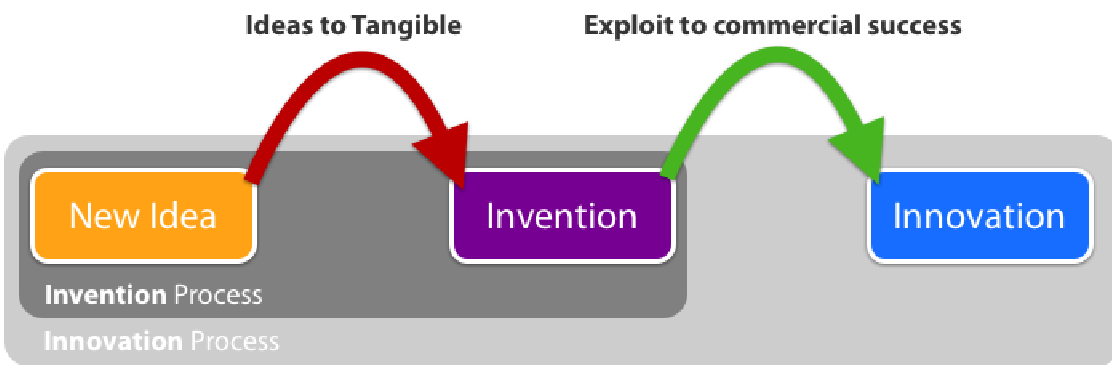


Figure 3 Distinction between invention and innovation (Du Preez *et al.*, 2009)

The term innovation is linked to the diffusion of such an innovation into an organisation, and it is this diffusion that can be problematic.

Zmud (1984) defines 'process diffusion' as the adoption of methods, tools and machinery to improve work behaviours and further suggests that significant uncertainty is present regarding the relevance of the process to the needs of the organisation, the way in which the process merges with the existing processes of the organisation and the willingness of the participants to change their way of doing things. This definition is applicable to teleradiology as it is a tool to improve work behaviours, and uncertainty with the way the process is adopted into current workflow (organisational) and the way of doing things (behavioural) is present.

As telemedicine is classified as an innovation, the terms diffusion and adoption are applicable. This project proposes that the invention as such is successful; that the innovation is partly successful in exploiting the invention to commercial success, but that the problem experienced in teleradiology in the Eastern Cape is the diffusion of this innovation into the organisation's processes.

3.3 Barriers to the Adoption of Telemedicine

Gagnon *et al.* (2005) states that the complete adoption of telemedicine in health care organisations is required to ensure that it is considered as a viable alternative method to deliver the necessary health care services. It is this adoption or diffusion of the technology into the industry that has however been the controversial discussion point in the literature.

The diffusion of innovations is a common problem in different sectors, not only healthcare. Rogers (1995) identifies the main elements in the diffusion of new ideas as: *"An innovation, which is communicated through certain channels, over time among members of a social system."* The theory that Rogers establishes, is that the communication of the innovation to adopters are the determining factor to the complete diffusion. Although this is true, his theory is largely technologically inclined. In the Eastern Cape communication could definitely be improved, but other issues are at hand that hinder the complete diffusion of telemedicine which surpasses technological factors.

Tanriverdi and Iacono (1998) propose three additional "knowledge barriers" with regard to the diffusion of telemedicine. They argue that new knowledge must be created, not only about the (1) technology, but also (2) the economics of telemedicine, (3) its organisational impacts, and (4) how to handle the behavioural changes. (Tanriverdi & Iacono, 1998)

This project anticipates that these four factors are the reasons for the ineffective implementation of teleradiology in the Eastern Cape. The four factors are the pillars of the cause-and-effect analysis shown in Figure 4. The following chapters discuss each of these implementation barriers, and propose possible ways to significantly lower these barriers in order to enhance the utilisation of the system.

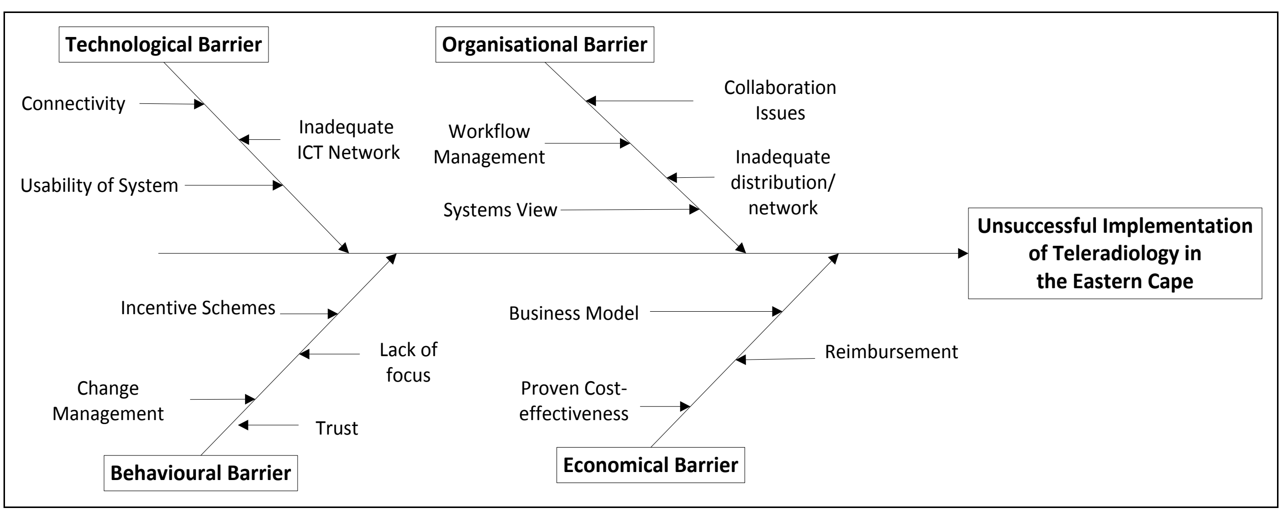
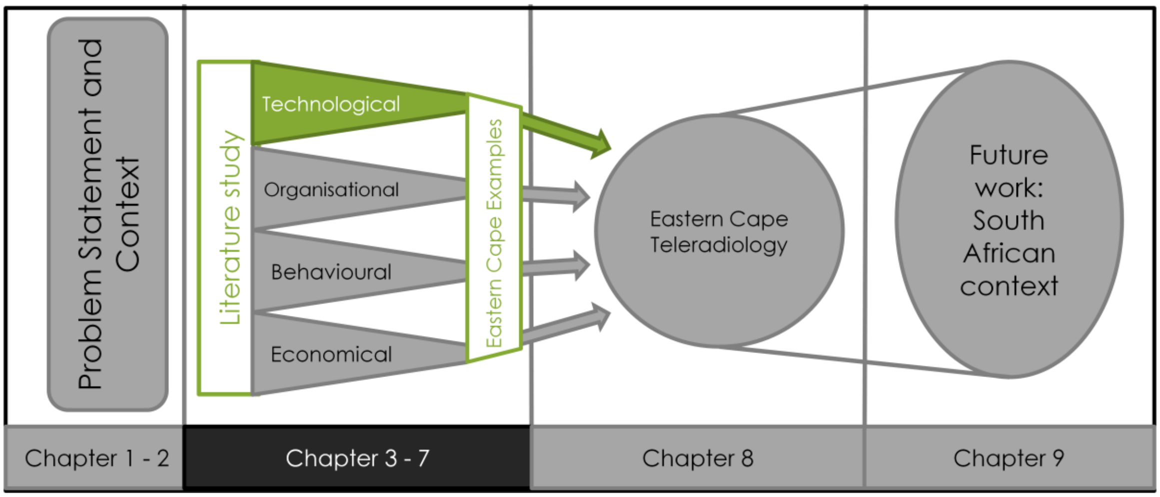


Figure 4 Proposed cause-and-effect analysis for teleradiology in the Eastern Cape

3.4 Conclusion

There exist certain barriers that prohibit the successful and sustainable implementation of telemedicine. For the purpose of this document the barriers are scoped to technological, organisational, behavioural and economical. Figure 4 shows that these barriers are intertwined and although each receives separate attention in the subsequent chapters, they need to be addressed systemically. Actions can be instigated to address these barriers. As an industrial engineering study, the focus of the project will be on workflow management, adopting a systems perspective, developing an adequate business case and instigating change management and motivation of the participants.

4. Technological Barrier



4.1 Introduction

In the previous chapter an overview was given of the barriers that hinder the sustained implementation and diffusion of telemedicine. Although other barriers play a role, it was found that the technological barrier will always be present due to the technological nature of a teleradiology system. During the visit to the Eastern Cape no serious issues regarding the use of the technological system at the radiology departments were observed, and an assessment of the system with regard to clinical viability is not within the competence of the student. As such, the technological barrier is scoped to the network that enables the transfer of data and the connectivity of the entire teleradiology system.

4.2 Connectivity

An interview with Ms. Jelena Simpraga, head of teleradiology in the Eastern Cape Department of Health, regarding the problems experienced with the system could be summarised to one concept: poor connectivity (Simpraga, 2010). As is often the case, the different components of a teleradiology system can be functioning perfectly, but without the presence of an important aspect, namely connectivity, the distribution of services (such as radiology) is impossible.

4.3 Teleradiology Communications Network

On the Paxeramed website (affiliated with the service provider that installed the sytem), it is stated that the Eastern Cape project is considered one of the biggest PACS (Picture Archiving and Communication System) projects worldwide with the aim to connect 27 governmental hospitals. (Paxeramed, 2010)

A project of this size requires a connection network that enables the teleradiology processes and workflow adequately. With the system being operated in public health care, a governmental environment, certain bureaucratic rules and procedures exist which must be adhered to. SITA (State Information Technology Agency) is an organisation with the aim to consolidate and coordinate the use of Information Technology in governmental organisations. As the teleradiology system under assessment is driven by the Department of Health and implemented in state hospitals, legislation has prevented the service provider of the system to install their own networks, and the SITA network is used as connection between the remote hospitals and the Data Centre at Bhisho.

The installation requirements for a new system (Richter (b), 2010) is summarised in the following Table 3. Although precise costing information is not available this specification can be used as point of departure for future costing exercises.

Table 3 Installation requirements for a new teleradiology system

Participant	Devices & Software
Remote Hospitals	X-Ray Acquisition Server Microsoft SQL Server Internet Information Services PACS Software
Data Centre	Applications Servers Database Servers Web-based servers Large Archiving Device
Radiologist	Webbased Viewing Software SQL Network DicomPort 104 Access

4.4 Connectivity Between Radiologists and the Data Centre

The architectural design of the network (Richter(b), 2010) shows two different methods through which connectivity between the radiologists and the data centre can be established.

Method 1 involves using a concentrator VPN (virtual private network) that is installed at the edge of the government's network. This entails running VPN client software at the radiologist station that allows access to the information at the data centre. Figure 4 illustrates this network setup. (Richter(b), 2010)

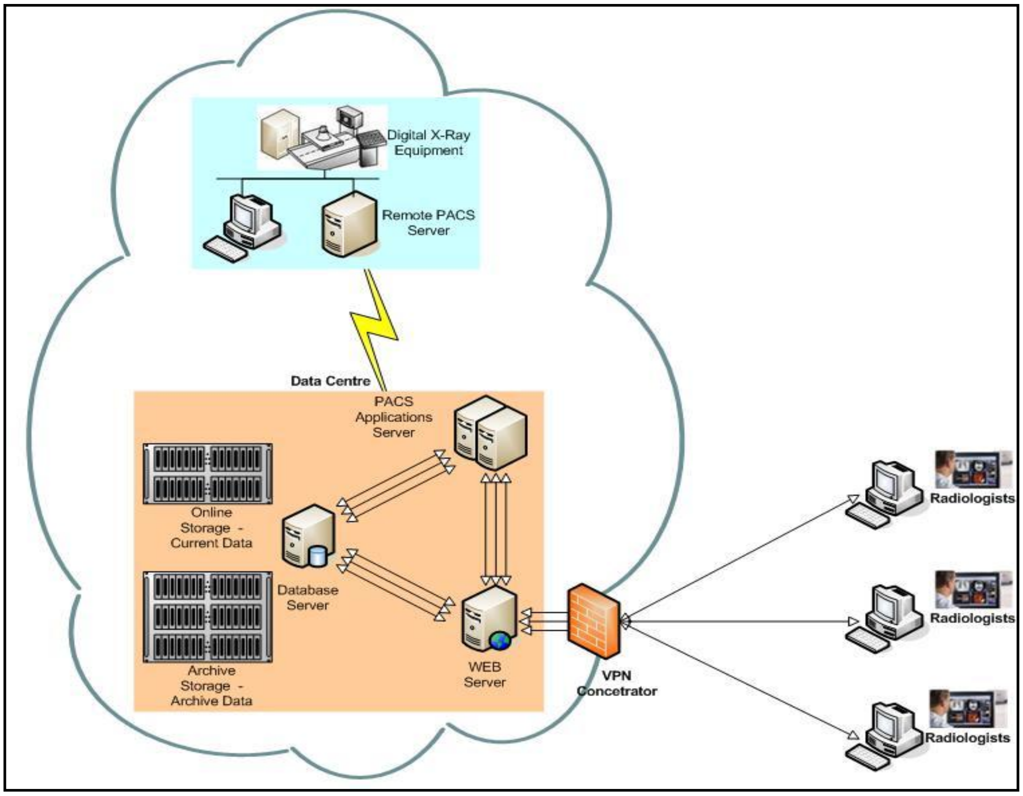


Figure 5 Teleradiology Network Diagram - Method 1

Method 2 involves the installation of a specialised APN router at the edge of the government network enabling GSM (Global System for Mobile) and 3G connectivity. Figure 5 illustrates this network setup. (Richter(b), 2010)

