

User evaluations of IT in healthcare: A case study of perceived fit of a health management information system

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Acknowledgement

I thank the Lord God my saviour and shepherd. May you continue to abundantly bless me as I continue to grow and learn from the world around me.

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Abstract

Mobile systems are increasingly growing in developing countries and have been a key interest for organisations looking to make scalable solutions for the developing world context. For the HIV/AIDS healthcare sector, this interest has seen great investment in healthcare systems augmented by mobile technologies. One such system is the EMIT system created by Cell-Life, a Cape Town based organisation that creates solutions for managing HIV and TB. The EMIT system is a mobile and web-based system used for health management information collection that was implemented for a number of community organisations engaged in HIV related awareness activities around the country. This research study collected the system's users' opinions on how appropriate they felt the EMIT system was for their task needs. The motivation behind this is to determine how appropriate it is to employ a health management information system, particularly one utilising mobile technologies, for information workers involved in HIV related community work. And in the process, identify potential focus areas for implementers and organisation managers to grow their organisations capacity.

Using the survey instrument for measuring user evaluations of fit developed by Goodhue (1998), data was collected from managers and fieldworkers from the organisations identified in the research case. Reflecting the increasing pervasiveness of mobile healthcare applications, the research approach is confirmatory and combines quantitative and qualitative data. The conclusions outline the variables that influence perceived fit for an information system that incorporates both desktop and mobile input modes, and suggests future research directions. Recommendations are also made for improving system fit for EMIT system implementations.

List of Acronyms

DHIS - District Health Information System

DOH - Department of Health

FITT - Fit between Individual, Task and Technology model

GPRS – General Packet Radio Service (A mode of data transfer for mobile devices)

HISP - Health information Systems Project

HIV/AIDS - Human Immunodeficiency Virus/ Acquired Immunodeficiency Syndrome

HMIS - Health Management Information Systems

SANAC - South African National Aids Council

TAM - Technology Acceptance Model

TPB - Theory of Planned Behaviour

TPC - Task to Performance Chain

TRA - Theory of Reasoned Action

TTF - Task Technology Fit

UNAIDS - United Nations AIDS council

UTAUT - Unified Theory of Acceptance and Use of Technology

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Chapter 1: Introduction

1.1 Background

There has been massive investment in information system resources to improve healthcare organisational capacity over the years, and recently there has been an increased emphasis on mobile technologies as a key technology for developing countries in this fight.

Over the years, government, public and private sector organizations have invested heavily in healthcare in a bid to improve service delivery and performance of healthcare systems.

Particularly in the South African health sector 14.1% of government expenditure was spent on health in 2007 (HST, 2009). There has been massive investment in information system resources to improve healthcare organisational capacity over the years, and recently there has been an increased emphasis on mobile technologies as a key technology for healthcare delivery in developing countries. Introduction of information and communication technologies (ICT's) can radically affect healthcare organisation and healthcare delivery and outcomes, however it is estimated that up to 60-70% of all software projects fail (Ammenwerth, Iller and Mahler, 2006). . It is the author's belief that organisations can benefit from evaluating the systems they fund and implement. This will in turn enable accurate assessments of the impact their efforts have on overall healthcare delivery and act as a precursor to managerial action. Organizations spend millions of dollars on information systems to improve organizational or individual performance, but objective measures of system success are extremely difficult to achieve (Goodhue, 2001). It becomes an important objective for organisations to be able to measure not only the impact their systems have on performance, but also the appropriateness of these systems all together. This implies evaluating an information system against its ability to fulfil the purpose for which it was designed within an organisation.

An apparent paucity of theory (Goodhue, 2001) is reflective of the need for further research

moderating effects that different implementations of the same system can have on user evaluations of that system.