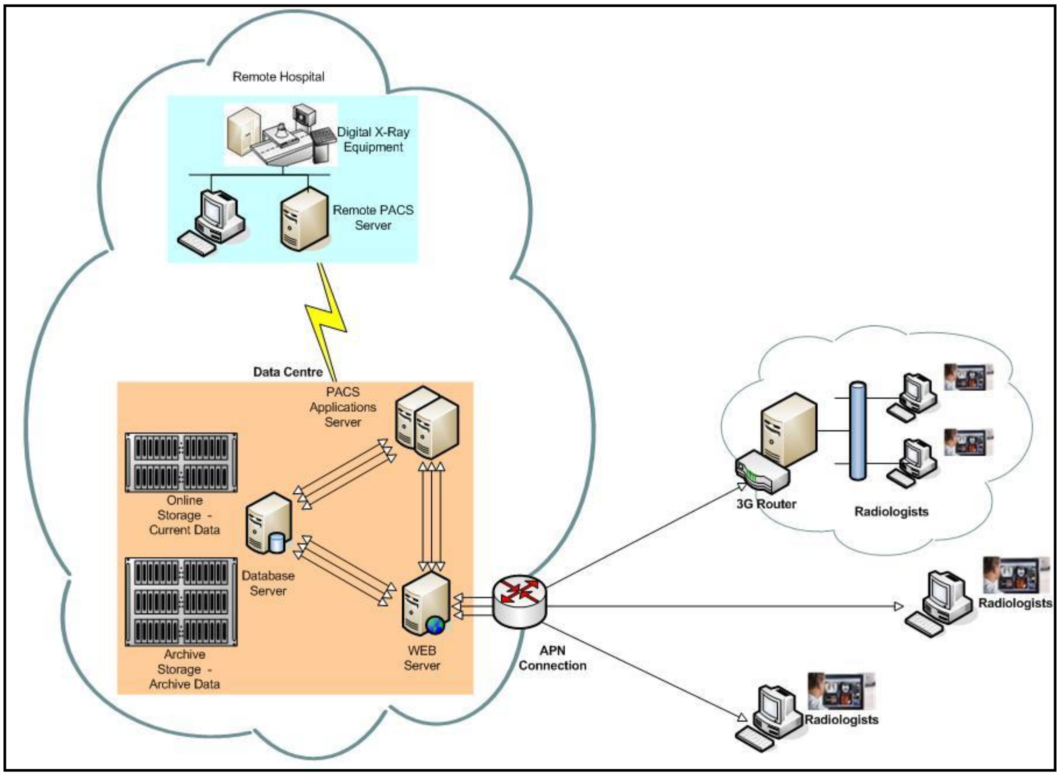


Figure 6 Teleradiology Network Diagram - Method 2

The two methods are compared in Table 4:

Table 4 Comparison of two alternative teleradiology networks

	Method 1	Method 2
Connectivity Medium	ADSL	3G
Speed	384Kps-1024Kps	Up to 7.8Mbps
Cost (Internet access in South Africa, 2010)	+- R0.06/MB	+- R0.50/MB
Access	Restricted Access	Full Access
Dependency	Dependent on internet access	Dependent on mobile network

The major comparison seems to be between the speed of transfer and the cost. While 3G will result in a higher cost, the connectivity enables the transfer of images at adequate speeds. Decision makers should weigh the benefits against the costs necessary to upgrade the current mode of connectivity.

A proposed solution is the elimination of the connection requirements between the data centre at Bhisho and the remote radiologist by appointing a dedicated radiologist at the data centre. This would result in a smaller communications network and available funds would be focused on the connection between the remote hospitals and the data centre. This proposed solution will be discussed with regard to the other implementation barriers in the following chapters.

4.5 Conclusion

The chapter discussed the technological barrier that is present in the diffusion of teleradiology in the Eastern Cape. The cause-and-effect analysis of Chapter 3 (p 15) is subsequently updated in Figure 7. It is clear that connectivity remains a barrier, and that this is something that affects the entire system. For the Eastern Cape system, it was found that usability of the system is not a cause of the unsuccessful implementation of teleradiology. Usability is however included in the cause-and-effect analysis to provide a framework for assessment for other projects.

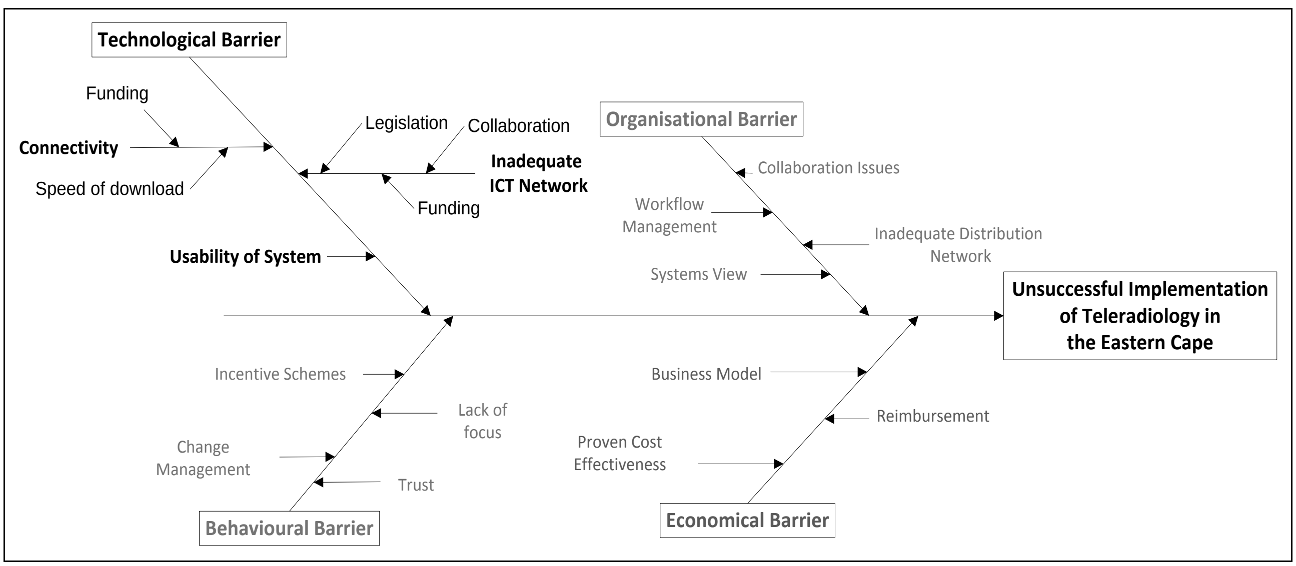
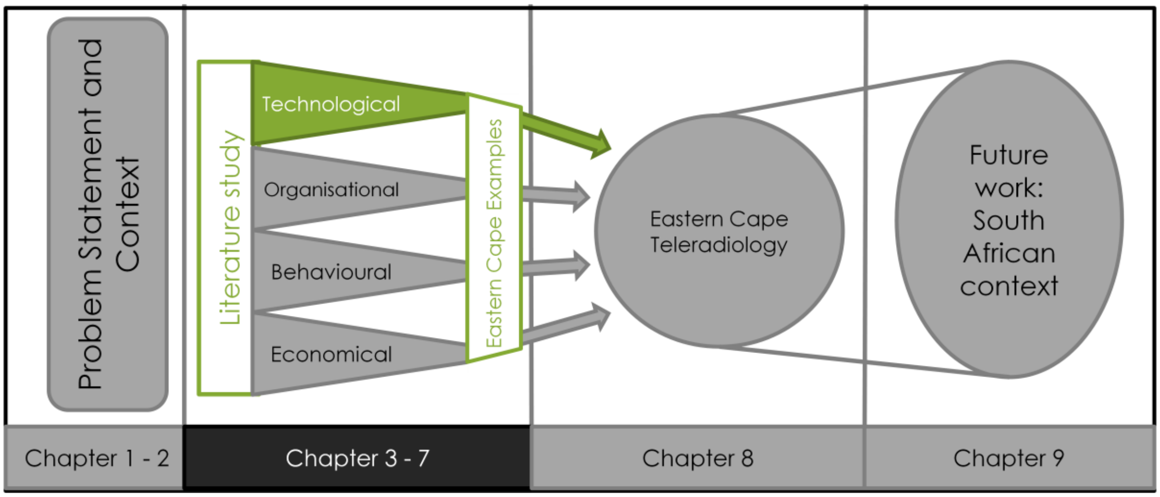


Figure 7 Expansion of the cause and effect analysis - a technological barrier focus

The nature of the healthcare system and legislation involved in the use of SITA's networks denotes a significant barrier. It seems as if the technological barrier is connected to an organisational barrier. For the use of the current system to be improved, better collaboration between the service provider and SITA need to be established and the Department of Health need to consider the advantages of using a network provider outside of SITA. The next chapter further elaborates on the different aspects of the organisational barrier to the diffusion of teleradiology.

5. Organisational Barrier



5.1 Introduction

In Chapter 3 three knowledge barriers as identified by Tanriverdi and Iacono (1998) were proposed as possible barriers to the successful implementation of teleradiology in the Eastern Cape in addition to a technological barrier that was discussed in the previous chapter. This chapter overviews the organisational factors that need to be addressed if teleradiology is to move forward in the province.

5.2 Workflow

5.2.1 Cross-organisational Workflow

Although the teleradiology system falls under the greater organisation of the provincial Department of Health, the individual hospitals are also classified as organisations. The unique organisational problem of telemedicine, is that due to the referral process, workflow and information has to progress across the boundaries of the organisations; the two organisations (hospitals) thus collaborate. The term cross-organisational workflow as found in the literature is applicable.

Workflow is defined by the Workflow Management Coalition (1999) as ***"The automation of a business process, in whole or part, during which documents, information of tasks are passed from one participant to another for action, according to a set of procedural rules."***

This definition is applicable to the teleradiology system as information (images) and tasks (requests for report) are transferred to another participant (the radiologist) for action (diagnosis). This concept is illustrated in Figure 8.

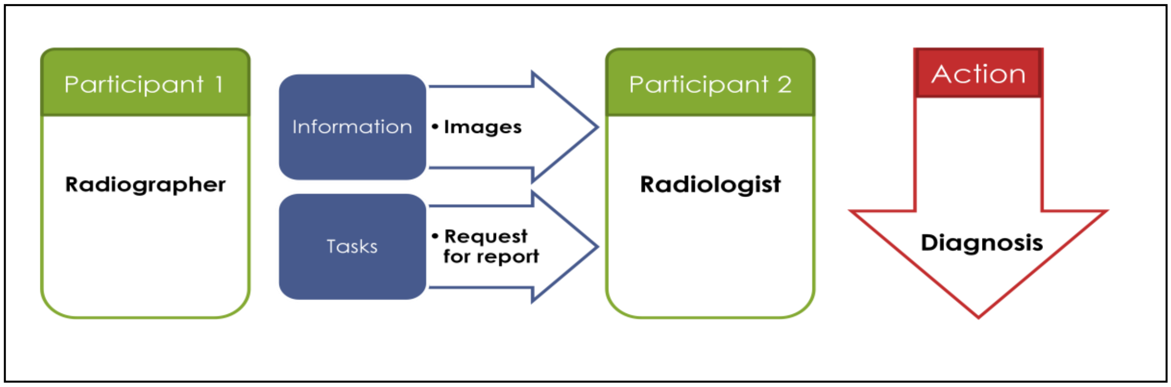


Figure 8 Illustration of the concept of teleradiology workflow

The Workflow Management Coalition (1999) further defines a business process as follows: ***"A set of one or more linked procedures or activities which collectively realise a business objective or policy goal, normally within the context of an organisational structure defining functional roles and relationships."***

In the teleradiology case, business process hence refers to the procedures of taking the radiology image, the correct diagnosis of the image and the patient's condition that are linked in fulfilling the objective of effectively treating patients.

Blake and Gomaa (2004) use the term 'services-based cross-organizational workflow' to describe ***"the workflow interaction when one business incorporates the services of another within its own processes"***. A parallel is once again drawn between this definition and teleradiology, as the hospital where the patient is treated incorporates the services of the radiologist at the referral site in their own process of treating the patient.

It is clear from the quoted literature that there exists a definite link between teleradiology and the term cross-organizational workflow. Blake and Gomaa (2004) present design aspects of an architecture that would support service-based workflow composition. Future work would include the design of this software architecture. This document briefly overviews the service capturing stage with process modelling of the information and workflow.

5.2.2 Current Information and Workflow in Teleradiology in the Eastern Cape

The teleradiology system is currently based on a pull model with regard to workflow. When the radiologist (customer) is available and has time to spend on the project, the information (images and patient data) is pulled from the system resulting in user-based scheduling. For the current model of the system, this pull of workflow makes sense. Pushing workflow from the hospitals (suppliers) will result in the unnecessary queuing of data at a radiologist who is currently unable to attend to the reports.

In the traditional manufacturing environment a pull system is said to be advantageous as inventory is minimised and the need of the customer defines the flow of work. In the teleradiology system the needs of two users has to be contrasted, namely the needs of the hospitals and the needs of the radiologists as both act as suppliers and customers during the different stages of the teleradiology process.

The drawback of the current pull system is that there is no control on the amount of reports that are attended to. This could result in a life-threatening report not being pulled from the system as the part-time radiologist could not find time in that week to attend to the teleradiology system. If the teleradiology system is to be implemented in a sustained way, the pull system needs to be managed in such a way that all the request for reports get pulled.

Reports are currently being sent from the radiologist to the central database at Bhisho where reports are accessed and downloaded by the different radiography departments of the hospitals. The current system is still relatively new, and the need for storage of the reports at the data centre is reasonable, but it is put forward that the downloading of the reports from the centre adds time between the initial screening of the patient and the treatment. As this is the ultimate goal of the system, the storage of reports is regarded as a non-value adding activity.

5.2.3 Model for Cross-organizational Workflow in Teleradiology

Figure 9 is a workflow diagram of the flow of work across organisations to the telemedicine hub. A management system that allows for the scheduling of the request for reports in order to manage the workflow to the radiologist is necessary. Although scheduling results in a push-system, it is proposed that for adequate cross-organisational workflow to take place, scheduling is necessary to ensure that all requests for reports are dealt with. A workflow management system could be designed in such a way that it combines the advantages of a push (scheduling) and pull (user orientated) system.

The workflow diagram model (Figure 9) also proposes that reports are sent to the databases of hospitals directly, to eliminate the time and connection needed for hospitals to access the database at Bhisho. If records of the entire system's reports are necessary, data can be sent from the hospitals to the data centre after the patient has been treated. This will ensure that the non-value adding activity, storage of reports, occurs at the end of the process after the patient has been treated.

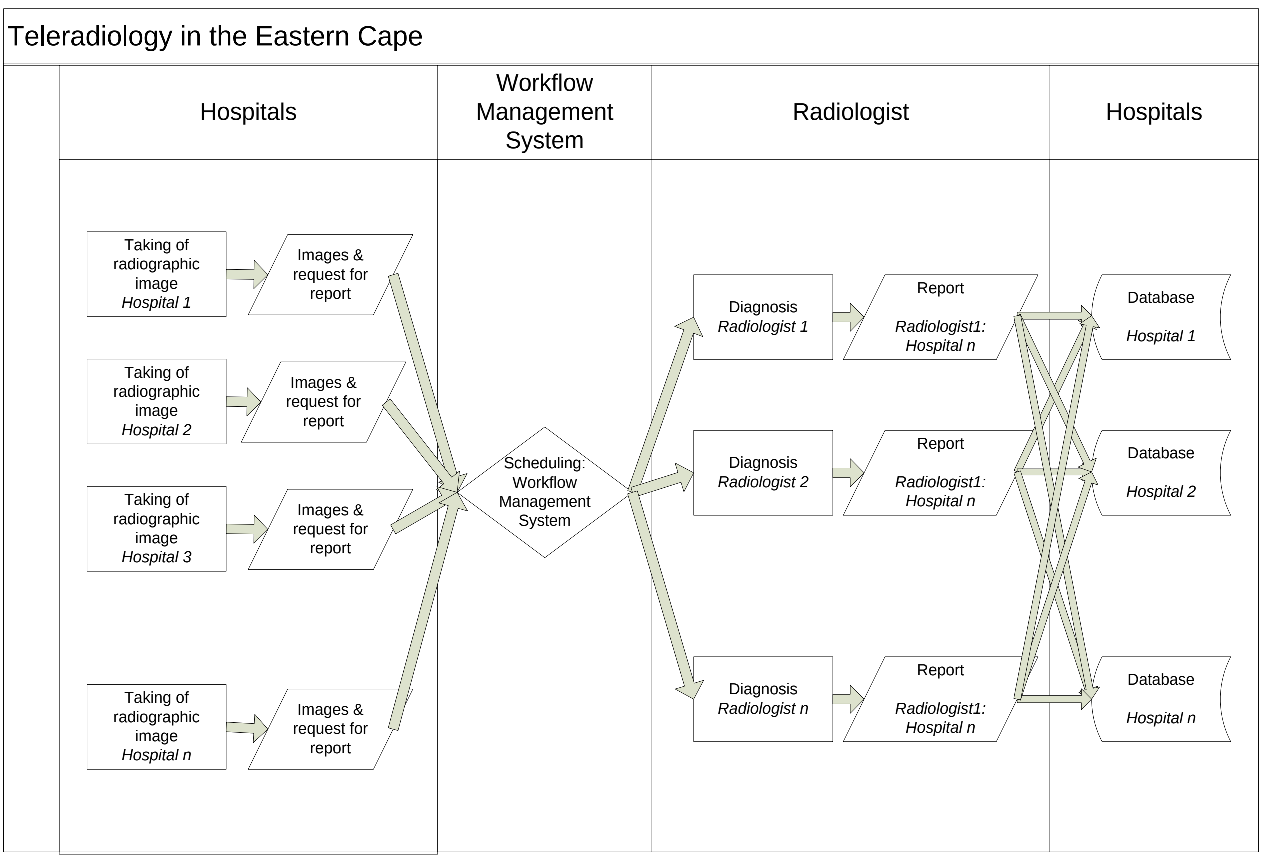


Figure 9 Diagram of the model for cross-organizational workflow in teleradiology

5.3 Collaboration and Knowledge Management

5.3.1 Collaboration

Collaboration – a means of expanding knowledge and decreasing uncertainty. (Paul, 2006)

In the book, *Creating Collaborative Advantage*, Huxham (1996) defines collaboration as working in association with others for some mutual benefit. Collaboration is said to be a concept that needs to be understood because of the following reasons:

- Collaboration is happening
- Collaboration is valuable
- Collaboration is difficult. (Huxham, 1996)

Paul (2010) redefines telemedicine as a form of virtual collaboration that assists health care providers to address the challenges of the healthcare environment. When transposing the above reasons onto teleradiology (specifically in the Eastern Cape), it is clear that collaboration, or the attempt to collaboration is happening in teleradiology, that the collaboration between the physician and the specialist is valuable in the treating of patients, and lastly, as can be seen in the problematic implementation of teleradiology, it is indeed difficult.

5.3.2 Knowledge Management

Bornermann (2003) defines knowledge management as "***the coordination of knowledge and the management of the organisational environment to support individual knowledge transfer and the subsequent creation and preservation of collective knowledge.***" Du Preez *et al*. (2009) interpret knowledge management as the management of an organisation with a specific focus on knowledge.

Fitzgerald *et al.* (2008) state that one of the main barriers in the diffusion of innovation in a health care organisation is the movement of knowledge across professional boundaries and that new mechanisms for sharing across boundaries need to be considered.

There exists a certain distinction between two types of knowledge, namely tacit and explicit. While explicit knowledge can be communicated and expressed in words, numbers or data, tacit knowledge refers to the subjective judgement, intuitive and personal, something that is hard to formalize. (Du Preez et al, 2009). Telemedicine is a unique case of knowledge transfer, and subsequently needs adequate knowledge management. The transfer from the radiographer to the radiologist consist of explicit knowledge (images, history of the patient, etc.) while the report from the radiologist to the radiographer, although explicit in nature (a typed report) was generated through the tacit knowledge of the radiologist that enabled him/her to interpret images and diagnose the patient.

5.3.3 Collaboration Towards Successful Knowledge Management in Teleradiology

A study of different telemedicine projects by Paul (2006) with a focus on the collaboration and knowledge management of the projects lists the conditions as tabulated in Table 5 on why teleradiology should be the simplest type of collaboration. It was however found, that although these factors are all in place to ensure that collaboration is fairly simple, social context did not facilitate effective collaboration, but was rather found to be a major barrier to knowledge transfer in the case of teleradiology. (Paul, 2006)

Table 5 Comparison of conditions for classification of collaboration type between literature and the Eastern Cape

Teleradiology	Type	Paul (2006)	Eastern Cape
Technology	Digital Radiography Asynchronous file transfer	Participants relatively comfortable with the use of both	Participants relatively comfortable with the use of both, although digital radiography is relatively new
Processes	Radiologist, Patient, Physician	Little process change	Positive process change (print outs etc).
Reimbursement		Specialist reimbursed	Specialist reimbursed (although very little)
Type of colla-boration activity	Explicit knowledge	Least complex	Least complex

In a study of the telemedicine network in Quebec, Canada by Gagnon *et al.* (2005), it was found that clinicians have a need for a list of available telemedicine providers and services. The study showed that clinicians have a need to know the consulting specialist and are also assured of their willingness to provide expertise, and that this awareness creates a successful telemedicine organisation (Gagnon *et al.* 2005). In the Eastern Cape, it was notable that clinicians often had no idea to whom their patient is being referred. This makes the telemedicine network abstract and intangible, and clinicians are less likely to make use of the system. It is proposed that the referring clinicians and the referral specialists meet to overcome the organisational barrier towards meaningful collaboration.

Hu, Chau and Liu Sheng (2000) identify the possibility of service risks as a significant factor to the successful implementation and adoption of telemedicine in an organisational environment. in essence, physicians are less likely to accept and use a system which introduces considerable risk to their work, possibly affecting their treatment of the patient and leading to a degradation of the service. The solution that Hu et al. (2000) propose is that a trial run of the system is done in which the diagnosis of the radiologists are discussed and evaluated or adequate evidence-based experimentation is done. In the Eastern Cape some doubts were raised as to the accurateness of the reports received from the specialist. If a new alternative to the current system, or a new system in another province is introduced, scientific trials should be undertaken to ensure that the service risks are minimised. These results should be widely distributed to enhance the acceptance of the system by the physicians.

5.4 Systems Thinking

"Systems thinking is a general conceptual orientation concerned with the interrelationships between parts and their relationships to a functioning whole, understood within the context of an even greater whole."

Trochim* et al. *(2006)

The definition by Trochim, Cabrera, Milstein, Gallagher and Scott (2006) above gives a general idea as to why systems thinking is an important concept when studying teleradiology. Systems thinking has in modern times been applied to the study of the public health sector, as public health itself is a complex system that involves a lot of participants from different sectors and different entities that enable the delivering of the service.

While the individual parts of teleradiology seem to be working at an acceptable standard in the Eastern Cape, it is projected that it is the integration of the different parts that is causing problems to be experienced with the implementation thereof. Best *et al.* (2008) states "systems thinking is an effective approach to foster deliberation across diverse disciplines and stakeholders." Lindstrom, Matheson and Tan (1998) propose that the shift from an object-based reality to a network-based reality (adopting a systems view) will be an ongoing challenge for health care leaders. This systems thinking approach needs to be applied to the situation to a certain extent to enable progress in the greater telemedicine network in the Eastern Cape between different stakeholders.

As identified by Sheng *et al.* (1999) decision interdependency is a relevant lesson to be learned for the management of a telemedicine system in an organisation. Concurrent engineering and shared decision making is very important, especially in an inter-organisational system such as that of teleradiology in the Eastern Cape. Acceptance and collaboration would have followed on interdependent decision making, where all parties involved were consulted and the system as a whole was addressed.

5.4.1 The Network of the Teleradiology System

Systems thinking in the teleradiology instance entails taking a step back and looking at the entire network. The view on the teleradiology network that is adopted is a hub of specialist radiologists with the referring hospitals on the spokes of the network. Technology management needs to look at issues at either connection ends or network externalities in an interorganisational environment such as teleradiology.

The birds-eye view is also the reason why the specialist hub of the Eastern Cape teleradiology system is identified as the bottleneck. Although there are some more issues at the externalities of the different referring hospitals, the externality that is common to all the hospitals need to function correctly before the rest of the system can be classified a success. It is projected that the radiologist hub needs to be in full working condition to ensure a successful teleradiology network.

5.5 Example of the Organisational Barrier – Cradock Hospital

Cradock Hospital is situated around 250 km north from Port Elizabeth and one of the biggest hospitals in a large agricultural community of the north-west of the Eastern Cape Province. Its use of teleradiology is considered to be the success story of the system. The statistics show the successes of the system at the hospital and the general contentment with the system. 8 out of 8 health professionals at the facility considered the advice from the specialist to be appropriate.