1.2 Research context and motivation

This study is of a confirmatory nature as it seeks to verify the assertions of Goodhue's theory on task technology fit, whilst applying the study in a South African context. This study also seeks to investigate organisations' perceptions on the benefits they expect to gain from the use of mobile and computer based technologies to support their processes. At the end, this study hopes to have determined the appropriateness of systems that incorporate mobile technologies to support such organisations' processes, determine whether the perceived benefits are realised and make recommendations based on the exploration. In order to achieve this a single system deployed across multiple organisations, and all its users, will be studied. The system is known as EMIT and has been developed by Cell-Life, a not for profit organisation based in Cape Town that specialises in technology solutions for the HIV/AIDS sector. Cell-Life implemented this system in a number of not-for-profit organisations that are engaged in HIV related community work, and as such a brief look into the HIV/AIDS sector in South Africa will be undertaken to gain more understanding of the context in which the system is used. Using a sample population, it is hoped a task profile of the organisations surveyed will be unearthed. This task profile will be useful in making recommendations for achieving fit for similar organisations with similar processes and supporting technologies.

1.3 Problem Statement

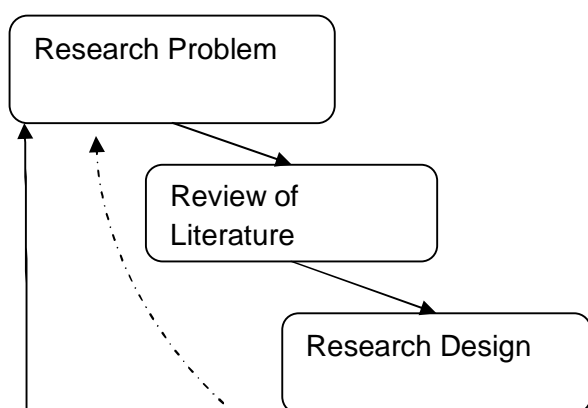
Much research has been done on end user perceptions of IT, user adoption of IT systems as well as evaluations of the actual systems. However, there is little literature on users' evaluations of IT systems on the healthcare industry (Pendharkar et. al. 2001). In the healthcare sector, many new systems are implemented with the purpose of improving service delivery in healthcare however there is little research conducted on whether these systems actually achieve their intended purpose.

- A lack of understanding of the users requirements by the implementers. (Littlejohns, 2003)

The problems listed above may be symptomatic of the poor fit between the systems and the task requirements, with the lack of understanding from both users and implementers being a potential cause of the low data quality and low utilisation. It is the aim of this study to investigate the appropriateness of such information systems by surveying the users of these systems and getting their evaluations of what extent the information systems meet their task needs. It is hoped that by investigating the fit, recommendations can be made regarding improving fit and as a consequence shed light on some of the problems within health management information systems (HMIS).

1.4 Research Process Overview

Figure 1 illustrates the research process utilized in conducting this study; the problem situation (the appropriateness of using mobile technology in IT systems to support HIV/AIDS health information management) was identified through past field studies, the literature review and a case study of a health management information system in use. While conducting the case study the researcher referred to the problem statement, also during the analysis of findings, to ensure that the research objectives were being met.



The research should contribute to the greater understanding of the problem situation and the findings have the potential to assist in the implementation of more scalable and sustainable mobile phone-based information health management projects for HIV/AIDS, and perhaps in the more general sense, for ICT for health development projects outside of the HIV/AIDS sector.

1.5 Thesis outline

This thesis consists of the following sections;

- a) **The literature review section** presents the findings from a review of the literature on HIV and the related health management information systems in use in South Africa.
- b) **The research method section** details the approach to the research problem.
- c) **The presentation of the case section** provides background information on the implementation case used to aid in investigating appropriateness of IS
- d) **The findings section** presents the results of the empirical study of the case presented to answer the research questions raised.
- e) **The conclusion and recommendations section** presents the conclusions from this research thesis and any recommendations for practitioners and any future research.

Chapter 2: Literature review

Awareness of the relevant literature and previous related empirical work is essential for all investigations, whether in qualitative or in quantitative research (Yardley, 2007). Therefore reviewing the literature before commencing the research (and while conducting the research) will provide the theoretical sensitivity and research fundamentals necessary to answer the research question.