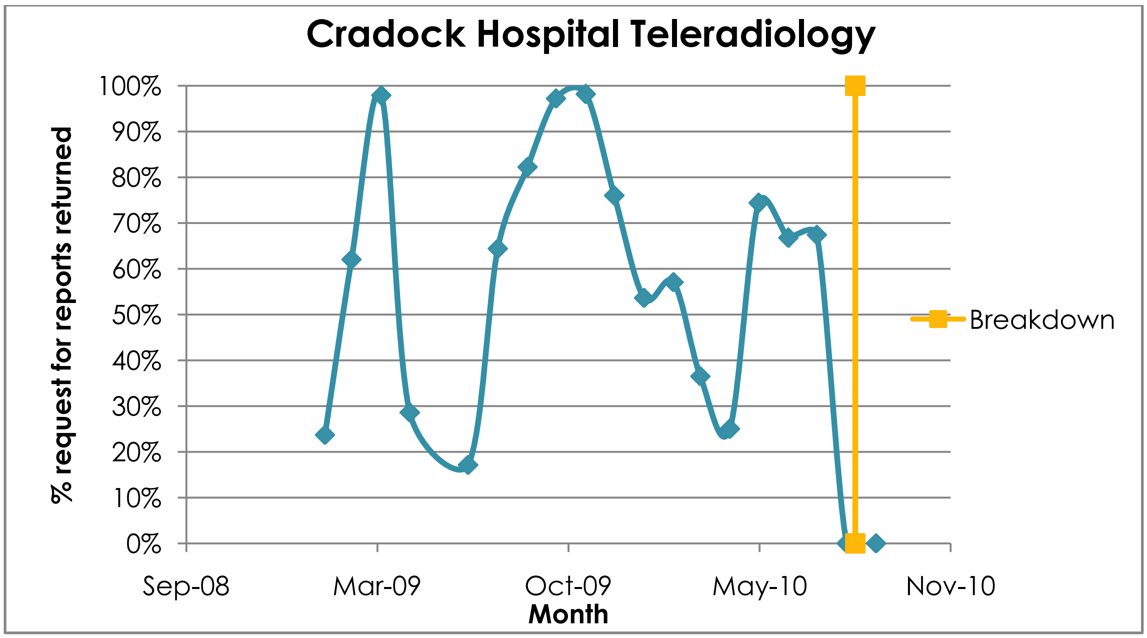


Figure 10 Cradock hospital statistics on percentage of request or reports returned

The graph in Figure 10 shows that the breakdown of one of the machines at the hospital has resulted in a complete shutdown of the system. Although this could be classified as a technological factor, in any other organisation a new machine or a technician would have been made available to address the problem. A systems view from someone within the Department of Health is necessary to ensure that bureaucratic barriers are not resulting in something as simple as a machine breakdown hindering the sustained implementation of teleradiology. Decision interdependency, collaboration and concurrent engineering between the hospitals, the suppliers of the equipment and/or the technicians and a manager of the entire system that can provide financial approval, could have lowered the organisational barrier.

5.6 Conclusion

This chapter investigated the organisational knowledge barrier that is present when telemedicine is implemented. The barrier was discussed with regard to teleradiology in the Eastern Cape. The need for cross-organizational workflow management, collaboration between all participants in the system and a degree of systems thinking were identified and the cause and effect analysis of Chapter 3 (p15) is further developed and shown in Figure 11. The combination of these three will result in the lowering of the organisational barrier in teleradiology in the Eastern Cape and will be considered in Chapter 8. The following chapter discusses the next barrier, behavioural factors.

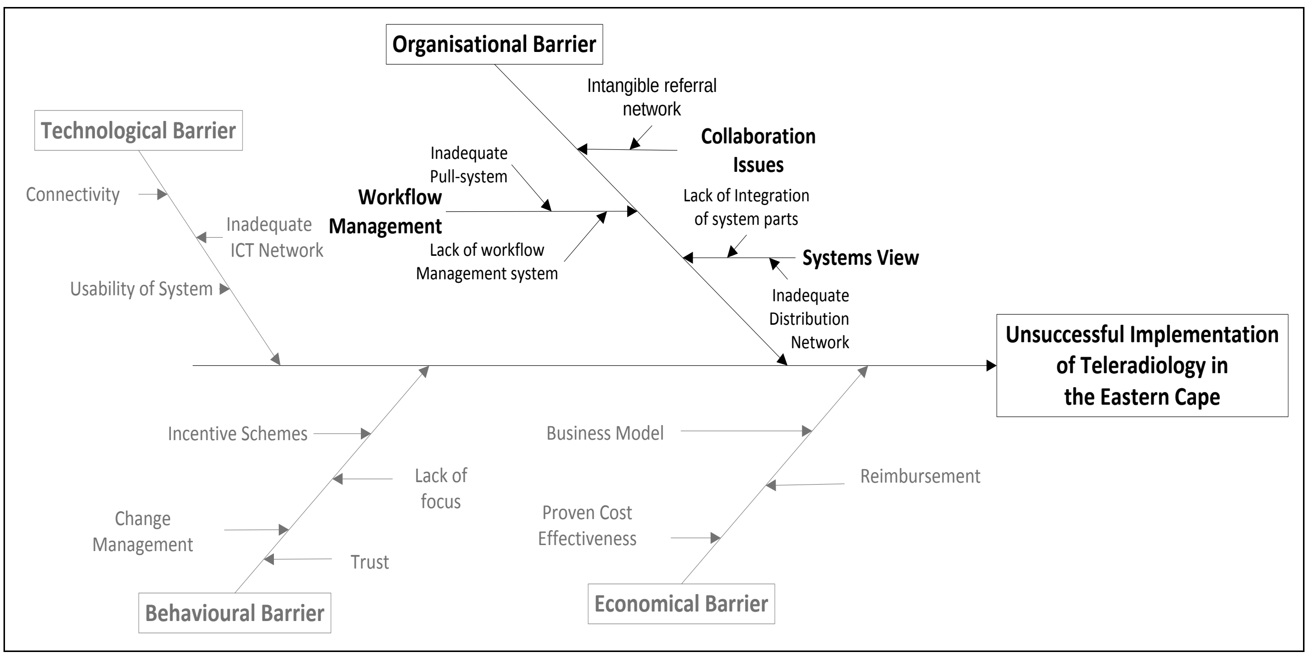
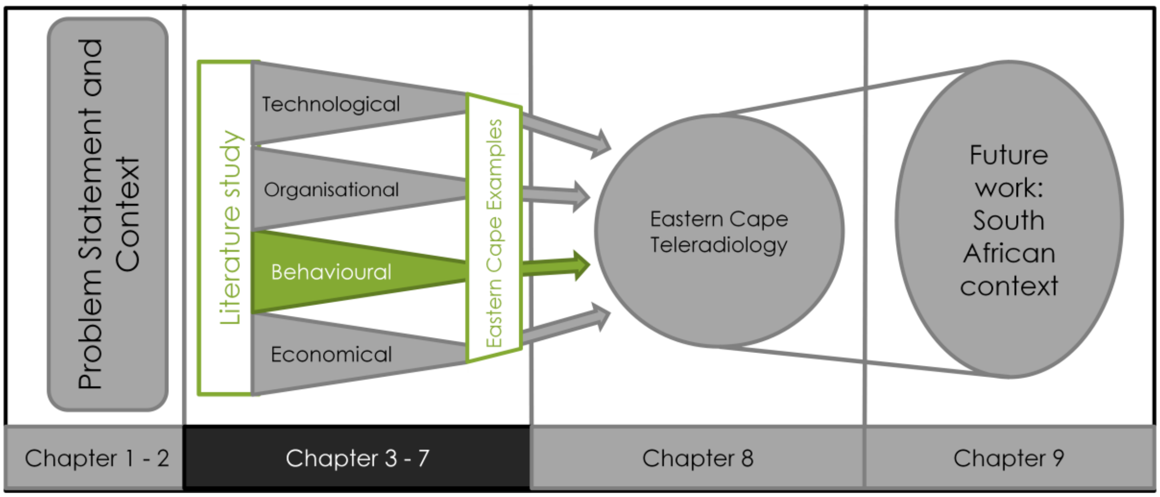


Figure 11 Expansion of the cause and effect analysis - an organisational barrier focus

6. Behavioural Barrier



6.1 Introduction

Chapter 3 identified four barriers as defined by Tanriverdi and Icano (1998) that inhibit successful implementation of telemedicine. The third of these barriers is the behavioural barrier. Although teleradiology is in principle a technological system, it is the interaction between the humans that use the system and the technology that is a major factor to the diffusion of the innovation in the health care service.

6.2 Incentive Schemes

> ***"Incentive systems are systems that encourage collaboration, managing across boundaries, and systemwide performance." Lindstrom* et al. *(1998)***

Sheng *et al*. (1999) identifies Change Management as a critical step in a Technology Management lifecycle such as telemedicine. In a discussion of a teleradiology case study, the management of radiologists' attitudes toward the system was deemed ineffective as no reward systems were established to promote the use of the system.

Fee for service is a term used in the literature to describe an incentive scheme where the income of the clinician depends on the quantity of services performed, and capitation refers to a scheme in which the income depends on the number of clients seen. Telemedicine is promoted in a lot of countries by introducing a fee for service or a capitation scheme for telemedicine cases done by clinicians.

In South Africa, public health care is run by government, and the government is the employer of all health care servants. This creates problems with regard to the development of incentive schemes and the introduction of remuneration for telemedicine. This in turn leads to a lack of motivation from the clinicians to make use of the system. It is proposed that the lack of incentive, especially at the referral site, is one of the major problems for the failure of telemedicine in the Eastern Cape. Specialists are more inclined to finish reports at their own hospital where there is more tangible pressure from the clinicians for quick diagnosis and reports than the intangible request for reports from the electronic telemedicine system. In addition, private radiologists receive a greater fee for service at their own firms and therefore these are priority.

Incentive schemes, especially with regard to remuneration schemes for telemedicine could be introduced, but this could mean that the specialist neglects its job at the facility where he is stationed. A possible solution could be to appoint a dedicated team of radiologists, at a separate facility. Remuneration will still be constant (in other words: not dependant on amount of reports) but since the specialists are dedicated to the telemedicine system, their focus will be more definite and time will be spent equally on the different sites' requests. At the recent South African Telemedicine Conference, Prof. Maurice Mars proposed that the lack of fee for service is the reason a lot of telemedicine initiatives are failing in South Africa (Mars, 2010). The following quote by Wranik and Durier-Copp (2010) creates the opposite view with regard to the support of salaries.

> ***"In a volatile environment such as the early implementation stages of telemedicine, fee for service or capitation will not always generate sufficient income as there might be a low patient population base. In contrast, salaries offer a stable income as it is independent of the number of patients."*** (Wranick & Durier-Copp, 2010)

This supports the solution of a dedicated, salary based radiologist in the initial unstable teleradiology system of the Eastern Cape.

Eastern Cape teleradiology currently makes use of approximately six radiologists in the private sector. With regard to monetary incentive, the payment per report written for a private client or patient is almost double of that that the government is willing to pay. While the current costing scheme for the teleradiology system is set at R65 per report, medical aid schemes pay up to R120 for a radiologist report (Richter (a), 2010). It is possible that other motivations are present, but on a costing level it is clear that incentive schemes from the government is not enough to ensure the radiologists' cooperation. A radiologist that is employed solely by the government will be dedicated to the system and incentive will be higher.

6.3 Change Management

Hitt, Miller and Colella (2009) identify three activities that are part of the transitional phase of planned change. Firstly, leaders should provide information and evidence that supports the proposed changes. Next potential constraints to making the change must be removed and lastly management should enable a shift in behaviour and implement the change by ensuring all the resources and training is in place.

In the hospitals visited in the Eastern Cape, the evidence supporting the change to telemedicine was mostly that experienced by the clinicians and to a lesser degree the radiographers. No visible evidence with regard to the cost savings and the accuracy of the diagnoses were available. Constraints to be removed such as low connectivity and inadequate radiologist reports were not within the clinical staff's capabilities. It is clear that change management in the teleradiological environment is very difficult. The public hospitals have a lot of difficulties in dealing with bureaucratic barriers and are often limited with regard to management.

As explained in the previous chapter, a complete systems view is necessary for effective change management, while the management of the different hospitals are scaled to within a node of the network. Change management should originate from someone with authority in the bureaucratic environment and with a view on the entire system. A manager of the entire system should interact with the clinical managers and staff at the different sites to help create a suitable environment for change management within the hospitals, or nodes of the system.

6.4 Conclusion

The chapter discussed the behavioural barrier that prevents complete diffusion of teleradiology in the Eastern Cape. As the system is dependent on humans to function amply, the behavioural barrier can mean the difference between a successful and unsuccessful system. This project identified the mismanagement of incentive schemes and the lack of change management throughout the entire system as components of the behavioural barrier. The cause and effect analysis of Chapter 3 (p15) is updated in Figure 12. The next chapter investigates the economical barrier which is directly related to the behavioural factor of incentive schemes.