2.1 Health Management in South Africa

This section reviews the structure and organisation of the health system in South Africa. This is to include both the private and public sector roles in the national health plan and systems propagated by both sectors. It is the researcher's hope that an understanding of this structure will aid in the understanding of the origins of and influences on the health information systems in use today. The review of the health system will also provide a backdrop against which the task requirements and characteristics of health care organisations are identified, and later on recommendations on achieving fit, within the local health care setup, with the technology systems that are implemented for them will be made.

The South African health care system with respect to HIV/AIDS is set up in a manner that allows coordination of multiple sectors in their individual responses to HIV/AIDS. The South African National Aids Council (SANAC) is the highest body providing strategic and political guidance for programmes targeted at HIV and AIDS and STIs. SANAC draws their authority from the cabinet and the inter-ministerial committee on AIDS (IMC). In 2006 SANAC agreed to have a broad structural arrangement consisting of a national AIDS council (the high-level overall coordinating body), sector level coordination and programme level coordination. The structural arrangement seeks to coordinate;

- Government clusters – the various clusters at the ministerial, director-general and provincial levels. The 'Social Sector Cluster' is the main cluster at national and provincial levels.

information management is the key to the success of any initiative, and as such there was a need to develop a national system for collecting and utilising health information with the aim of achieving the government's goal of equitable healthcare for all.

According to the Department of Health website (2010), the Minister of Health established a committee in 1994 to facilitate the development of a national strategy for the implementation of a comprehensive National Health Information System for South Africa (NHIS/SA). The committee consists of the provincial Members of the Executive Council (MEC's) for Health, the Department of Health, other relevant Government Departments, Academic and Research Institutions, and also the Private Sector.

The main commodity of NHIS/SA, that is data/information, was to be addressed under the following guidelines;

- Data to be collected at the point of its generation
- Data collection is to enable service assessment as well as self-assessment
- Service delivery personnel would have responsibility for the collection of data relevant to their specific duties
- Where feasible, the basic analysis of the data would be carried out at the point of collection
- Collection, aggregation and analysis of data would follow the organizational structure of health services; that is national data would comprise of the sum of the provinces, provincial data of the sum of its regions, regional data of the sum of its districts.

Work by the committee started in April 1995 and the policy and strategy for development was based on the above principles. The principles defined by the DOH committee still influence the indicators that local health facilities record information against, and as such influence the characteristics of their tasks. This is the case where an indicator is required for

2.2 State of South African HIV/AIDS health sector

The study seeks to investigate appropriateness of the HMIS for the task needs of the health care worker; however the system at the heart of this study was implemented across South African in organisations focused on HIV/AIDS community work. In order to provide a more thorough investigation it is necessary to look at the HIV/AIDS health sector and garner context for the HMIS with focus being placed on the task needs of HIV/AIDS sector workers.

The literature reviewed is awash with statistics on the state of efforts to combat HIV/AIDS. It is important to note however, especially for future researchers, that statistics are collected and measured across varying indicators. For this reason monitoring and evaluation of these efforts is difficult if comparisons are to be made between different projects. Furthermore the sector is both blessed and cursed by the keen support of both public and private sector participants. The Government of South Africa first established the National AIDS Coordinating Committee of South Africa (NACOSA) in 1992 and created the South African National AIDS Council (SANAC) in 2000 (DOH, 2008). In March 2007, the government released a new five year plan to address the epidemic: HIV and AIDS and STI Strategic Plan for South Africa 2007–2011, designed to guide the country's multisectoral response to HIV/AIDS (Dorrington, 2006). Comprehensive policies and programs are in place and significant resources, mainly domestic and in the form of external aid, have been committed to address the epidemic in South Africa (Kaiser foundation, 2008). The involvement of both the public and private sectors results in increased attention on HIV/AIDS however it is often the case that the information systems used by the different sectors are disjointed and as such the individual information systems become silos of information and in many cases represent a duplication of effort. Future researchers should thus be weary of comparisons between different health information systems as each system is suited to the goals of the initiating donor and/or funder.

the fight against HIV/AIDS has been on the increase since 1993 as illustrated by the graph below;

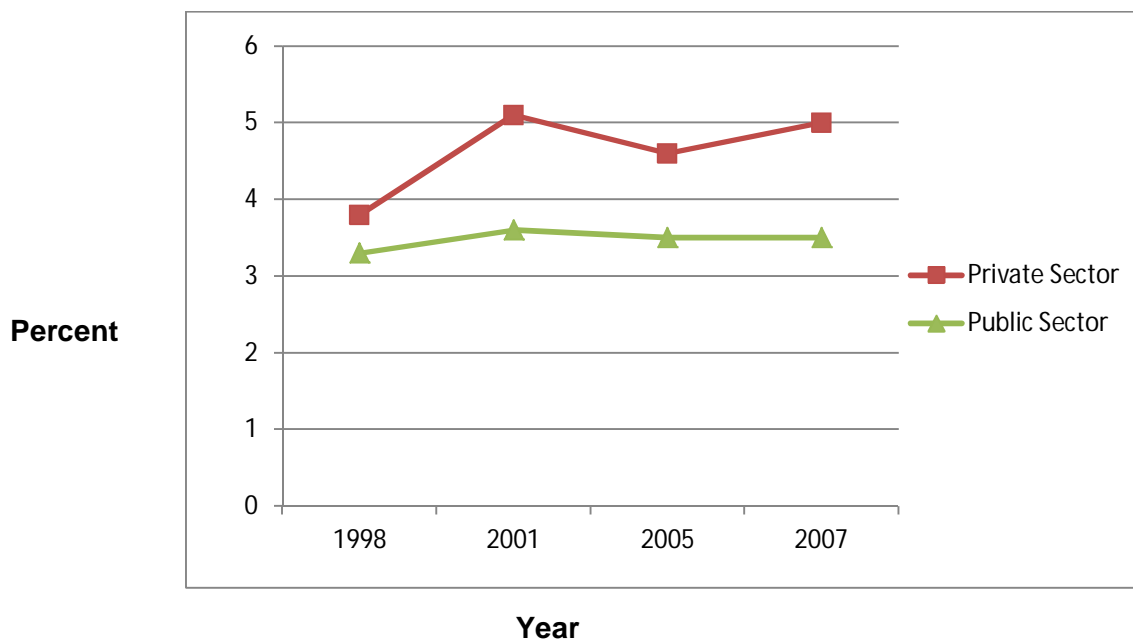


Figure 2: Public vs. private sector expenditure contribution as a percentage of national gdp

By 2003 it appeared as if financing was no longer the major obstacle. According to the SA Treasury, Department of Health Funds earmarked for HIV/AIDS are to increase from almost R4.5 billion in 2001/2 to over R7.5 billion in 2005/6 (Treasury, 2003). However, increases in HIV/AIDS funds, while necessary, may not be sufficient and rapid increases have already been found to result in some unintended consequences; such as added pressure on scarce skills and resources to disperse their budgets. Other issues characterising the state of the HIV/AIDS sector in South Africa is the lack of strong and committed political leadership. Leadership and direction on HIV/AIDS in South Africa has been inconsistent and divisive, with contrasting policy standpoints on the epidemic. The HIV/AIDS sector in the country is also plagued by disparate distribution of resources for response to the epidemic. According

current iteration of the national strategic plan is for the period 2007 to 2011. The plan outlines a holistic approach to countering the epidemic, involving prevention, treatment and cares, backed by national and provincial structures to implement the plan. These are mainly provinces, districts and local authorities. The private sector and NGOs augment the services provided by the government. The structural organisation of the bodies responsible for the implementation of the NSP is provided in the appendix M.