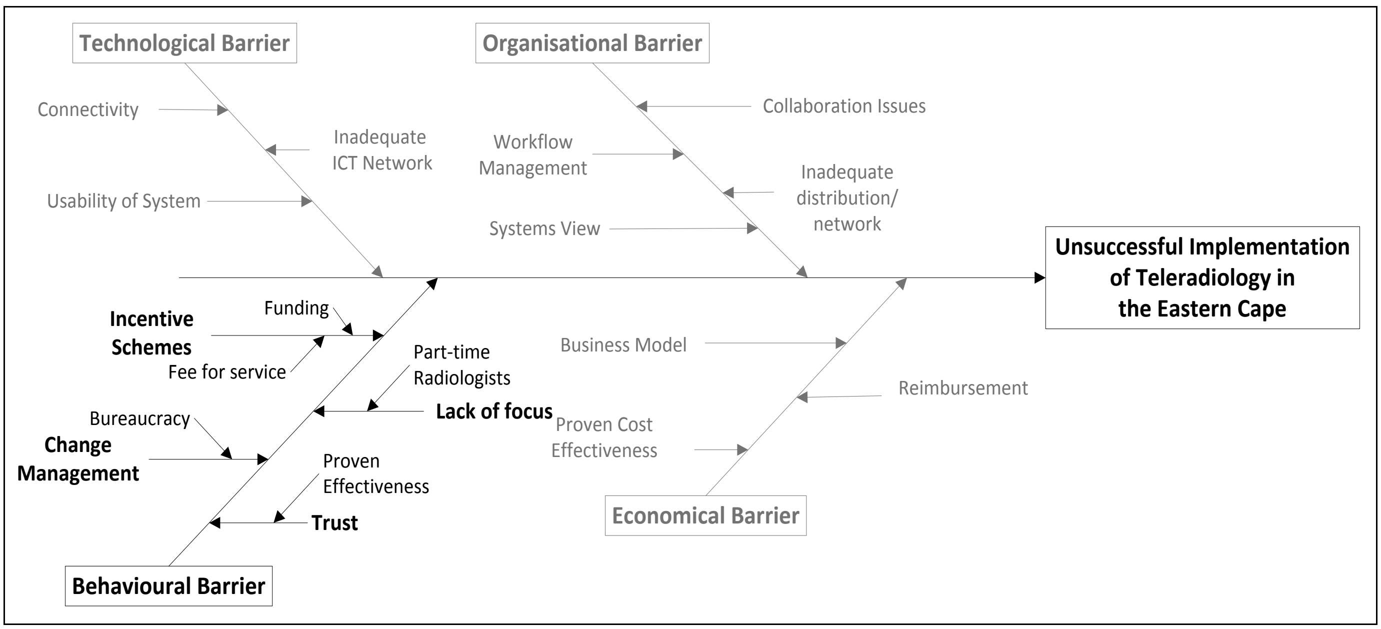
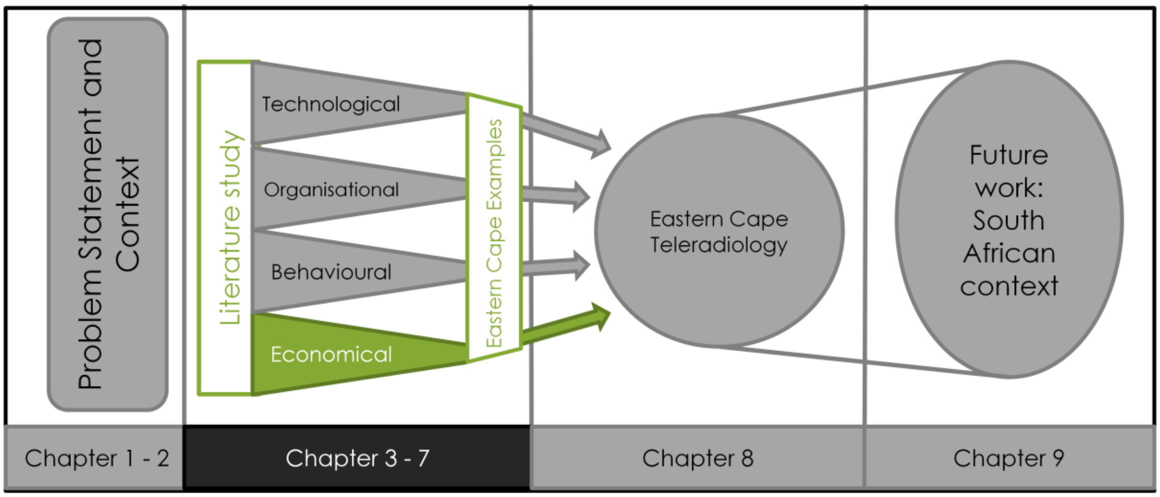


Figure 12 Expansion of the cause and effect analysis - a behavioural barrier focus

7. Economical Barrier



7.1 Introduction

The previous chapter concluded the discussion on the behavioural barrier to telemedicine by singling out two factors; change management and incentive schemes. These incentive schemes were directly linked to reimbursement schemes, and this then introduces the last barrier, the economical barrier. Tanriverdi and Icano (1998) define the economic knowledge barriers as the inability to develop business models that satisfy all involved in telemedicine.

7.2 Cost-effectiveness

The literature on telemedicine and the evaluation of telemedicine illustrated that there seems to be a void with regard to the assessment of cost-effectiveness of telemedicine.

A systematic review of the literature states that in the fifty reviewed assessment studies adequate data on effectiveness and cost-effectiveness of telemedicine are still lacking and that there is a lack of studies that uses a scientific control-case to compare the costs and benefits of such a system. It further states: "Scientific data concerning the effectiveness of telemedicine remain limited" (Roine, Ohinmaa & Hailey, 2001).

It seems as though cost-effectiveness and a true business model for telemedicine is deemed as absolutely necessary if this mode of health-care is to be continued in the country. "The case for cost-effectiveness is far from proven and this area of research requires immediate attention if potential users are to be convinced of the value of telemedicine." (Brebner, Brebner & Ruddick – Bracken, *2006)*

In the Eastern Cape, radiographers at most hospitals were aware of the benefits related to the digitising of images. At Uitenhage hospital, this was regarded as an achievement in the department in driving down the cost of the service. This does however not imply that the cost-effectiveness of teleradiology has been proven and accepted by the users. Taking Uitenhage as instance once again, the unsuccessful teleradiology system is replaced by a private consulting radiologist that do the hospital's reports. As clinicians are generally removed from the financial department and decisions regarding costs, this is regarded as an easier and proven custom and the cost-effectiveness of the practice is deemed irrelevant.

The clinician's view is however contrasted with that of management; in healthcare, especially the public sector, a manager's concern is providing quality service at the lowest possible cost. It is proposed that the economic barrier to telemedicine implementation implies that knowledge regarding cost-effectiveness need to be created for the management of the different hospitals to ensure adequate support from the authority figures in the organisations.

Literature demonstrates that cost-effectiveness is a very important aspect of telemedicine that is often neglected and necessary to convince management of a system. This will be considered during the assessing of alternatives in Chapter 8.

7.3 Business Case

A business case is built to justify the existence of a project. It should include people, processes, and technology changes. Of course, a business case is directly related to financial terms, as it is often used in profit-organisations. A business case is a statement of the goals for telemedicine programs that are backed by detailed financial analysis showing viability, sustainability and return on investment in achieving goals (Med-RT, s.a.).

In the telemedicine environment, profit is not always the main goal, and other benefits such as improved health-care and better utilisation of specialist are equally important. However, any project or alternative should be able to prove its viability and sustainability in the challenging economic world of the 21st century. A telemedicine business case (Med-RT, s.a.) is applied to teleradiology in the Eastern Cape in Figure 13 by identifying direct revenue, direct cost, indirect cost and enhanced revenue/ reduced cost.

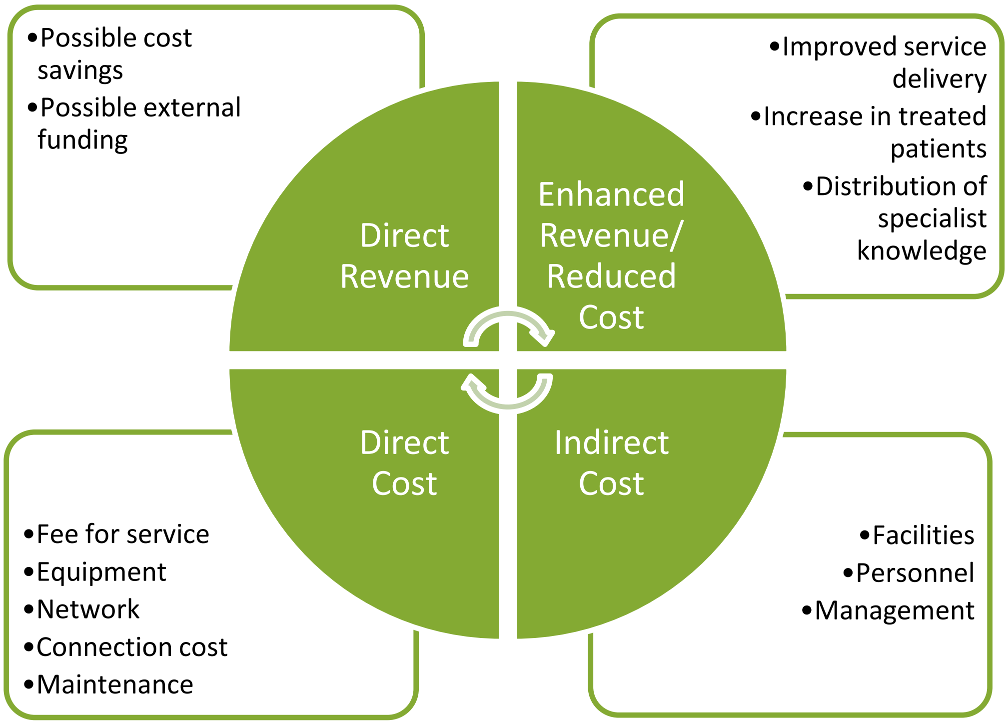


Figure 13 Business case for Teleradiology in the Eastern Cape

The figure provides a framework that is used when developing a business case to address the economic barrier. While cost components are easily deducted, revenue in a telemedicine system is not necessarily monetary, and revenue needs to be measured in alternative ways. It is apparent that the teleradiology system in the Eastern Cape lacks direct revenue, and this could contribute to the economic barrier.

The following quote by Yellowlees (2005) emphasizes that at this stage of implementation, failure of the complete adoption and sustained use of the system could be detrimental to the bigger telemedicine strategy in the province and in South Africa. With the financial investment already made, the business case regarding cost is transformed.

"The cost of failing to introduce a telemedicine system properly is enormous. These comprise not only the financial costs of the equipment and time put into the development, but perhaps more importantly the long-term psychological costs of failure." (Yellowlees, 2005)

7.4 Example of the Economical Barrier – Uitenhage Provincial Hospital

Uitenhage Provincial Hospital is situated close to the Port Elizabeth Hospital Complex to which patients are referred. Uitenhage has achieved remarkable successes in teledermatology and the presence of a telemedicine champion should contribute to the successful implementation of teleradiology. As explained earlier, there are some doubts as to whether cost-effectiveness at Uitenhage has been properly demonstrated. A comparison between the two modes of service delivery (consulting private radiologist and teleradiology) provides an overview of the costing of the system at the hospital. Uitenhage is unique as the private radiologist has continued delivering services during the implementation phase of teleradiology. This could provide interesting data on the clinical viability of the system, but as stated earlier, this is beyond the scope of this project. On a cost-effectiveness level this mode of service delivery, although necessary due to the unstable nature of the system, results in a doubling of the cost.

Table 6 shows the comparison in cost of the two different modes of service delivery practised at Uitenhage Hospital; teleradiology and a consulting private radiologist. The teleradiology data is obtained by obtaining a mean with a confidence interval of 95% from the number of cases that needed referral to a radiologist according to the statistics obtained from the hospital. This is multiplied by R65.00 (the cost per report for the teleradiology system). The consulting radiologist data is gathered from the costing document as drawn up by the Radiologist Society of South Africa (RSSA, 2008) and adjusted according to the newest available data on salary per year in the public sector (R962, 174). Assumptions are made regarding the productivity factor and the minutes per session at the hospital.

Table 6 A comparison of cost on two different modes of delivery of radiology at Uitenhage Hospital

Uitenhage Cost Comparison

Teleradiology

Month	**Radiologist cases**	
May-09	232	
Jun-09	146	
Jul-09	145	
Aug-09	121	
Sep-09	144	
Oct-09	183	
Nov-09	211	
Dec-09	137	
Jan-10	122	
Feb-10	146	
Mar-10	131	
Apr-10	137	
Mean	154.58	
StdDev	35.29	
N	12	
alpha	5%	
Z	1.96	
H	19.97	
Number of reports per month:		**155**
Confidence interval (95%):		135
		175
Fee per report:		R 65.00
Teleradiology cost:		R 10,075.00
		R 8,775.00
95% Confidence		R 11,375.00

Consulting Radiologist

Salary per year	R 962,174
Available minutes per year	
Workdays per year	365.25
Less weekends	105
Public Holidays	11
Sick Leave	8
Annual Leave	22
Net Days	219.25
Hours per working day	8
Available minutes per year	105240
Productivity factor	0.75
Actual minutes per year	78930
Cost per minute	R 12.19
Minutes per session	120
Sessions per week	2
Weeks per month	4
Cost per month	R 11,702.61

As shown in Table 6 the cost of the consulting radiologist exceeds that of the upper limit of number of cases' cost with teleradiology, and teleradiology seems to be the most cost-effective solution, albeit fairly marginal. The initial costs regarding capital investments in the teleradiology system are not considered as it is already installed and not regarded as part of the current cost-effectiveness analysis. Should a new system be installed at a different hospital, a complete analysis on the cost of equipment and connectivity should be considered.