In conclusion, this section has investigated the structure of the South African health sector and it has emerged that the national response to HIV/AIDS has been taken on by various sectors which has resulted in a dense structure made up of special committees.

Coordination of these various groups across sectors is crucial in ensuring an effective fight against the pandemic. The establishment of an NHIS/SA and SANAC are attempts at coordination of data collection and management of health information pertaining to HIV/AIDS. The relative lack of medical personnel and funding are opportunities for health information systems to improve health care organisational capacity. It is hoped that through this research study conclusions can be reached about the effectiveness of HMIS in increasing organisational capacity by ensuring that the HMIS fit the health care task needs. The next section looks to investigate the various HMIS employed in the HIV/AIDS sector in South Africa given the state and structure of the health care sector as a whole as discussed above.

2.3 Health Management information systems

2.3.1 An Overview

Health information management incorporates all the data needed by policy makers, clinicians and health service users to improve and protect population health (Carlson, n.d). A health information system thus can be seen as a comprehensive and effective system responsible for gathering this much needed data. A health information system (HIS) is defined here as a system that integrates data collection, processing, reporting, and use of

making and strategic implementations. But most importantly, investment and improvements to health management information systems will drive improvements to the quality of healthcare services rendered to the community.

Fenenga and Jager (2007) break down an HMIS as a system consisting of two entities. The first entity in an HMIS is the data collection level where data is collected and transformed into information. The second entity is the conceptual level where analysis and feedback take place to transform the information into knowledge for decision making. This break down of an HMIS provides a more accurate description of what an HMIS is as well as provides insight into the tasks that interact with an HMIS. The HMIS is thus more than a tool for collecting data but is also an instrument to aid decision making by providing knowledge for decision making. The healthcare worker's tasks are more closely related to the HMIS they use and as such it is all the more important to find an appropriate fit between task and technology system if healthcare efforts are to be truly effective. Fenenga and Jager (2007) also linked HMIS to organisational development by reporting on their experiences with Ugandan HMIS programme. According to them, by effectively aligning organisational processes to the two entities that make up an HMIS described above, an organisation will strengthen its components at those points that interact with the HMIS and ultimately develop as an organisation. This is an allusion to the notion of fit, as the alignment of tasks to the system will result in improved performance and thus organisational development.

According to Gebauer (2006), research in mobile information systems in particular has evolved in recent years. Academia has identified development and research issues (Tarasewich, Nickerson and Warkentin 2002; Varshney, Malloy, Jain and Ahluwalia. 2002; Varshney and Vetter 2001), conceptualized business models for telecommunication services providers, devices and applications (Haaker et al. 2004, Varshney and Vetter 2001), identified strategies for system development (Kemper and Wolf 2003; Krogstie et al. 2004), and detailed development cost and infrastructure standards (Balasubramaniam et al. 2001). In the realm of healthcare. research often refers to the field of electronic health (eHealth)

- Education and awareness
- Remote data collection
- Remote monitoring
- Communication and training for healthcare workers
- Disease and epidemic outbreak tracking
- Diagnostic and treatment support

These key applications listed above are meant to augment the healthcare workers tasks. The effectiveness of these applications will only be seen where there is a fit between tasks and applications. Meanwhile, mHealth applications continue to propagate throughout developing countries around the world. The map in appendix F shows the global geographic distribution of 51 mHealth programs surveyed as part of a UN report prepared by Vital Wave Consulting (2008). Though vital wave consulting does not provide an exhaustive list of mHealth applications, the compilation of applications surveyed does provide an indication of the focus areas of mHealth applications across the developing world. Boroto (2009) went on to group the applications surveyed by Vital Wave Consulting by the application areas listed above (appendix G). The mHealth initiatives appear to have a focus on data collection and remote monitoring. Data collection involves collecting information to populate the health information systems while remote monitoring is concerned with using technology to perform patient follow-ups - for example using mobile phones to remind AIDS patients to take medication and make doctors visits. There is also increasing attention to this field from academia, donor agencies and corporate companies such as Nokia.