Table 7 shows a Present Value analysis over 5 years, using the mean of the South African inflation rate in the months of September 2009 – August 2010, 5.16% (South African Reserve Bank, 2010). The salary of a consulting radiologist is contrasted to the fee for service costs per report of teleradiology. The present value analysis shows that a new teleradiology system need to incur capital cost between R23 106.19 – R206 483.03 (95% confidence level) if it is to be considered cost-effective in comparison to a consulting radiologist. Once the exact figures concerning the cost of teleradiology equipment is available the decision maker should consider procurement decisions within context of the ranges provided through this cost analysis.

Table 7 Present value analysis of two radiology options over 5 years

Present Value			n	5
5 years			i	5.16%
Teleradiology		**Consulting Radiologist**		**Difference**
Lower CI	R 618 896.83	R 825 379.86		R 206 483.03
Mean	R 710 585.25			R 114 794.61
Upper CI	R 802 273.67			R 23 106.19

The Uitenhage Hospital and present value analysis highlights the problem with regard to cost analysis that is found throughout literature as the two options (teleradiology vs private consulting radiologist) is contrasted in monetary terms, but other benefits related to teleradiology are neglected. A true business case will include a contrast in the availability of the radiologists, the amount of cases referred by the two systems (resulting in more efficient health care delivery) and the difference (if any) in clinical effectiveness. A summary of these factors are listed in Table 8.

Table 8 Non-monetary contrast between consulting radiologist(s) and teleradiology

	Consulting Radiologist	Teleradiology
Availability of radiologist	2 times per week	Daily
Amount of cases	Increase in cases will result in an additional radiologist (increase in cost)	Can increase considerably due to the network of radiologists available
Clinical effectiveness	Normal	No case-controlled evidence

7.5 Conclusion

The chapter discussed the economical barrier present in the implementation of teleradiology. Although literature demonstrates a lack of cost-effectiveness studies and in particular in a quantitative analysis of improvement in health and service delivery, the chapter shows that cost-effectiveness can be demonstrated by comparing two different modes of deliveries that result in the same added quality of life. Regardless, there remains a void with regard to quantifiable data on accessibility and clinical effectiveness of the two modes. While accessibility simply is not in the scope of this project, clinical effectiveness is not within the student's competence. Although the case for cost-effectiveness is multi-faceted, an economic evaluation can assist decision makers in differentiating between different options. The cause and effect analysis of Chapter 3 (p. 15) is expanded with regard to the economic barrier in Figure 14.

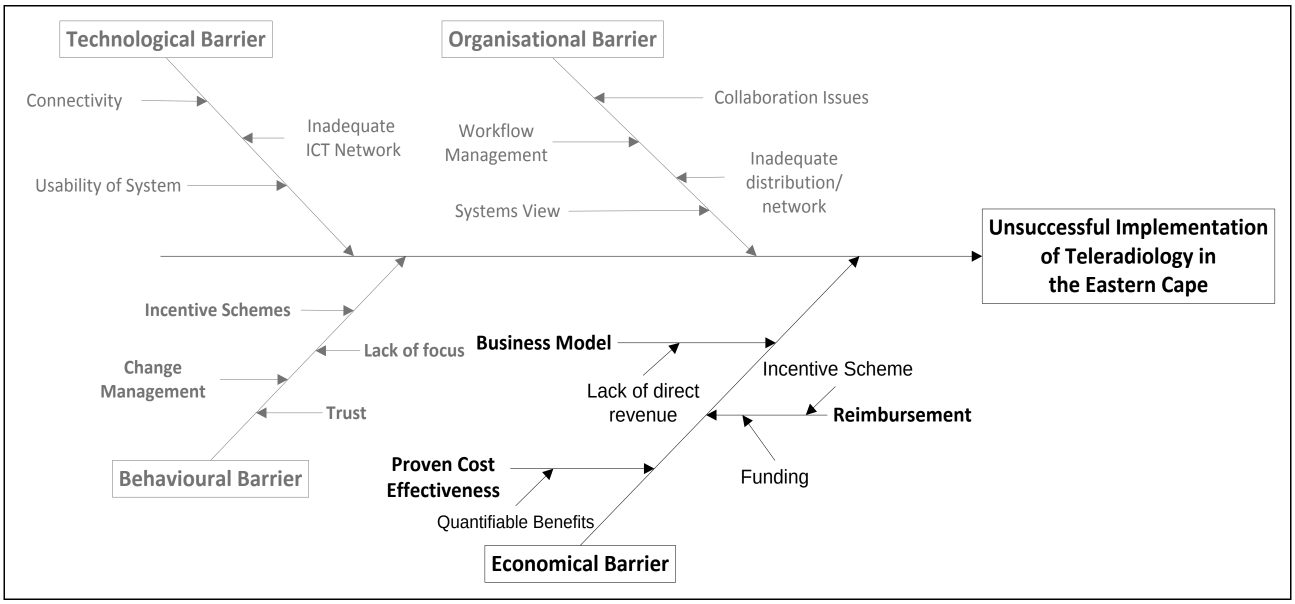
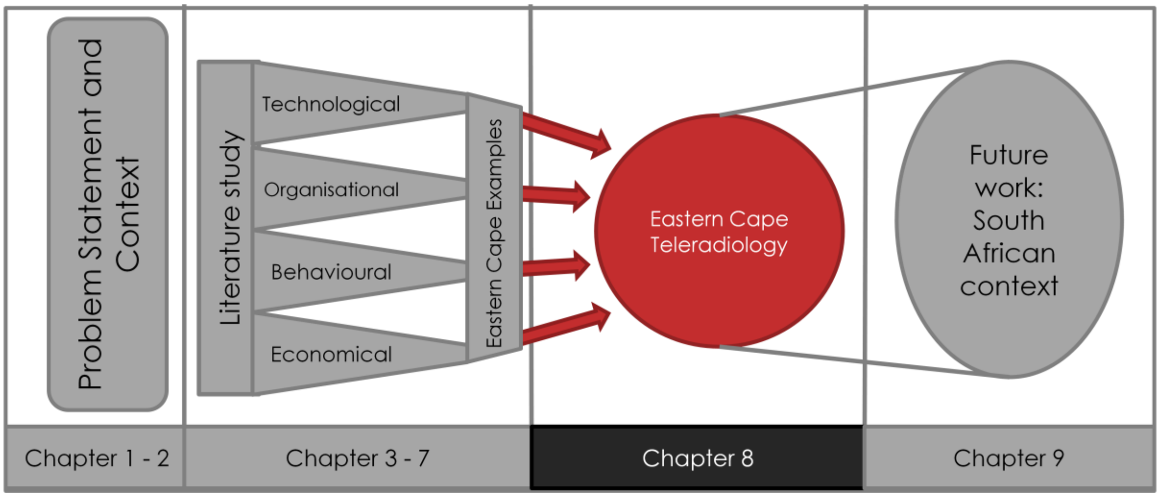


Figure 14 Expansion of the cause and effect analysis - an economical barrier focus

8. Teleradiology in the Eastern Cape



8.1 Introduction

The previous chapters overviewed the implementation barriers that are present in teleradiology in the Eastern Cape, starting with a broad view of the literature and narrowing it down to examples in the Eastern Cape. This chapter investigates the barriers in an integrated way with regard to the entire system. The complete cause and effect analysis is attached as Appendix A. Alternative solutions are proposed and the effect of these on the barriers is compared through the analytic hierarchy process.

8.2 Interrelatedness of the Implementation Barriers

It is notable that on some levels, the different implementation barriers are interlinked. For example, one of the major technological elements in a teleradiology system is the speed at which images and information is transferred from the referring hospital to the referral radiologist. This technological element influences the behavioural, economical and organisational barriers. Suppose a connection speed enables images and request for reports to be downloaded at 3 - 5 minutes per report. This results in a throughput rate of 20 reports per hour. With the incentive scheme currently in place, this could result in a payment of R1300 per hour.

If the technological barrier is lowered, and images and request for reports can be downloaded in 30 seconds, throughput rates increase to 100 reports per hour and a payment of R6500 per hour.

Factors such as the speed at which the report is typed become a factor, and 100 reports per hour are not necessarily feasible, but the given example just gives an indication of the interrelatedness of the different barriers. The example is summarised in Table 9. Should the technological barrier be lowered, the organisational barrier with regard to scheduling and rate of workflow is improved and the economical and behavioural barriers are affected by the amount of payment generated by the radiologist.

Table 9 An example of the interrelatedness of the implementation barriers

Technological	Organisational	Economical and Behavioural	
Time of download	# of reports per hour (throughput)	Payment per hour	
5 minutes	20	R1300	
30 seconds	100	R6500	

The lowering of implementation barriers is an iterative process that can also be explained with the example above. Once connection problems are addressed (technological), the throughput rate of reports is dependent on other factors such as the number of radiologists and the amount of money available. Scheduling and workflow management become new barriers that were not present while the technological barrier impeded the throughput rate.

8.3 Cost-effectiveness of Dedicated Radiologist(s) and Teleradiology

As proposed in chapters 4 – 7 (pp. 16-41), a dedicated radiologist employed by the Eastern Cape Department of Health might result in the lowering of different barriers. The technological barrier will be lowered as the radiologist will have direct access to the distribution centre at Bhisho. The organisational barrier will be lowered as the boundary between public and private organisation will no longer be present, workflow can be scheduled due to the fact that the radiologist is dedicated to the system and systems thinking will be promoted due to the dedication and the presence of the radiologist at the primary node of the system. As explained in Chapter 6 (p. 32), the behavioural barrier will be lowered due to the salary-based payment (provided the salary is high enough). The case for cost-effectiveness is however not as easily explained and a study of the costs of the two different options needs to be considered. Table 10 shows the calculations to determine the amount of reports currently being requested in the Eastern Cape. The number of hospitals are also tabulated and expressed as a percentage of the projected total hospitals to be involved in the system.

Table 10 Number of reports currently needed in the Eastern Cape

Number of reports			
Teleradiology			
Month	**Radiologist cases**		# of hospitals
Sep-09	1495		4
Oct-09	3029		5
Nov-09	4020		6
Dec-09	2653		6
Jan-10	1802		7
Feb-10	2001		10
Mar-10	1467		9
Apr-10	384		11
May-10	2215		14
Jun-10	2270		12
Jul-10	2744		20
Aug-10	1625		16
Mean	2142.08	Average:	10
StdDev	920.79	Projected total:	21
N	12	**Percentage of hospitals currently reporting**	**47.62%**
Alpha	5%		
Z	1.96		
H	520.979		

Table 11 shows the expected number of reports that will be requested if all the hospitals participate and summarises the comparison of the costs and capacity of a radiologist that is dedicated to the system and the part time private radiologists that constitute the current system.

Table 11 A comparison of costs and capacity of dedicated radiologist(s) and part time private radiologists

			Dedicated Radiologist			**Part-time Radiologist**	
	Nr. of reports:	Nr. of reports if all 21 hospitals participate:	Nr. of minutes needed per month	Nr. of radiologists needed (roundup)	total cost (year)	Nr. of reports per year	total cost (year)
Mean:	2142.08	4499	44990	7	R 6 735 218	53988	R 3 509 220
Confidence interval (95%):	1621.10	3405	34050	6	R 5 773 044	40860	R 2 655 900
	2663.06	5593	55930	9	R 8 659 566	67116	R 4 362 540
			Minutes per year:		78930	Cost per report:	
			Minutes per month		6577.5		R 65
			Salary per year		R 962 174		

The current system (referral to various radiologists and fee for service) results in remarkable lower costs, as the cost per report (10 minutes * R12.10) result in a far higher cost than R65.

The cost analysis has shed some doubt on the capacity of the current system. If a total of 25 707 reports were requested in a year, the non-participating hospitals are incorporated, and the time trials of the Radiologist Society of South Africa (2008) are used, the system generates enough work for 7 dedicated radiologists. The current system of approximately 6 part-time radiologists implies that the 100% utilisation of the teleradiology system would result in more than 100 % of their time to be spent on the system. Not only is this not feasible (the network of referring radiologists needs to be expanded) but as discussed earlier, the incentive for taking part in this project is relatively low, and a radiologist at a private practice spending more than 50% of their time on the system is considered unviable.

These factors are all considered in the Analytic Hierarchy Process that is used to evaluate the alternatives to the system in the next section.

8.4 The Analytic Hierarchy Process

The analytic hierarchy process (AHP) is an operations research tool developed by Thoma Saaty that is used to make decisions in situations involving multiple objectives (Winston, 2004). The tool involves developing a hierarchy of the original problem (in this case a sustained teleradiology system) by subdividing it into objectives to be reached. A number of alternatives is assigned a relative score (s_j) with regard to the objectives being fulfilled. The alternative with the highest score is chosen.

8.4.1 Notation

i	=	1, 2, 3... n (i^{th} Objective to be fulfilled)
w_i	=	weight assigned to the i^{th} objective
j	=	1, 2, 3... n (j^{th} alternative being considered)
s_j	=	overall score assigned to j^{th} alternative
A	=	Pairwise comparison matrix

8.4.2 Objectives

The objectives of the system are used as a measurement for the different alternatives and summarised in Table 12. The objectives are derived from the previous chapters on the different barriers in an attempt to address each of the barriers that hinder the sustained implementation of teleradiology in the Eastern Cape.

Table 12 Summary of objectives considered in Analytic Hierarchy Process

i =	Objective	Explanation	Symbol	Barrier
1	Cost-effectiveness	Is the alternative cost-effective?	CE	Economic
2	Workflow management	Will the alternative contribute to successful workflow management?	WFM	Organisational
3	Collaboration	Does the alternative offer a viable mode of collaboration between the different participants?	COL	Organisational
4	Connectivity	Will the alternative result in better connectivity?	CON	Technological

i =	Objective	Explanation	Symbol	Barrier
5	Incentive	Will the alternative promote incentive of the participants?	IN	Behavioural

8.4.3 Alternatives

The alternatives to be considered for a sustained teleradiology system can be expanded to include other options.Table 13 lists the alternatives that are considered in this project.

Table 13 Summary of alternatives considered in Analytic Hierarchy Process

j =	Objective	Explanation	Abbreviation
1	As is system	The current system is left as it is.	AI
2	No Teleradiology	An alternative of no teleradiology is considered (used as control case if decision maker wants to introduce a new system).	NT
3	Improve connectivity	Connectivity is improved, both between the hospitals and Bhisho, and Bhisho and the radiologist.	CON
4	Appoint dedicated radiologist(s) at Bhisho	A dedicated radiologist to the project with direct access to the distribution centre is appointed.	DR

8.4.4 Discussion of the Analytic Hierarchy Process Results

The different matrices used to calculate the relative weights are attached as Appendix B. The graphical presentation of the hierarchy and different weights are presented in Figure 15. The final scores are as follows:

$S_1 = 0.30$

$S_2 = 0.16$

$S_3 = 0.22$

$S_4 = 0.32$

The purpose of the analysis of the different objectives and alternatives is to provide a framework that decision makers can use to compare different alternatives. It is still interesting to note that the application of the process to the Eastern Cape system results in the proposed dedicated radiologist(s) at a central telemedicine hub in Bhisho. The 'No Teleradiology' alternative is difficult to assess as the teleradiology system is already in place, and objectives such as cost-effectiveness are certainly not met if no teleradiology is installed. In addition, the project does not include any clinical analysis on the accuracy of the system. Figure 16 summarises the hierarchy followed to evaluate the alternatives.

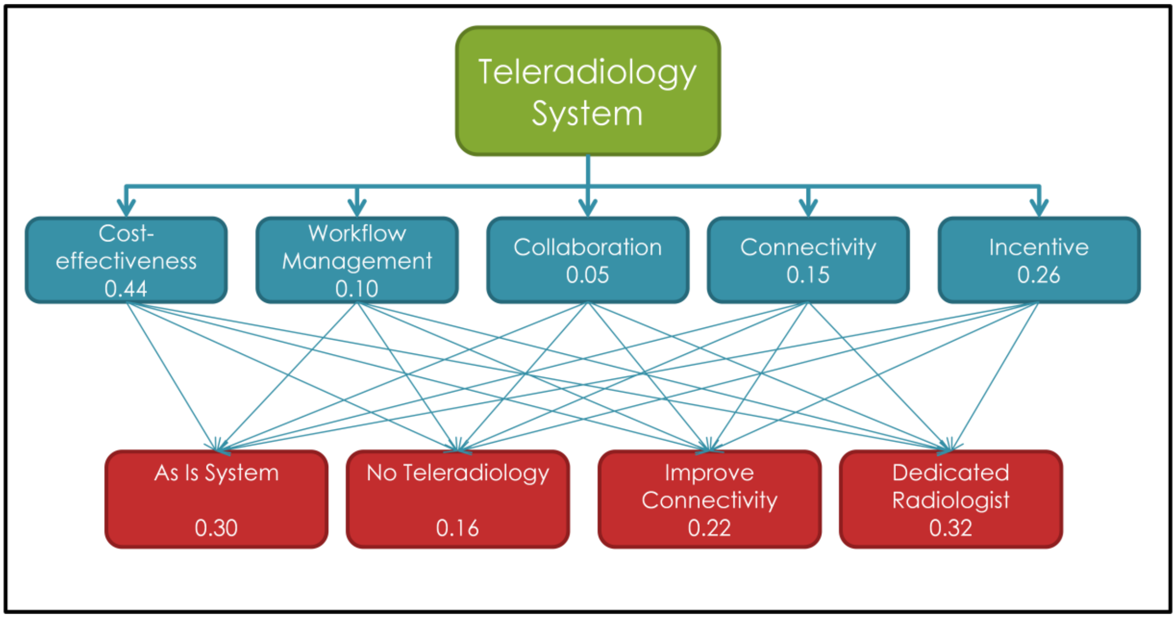
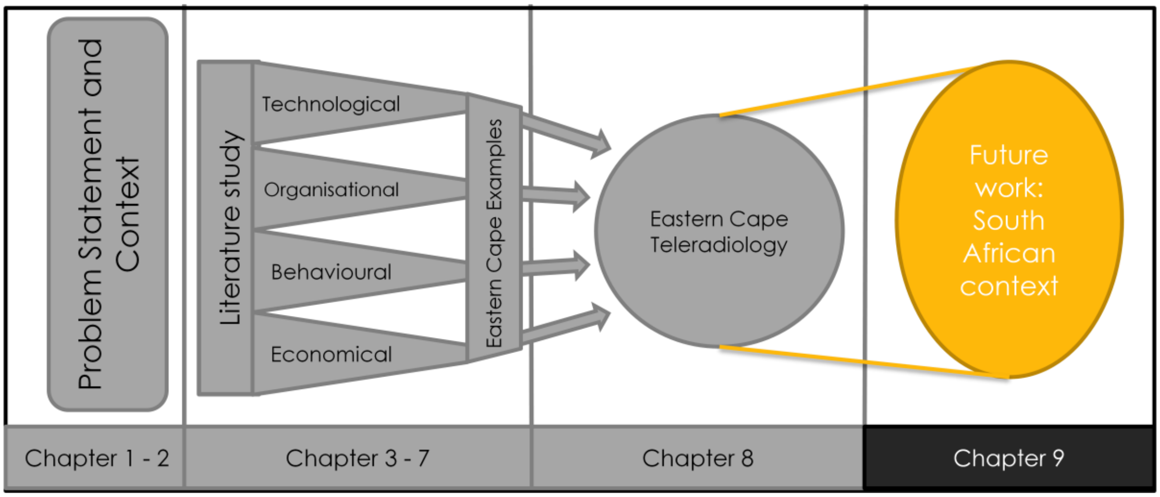


Figure 15 Graphical presentation of hierarchy used in decision making process

8.5 Conclusion

The chapter integrated the literature and discussions on the different implementation barriers by extrapolating the knowledge onto the entire Eastern Cape teleradiology system. The interrelatedness of the different implementation barriers were discussed, illustrating that the implementation barriers should be considered in a holistic manner. Two alternatives were discussed with regard to their effect on the implementation barriers. Lastly the different alternatives were assessed through the Analytic Hierarchy Process by measuring the degree to which certain objectives are fulfilled. It is clear that the merging of implementation barriers pose a unique problem and that a systems view needs to be adopted to ensure that a teleradiology solution addresses all four barriers.

9. Conclusion and Future Work



9.1 Value of the Project to Telemedicine in South Africa

The teleradiology system in the Eastern Cape has great potential to be a successful and sustainable telemedicine initiative, and as explained in this document, once the barriers to the complete diffusion has been lowered, the system will serve as an example of the value of teleradiology to the health care system of South Africa.

The project contributes to telemedicine in South Africa by providing an original view on the barriers present when implementing teleradiology initiatives. The output of the project is a framework towards enhanced utilisation that can be applied to various telemedicine projects and is not limited to teleradiology.

The project contributes towards the literature regarding the implementation of telemedicine in a developing country such as South Africa and the barriers present in the country's health care system.

A telemedicine strategy for South Africa is currently being drafted. This document is delivered to the Manager of Telemedicine to be used as input in the drafting of the telemedicine strategy to ensure that the barriers identified are sufficiently addressed in all future telemedicine projects in South Africa.

9.2 Value of the Project to the Student

This project was undertaken to assess the implementation of teleradiology in the Eastern Cape. The value of the project to the student was learning to continuously reassess the problem and changing direction once a certain path followed did not result in a solution. The project also required a lot of patience as working in a multi-disciplinary, uncertain, developing and bureaucratic environment can be frustrating at times. Independent learning ability and professional conduct was proven through the independent study of the literature as well as interaction with stakeholders.

As part of the Industrial Engineering studies, the project was valuable as a large system that involves technology, people, legislation, processes and a costing focus was assessed and experience in addressing and integrating different aspects to obtain a solution was gained.

In addition, valuable experience was gained in managing a busy academic schedule, executing a project with definite milestones and independently applying the knowledge gained in previous years of study.

9.3 Future Work

The following are some points that were not within the scope of the project, either because of time or competence limitations but that will certainly contribute to the assessment and the sustained implementation of the teleradiology system.

- The development and installation of a work-flow management system to enable the equitable distribution of the request for reports to the radiologists.

- The service provider is currently installing devices that will measure the performance of the different PACS and at Distribution Centre. These measurements will give a clear indication as to where the bottleneck in the current technological system is located. This data will contribute to the work done in this project and might shed light on new issues that need to be addressed.

- A clinical analysis of the quality of images sent through the system and the quality of reports. Although the quality of images can be assessed by an engineering student, a true clinical study is not within the competence of the student.

- A clinical assessment on the percentage of the images that requires a radiologist report. Richter (2010a) suggests that some of the clinicians at the hospitals diagnose patients from images without proper radiographic knowledge. The ideal is that all radiology images are accompanied by a radiologist report.

- A limitation of the project is the lack of exact costing data, especially with regard to the capital cost of equipment as the system under assessment has already incurred these costs. If precise data is available, a comprehensive cost analysis can be executed.

9.4 Conclusion

The problem statement and title of the project was to assess the implementation of teleradiology in the Eastern Cape and the outcome scoped to an assessment and a framework towards the enhanced utilisation of the system. This document demonstrates the methodology followed to achieve this outcome. The project required a great deal of literature study to ensure that the system is assessed from a wide perspective. This wide view was narrowed by applying the literature to aspects of the systems in the Eastern Cape witnessed during the MRC Monitoring and Evaluation during June 2010 and through interviews with role players in the system. Although the assessment of the different implementation barriers present in the system fulfilled the original problem statement; an engineering perspective of providing possible alternative solutions was included to contribute to the lowering of these barriers and to contribute to a framework that can be used by future assessors and decision makers.

It is anticipated that the work presented in this document will contribute to the literature available on the implementation of teleradiology, specifically in South Africa and other developing countries. The project provides a framework of assessment that can be applied to any telemedicine initiative and is not limited to teleradiology. In addition, this project should provide an original view on the current system to decision makers in the province and subsequently contribute to the sustained implementation and higher utilisation of the system in place.