The ensuing section discusses health information systems specific to the South African context.

2.3.2 Health Information Systems in South Africa

There are many information systems in place to aid healthcare services delivery. In South Africa in particular, government aided projects to provide health and management

One of the largest health information system project undertaking in South Africa was the implementation of a hospital information system in Limpopo province (Littlejohns, Wyatt and Garvican, 2003). The project was initiated in response to a national strategy to restructure health care after the 1994 elections. Changes included shifting resources from tertiary and secondary care to primary care, devolution of management to district level, and redistribution of resources in response to perceived geographical and sectoral need. IBM was awarded the contract for implementation at a cost of R134m. According to Littlejohns et. al. (2003) this figure represented 2.5% of the province's annual health and welfare budget. It was also the largest health information system project of its kind, covering 42 hospitals, comprising two mental health institutions, eight regional hospitals (two acting as a tertiary complex with teaching responsibilities), and 32 district hospitals. It was initiated in 1997 and a pilot system was introduced into Mankweng Hospital in September 1998. An investment in a health information system of this magnitude is evidence of the need for better health information management, however like many other projects before it this implementation failed as well. Among the reasons for failure identified by Littlejohns et. al. (2003) were; inadequate infrastructure as well as with the functioning and implementation of the system as well as not ensuring users understood the reasons for implementation from the outset and underestimating the complexity of healthcare tasks. These reasons are symbolic of the questions this research is trying to answer, questions around the interaction of healthcare tasks with the implementation and characteristics of the technology solution(s).

One of the most widely used health management information systems in South Africa is the District Health Information System (DHIS). DHIS is an open-source health management information system and data warehouse. It is developed by the Health Information Systems Programme (HISP) project. This project was piloted in 1996 in a baseline survey in Mitchells Plain, Cape Town South Africa (HISP, 2002). After a successful pilot, additional pilot sites were set up in Khayelitsha, Blaauwberg and later the South Peninsula. The DHIS was rolled out in the Western Cape in mid-98, and the Eastern Cape in 1999 to three health districts. A

DHIS across the country. The table below lists some of the case studies of successful implementations around South Africa. The general outcome of the implementations of the DHIS is the establishment of consistent processes and standard indicators in different districts, allowing for comparative analysis and strategy formulation.

Table 1: Example implementations of the DHIS. Adapted from HISP website (2009)

Project	Description
Emergency Medical Rescue Services (EMRS), Northern Cape	Implemented as a module of DHIS. Types of information presented: total EMS headcounts; % of cold cases referred to Kimberley; fleet management; utilisation rate; availability of ambulances; average workload per EMS practitioner.
The Alfred Nzo and Chris Hani municipalities, Eastern Cape	General information for management collected through DHIS. Data collected used to reveal low drug stock levels and low immunisation coverage from which a successful strategy was developed.
South Peninsula in Cape Town	TB control using strategy formulated from DHIS data collected on patient treatment figures, comparative figures between districts etc.
The Rustenburg District in North West province	Standardized data capture forms, and processes resulting from requirements imposed by using the DHIS software led to the province winning a national best practices competition
Lejweleputswa district in the Free State	New system implemented in 1999 (ISDS/HISP support). Resulted in local validation rules being developed; district goals and targets revised to match with the DHIS Software.

Some HMIS projects focus exclusively on using mobile technologies in the form of cellular phones, pda's and tablet computers. These projects use only mobile devices to provide the entirety of the information system being used to deliver essential health services. Such projects include Project Masiluleke. The word masiluleke means "hope and warm counsel" in Zulu, one of South Africa's main languages. Project Masiluleke is designed to harness the power of mobile technology as a high-impact, low-cost tool in the fight against HIV/AIDS. The project aims to revolutionize the public health response to HIV/AIDS in South Africa and other parts of the globe by using mobile phones by providing a suite of interventions that

however been criticised for not being scalable as there are cost implications of using sms, as such continuous funding is required to keep the service running and growing.

Some researchers view the role of information systems in healthcare as facilitators to the reduction of the conceptual gap between technological capabilities and society's requirements when it comes to healthcare service delivery. The social technical gap is the "divide between what we know we must support socially and what we can support technically" (Ackerman, 2000). Social requirements are a sub-set of requirements that make up social tasks. Dwyer (2007) argues that the social technical gap can be conceived of as a specific instance of task technology fit. Therefore it describes the lack of fit between social requirements and technical solutions.

2.3.3 HMIS implementation challenges

The practicality and need for HMIS systems as well as the potential benefits are apparent from the literature and case studies presented above, but it seems the perceived benefits of employing electronic HMIS are not realised in many cases. The challenges identified from the case studies in literature can be categorised into strategic and operational challenges.

Strategic challenges include difficulties in integrating public and private sector information. This is often the case where silos of information are built up as the two sectors implement competing HMIS. This also relates to the challenge of dealing with competing donor and national programme requirements. There is also a lack of understanding of the needs of health sector organisations by implementing organisations who are primarily from IS and IT backgrounds. Operational challenges are revealed during the implementation (and later through continued use) of the HMIS. These include inconsistencies in the measurement, coding and data storage policies between different HMIS. As already seen, the data policies are influenced by the monitoring and evaluation indicators defined by the HMIS project driver (whether government or donor). Finally there is the challenge of human resource capacity wherein the understanding, expertise and will to effectively use the HMIS is lacking.

Chapter 3: Task Technology Fit – Concepts and Models

3.1 Technology models in research: in search of a theoretical framework for investigating appropriateness

An array of theoretical models has been used in information systems research to analyse technology and its interaction with its intended users. The models found in literature explore the areas of technology acceptance, utilisation, sustainability and scalability and technology innovation diffusion. The rest of this section will explore the different models, the purpose being to gather different viewpoints on how researchers have investigated the relationship between technology and the people affected by it both on an individual and organisational level. Thus this section will take an investigative approach to reviewing the classical technology models and their suitability for assessing the appropriateness of a particular technology in the context of health information management systems.

The various technology models discerned in literature have been developed in specific contexts, and more-so have been adapted and/or adopted from other research fields and contexts. This means the researcher has to be prudent in selecting a theoretical framework that is best able to answer the research question. This section will briefly detail the models found in literature, however exploring the limitations of each technology utilization model is beyond the scope of this study. Much of the literature found in the investigation of existing technology models espouses the users' behaviour and behavioural characteristics as a key determinant in technology appropriateness. The key theme being that the success of a technology is shown by the extent to which it is used (usage behaviour) and thus determining human behaviour is essential in ascertaining how "successful" the technology will be in solving a particular problem.

The theory of reasoned action (TRA) (Fishbein & Ajzen, 1975), and its derivative, the theory of planned behaviour (TPB) (Ajzen, 1991), are theories explicitly concerned with behaviour and as a result focus on behavioural change or intent to change and cognitive processing. In

theoretical models grounded in information systems research thus these behavioural models would not be appropriate as the core models for investigating technology appropriateness.

An extension of TRA, the Technology Acceptance Model (TAM) has been developed after two variables namely perceived usefulness and perceived ease of use were identified as key determinants of technology acceptance (Davis et al, 1989; Briggs et al, 2001). This model has become very popular and has been used and, at occasions, extended by various I.S researchers (Benbasat & Barki, 2007). One such extension of this model is the Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh et al. (2003). The theory was developed through a review and consolidation of the constructs of eight models that earlier research had employed to explain IS usage behaviour (theory of reasoned action, technology acceptance model, motivational model, theory of planned behaviour, a combined theory of planned behaviour/technology acceptance model, model of PC utilization, innovation diffusion theory, and social cognitive theory). Like TAM, this model supposes that behavioural intention and usage behaviour are the key dependent constructs for determining technology usage amongst individuals. It appears behaviour is the only aspect of the technology utilization concept explored by these models. By focusing on behaviour towards the technology, the actual technology solution is almost absolved from scrutiny and as a result leans towards the assumption that the system is appropriate for the tasks but the users' perception of its usefulness, ease of use etc. are the determinants of success.