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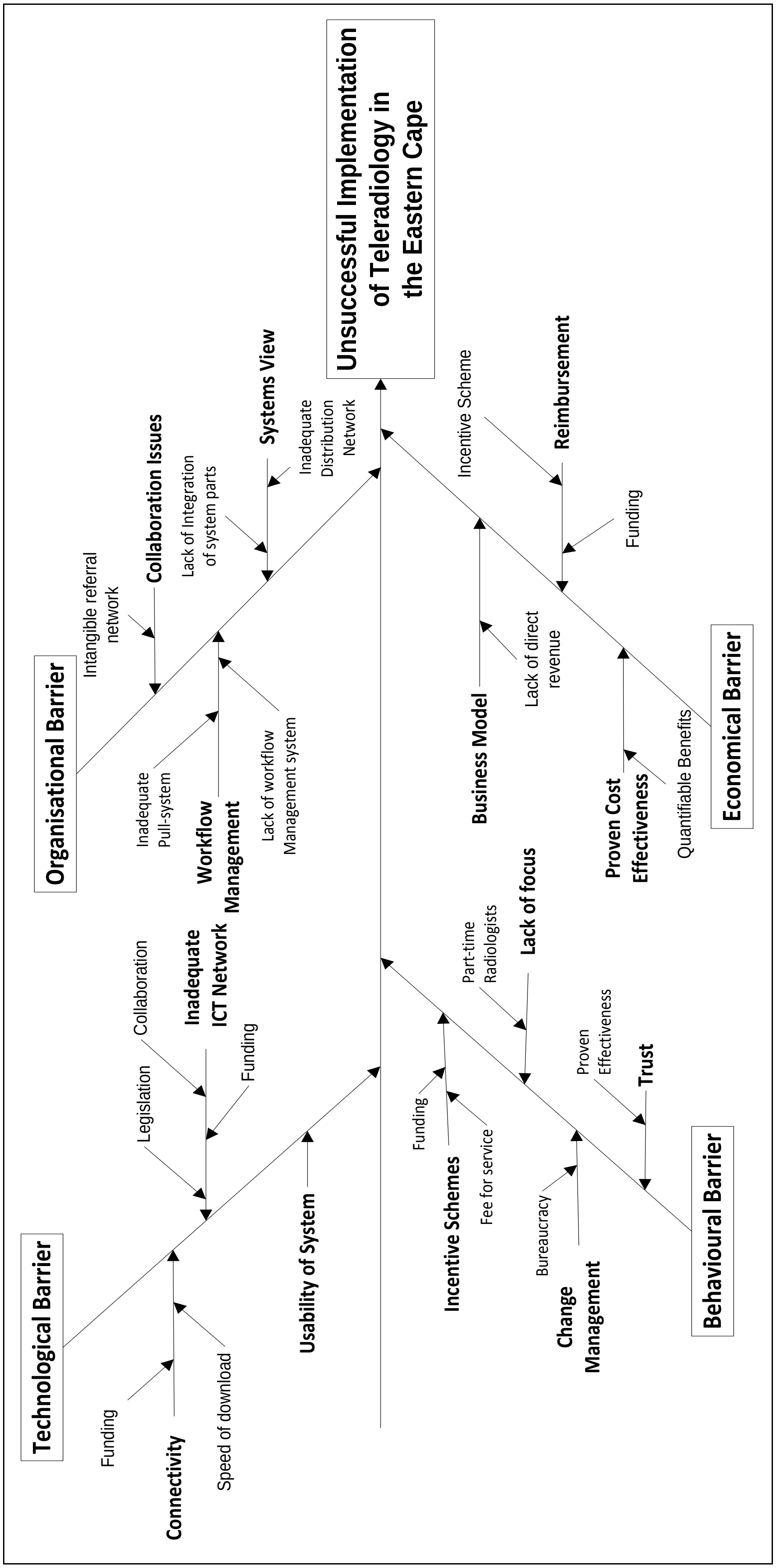
Appendix A:
Complete Cause and Effect Analysis


Unsuccessful Implementation of Teleradiology in the Eastern Cape
Organisational Barrier
Collaboration Issues
Intangible referral network
Lack of Integration of system parts
Systems View
Inadequate Distribution Network
Workflow Management
Inadequate Pull-system
Lack of workflow Management system
Economical Barrier
Reimbursement
Incentive Scheme
Funding
Business Model
Lack of direct revenue
Proven Cost Effectiveness
Quantifiable Benefits
Technological Barrier
Connectivity
Funding
Speed of download
Inadequate ICT Network
Legislation
Collaboration
Funding
Usability of System
Behavioural Barrier
Lack of focus
Part-time Radiologists
Trust
Proven Effectiveness
Incentive Schemes
Funding
Fee for service
Change Management
Bureaucracy

Appendix B:
Analytic Hierarchy Process

Abbreviations:

i =	Objective	Symbol	j =	Objective	Abbreviation
1	Cost-effectiveness	CE	**1**	As is system	AI
2	Workflow management	WFM	**2**	No Teleradiology	NT
3	Collaboration	COL	**3**	Improve connectivity	CON
4	Connectivity	CON	**4**	Appoint dedicated radiologist(s) at Bhisho	DR
5	Incentive	IN			

Objectives:

WEIGHTS (A)

	CE	WFM	COL	CON	IN
CE	**1**	**4**	**6**	**3**	**3**
WFM	**0.25**	**1**	**3**	**0.5**	**0.33333**
COL	**0.16667**	**0.25**	**1**	**0.25**	**0.2**
CON	**0.33333**	**2**	**4**	**1**	**0.33333**
IN	**0.33333**	**3**	**5**	**3**	**1**

MATRIX (A NORM)

	CE	WFM	COL	CON	IN
CE	0.4800	0.3902	0.3158	0.3871	0.6164
WFM	0.1200	0.0976	0.1579	0.0645	0.0685
COL	0.0800	0.0244	0.0526	0.0323	0.0411
CON	0.1600	0.1951	0.2105	0.1290	0.0685
IN	0.1600	0.2927	0.2632	0.3871	0.2055

DECISION MAKER WEIGHTS (W)

i	w_i
1	0.4379
2	0.1017
3	0.0461
4	0.1526
5	0.2617

Alternatives:

DECISION SCORES ON OBJECTIVES:

Cost-effectiveness (i=1)

	AI	NT	CON	DR
AI	1	3	5	5
NT	0.33333	1	5	2
CON	0.2	0.2	1	1
DR	0.2	0.5	1	1

w_{ij}	Scores
W_{11}	0.54686
W_{12}	0.26099
W_{13}	0.0881
W_{14}	0.10405

Workflow Management (i=2)

	AI	NT	CON	DR
AI	1	1	0.33	0.16667
NT	1	1	1	1
CON	3	1	1	0.33333
DR	6	1	3	1

w_{ij}	Scores
W_{21}	0.11752
W_{22}	0.2321
W_{23}	0.21089
W_{24}	0.43949

Collaboration (i=3)

	AI	NT	CON	DR
AI	1	7	0.33	0.14286
NT	0.14286	1	0.125	0.11111
CON	3	8	1	0.16667
DR	7	9	6	1

w_{ij}	Scores
W_{31}	0.12875
W_{32}	0.03695
W_{33}	0.21016
W_{34}	0.62415

Connectivity (i=4)

	AI	NT	CON	DR
AI	1	3	0.14	0.33333
NT	0.33333	1	0.11111	0.11111
CON	7	8	1	3
DR	3	9	0.33	1

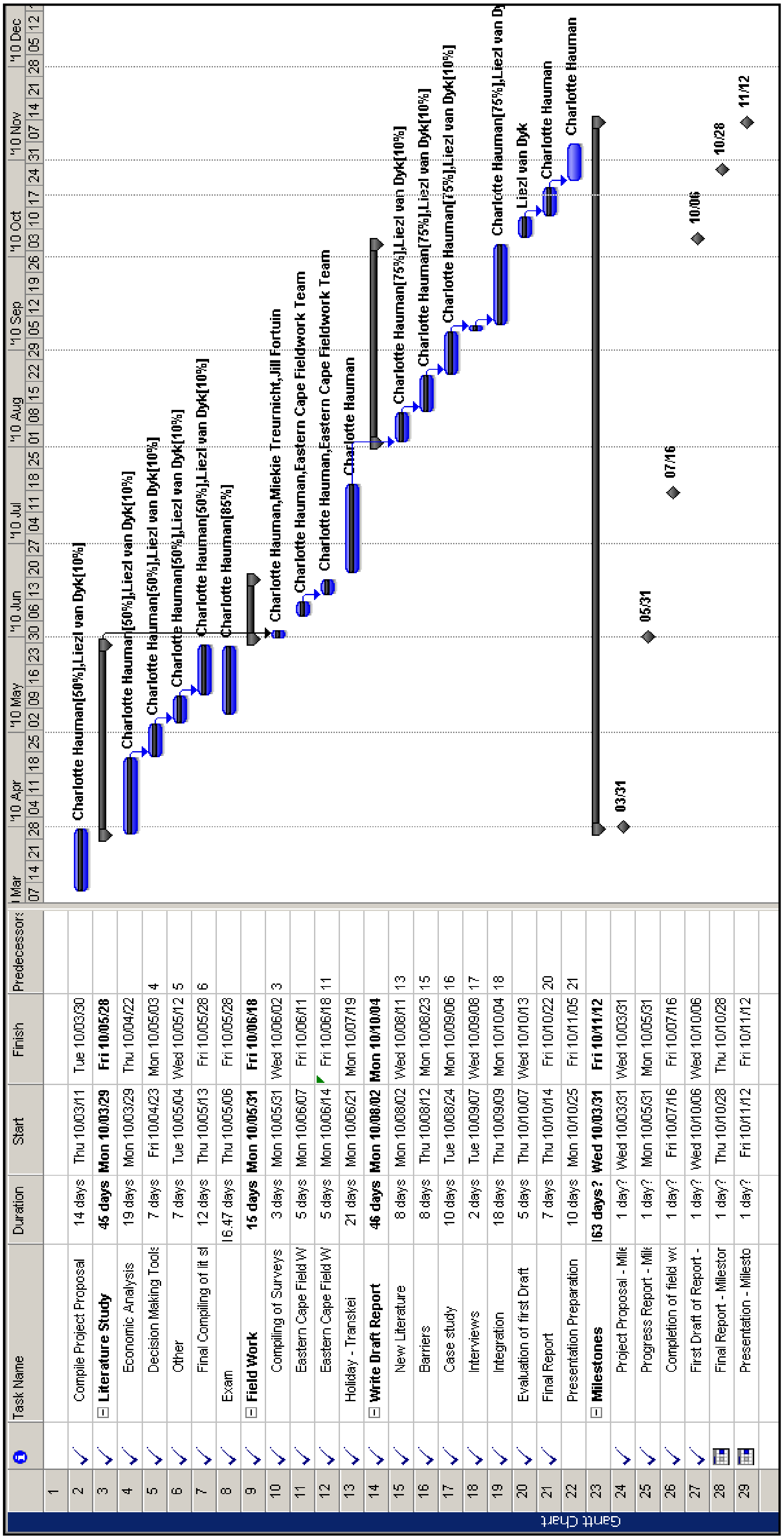
w_{ij}	Scores
W_{41}	0.09902
W_{42}	0.04301
W_{43}	0.5759
W_{44}	0.28207

Incentive (i=5)

	AI	NT	CON	DR
AI	1	4	0.17	0.11111
NT	0.25	1	0.2	0.125
CON	6	5	1	0.2
DR	8	6	5	1

w_{ij}	Scores
W_{51}	0.10478
W_{52}	0.04934
W_{53}	0.25057
W_{54}	0.59531

Appendix C:
Project Plan



	Task Name	Duration	Start	Finish	Predecessors
1					
2	Compile Project Proposal	14 days	Thu 10/03/11	Tue 10/03/30	
3	**Literature Study**	**45 days**	**Mon 10/03/29**	**Fri 10/05/28**	
4	Economic Analysis	19 days	Mon 10/03/29	Thu 10/04/22	
5	Decision Making Tools	7 days	Fri 10/04/23	Mon 10/05/03	4
6	Other	7 days	Tue 10/05/04	Wed 10/05/12	5
7	Final Compiling of lit st	12 days	Thu 10/05/13	Fri 10/05/28	6
8	Exam	16.47 days	Thu 10/05/06	Fri 10/05/28	
9	**Field Work**	**15 days**	**Mon 10/05/31**	**Fri 10/06/18**	
10	Compiling of Surveys	3 days	Mon 10/05/31	Wed 10/06/02	3
11	Eastern Cape Field W	5 days	Mon 10/06/07	Fri 10/06/11	
12	Eastern Cape Field W	5 days	Mon 10/06/14	Fri 10/06/18	11
13	Holiday - Transkei	21 days	Mon 10/06/21	Mon 10/07/19	
14	**Write Draft Report**	**46 days**	**Mon 10/08/02**	**Mon 10/10/04**	
15	New Literature	8 days	Mon 10/08/02	Wed 10/08/11	13
16	Barriers	8 days	Thu 10/08/12	Mon 10/08/23	15
17	Case study	10 days	Tue 10/08/24	Mon 10/09/06	16
18	Interviews	2 days	Tue 10/09/07	Wed 10/09/08	17
19	Integration	18 days	Thu 10/09/09	Mon 10/10/04	18
20	Evaluation of first Draft	5 days	Thu 10/10/07	Wed 10/10/13	
21	Final Report	7 days	Thu 10/10/14	Fri 10/10/22	20
22	Presentation Preparation	10 days	Mon 10/10/25	Fri 10/11/05	21
23	**Milestones**	**163 days?**	**Wed 10/03/31**	**Fri 10/11/12**	
24	Project Proposal - Mile	1 day?	Wed 10/03/31	Wed 10/03/31	
25	Progress Report - Mile	1 day?	Mon 10/05/31	Mon 10/05/31	
26	Completion of field wo	1 day?	Fri 10/07/16	Fri 10/07/16	
27	First Draft of Report -	1 day?	Wed 10/10/06	Wed 10/10/06	
28	Final Report - Milestor	1 day?	Thu 10/10/28	Thu 10/10/28	
29	Presentation - Milesto	1 day?	Fri 10/11/12	Fri 10/11/12	

Project Plan Review

The project was to a large extent executed according to plan. A few deviations are explained below.

The initial project plan did not have the exact dates of the field work, but due to the length of the university holiday, this change did not affect the execution of the original plan.

The biggest change in the original project plan was the study of new literature (Task 15) that was necessary due to the shift in focus of the project after the field work. Due to the project plan allowing for enough time to write the report, the *New Literature* task replaced the writing of Part A without upsetting the project plan.

The final integration and formatting took longer than expected. The evaluation of the first draft by the study leader was however shorter and subsequently the project was finished on time.