The theory of task technology fit (TTF) considers the fit between task and technology for effective use of technology (Goodhue and Thompson, 1995). The Fit between Individual, Task and Technology (FITT) model, a derivative of TTF, emphasises the need for a fit between the attribute of individuals, the attributes of task, and the attributes of technology (Ammenwerth et al, 2006). Both these models give greater credence to the technology (or information system) itself in addition to the behavioural aspects espoused by the other models.

models are not applicable particularly when the system is forced upon users in a top-down technology implementation process (Reunis et al, 2006). To the extent that utilization is not voluntary, performance impacts will depend increasingly on task-technology fit rather than utilization (Goodhue and Thompson, 1995). Models focusing on fit alone do not give sufficient attention to the fact that systems must be utilized before they can deliver performance impacts. The fit models fail to consider the technology's adoption context (Boroto, 2009); however they do emphasize task, individual and technology fit.

Due to the limitations inherent in both the utilization and the fit models, Goodhue and Thompson proposed a model that combines both. This model has come to be recognised as the technology-to-performance chain (TPC). The core premise of this model is that technologies must be utilized *and* fit the task in order to have any performance impact. Irick (2008) concurs with this premise saying that the TPC model gives a more accurate picture of how the tasks, technology and utilization of this technology relate to observable changes in performance.

This research is investigating the appropriateness of health management information systems and these are more often than not, imposed on health workers by management. Therefore, utilization is assumed and focus should be given to the technology fit as a predictor of performance. As a result it is the researcher's opinion that fit models are preferable to behaviour models since the users' behaviour is inherently altered by a top-down implementation which renders behaviour as a biased measure of appropriateness.

In this section, the different models espoused in research were reviewed and used to inform the choice of research model most appropriate to answering the research question. The review of these models revealed that although these models have contributed greatly in the study of technology utilisation and innovation diffusion, they have limitations. Three main common limitations emerged; the lack of a unifying theory regarding technology utilisation (and innovation diffusion), the focus on one aspect of the technology utilisation concept and

3.2 Theoretical underpinnings of TTF

3.2.1 Task-technology fit to explain IS success

The core research question seeks to investigate the extent to which users perceive their task needs have been met by a newly introduced information system. This leads to a focus on the task-technology fit as described by Goodhue (1992, 1995). Whether or not task needs are met, is an assessment made by considering the performance impacts of the system under scrutiny. According to Goodhue (1995), the heart of the task-technology fit model is the assumption that information systems give value by being instrumental in some task or collection of tasks and that users will reflect this in their valuations of the systems. Thus, the link between information systems and performance impacts will be due to a correspondence between task needs and system functionality (task-technology fit). Staples and Seddon (2004) went so far as to confirm that the technology-to-performance model can explain performance for both mandatory and voluntary use settings. This is important to remember as both use settings can exist in a health care setting, with the usage scenario being mandatory more often than not.

3.2.2 Theory of Task Technology Fit

Goodhue defines task-technology fit (TTF) as the degree to which a technology assists an individual in performing his or her tasks. More specifically, it is the fit among task requirements, individual abilities, and the functionality and interface of the technology (Goodhue, 1997).

Goodhue and Thompson (1995) assert that in order for an information system to have a positive impact on individual performance the technology must be utilized, and there must be a good fit with the tasks the technology supports. If either the fit or the utilization are lacking, the technology will not improve performance. In the context of this research, health management workers assess their performance in the hope that their assessment will shed light on the fit of the technology to their tasks. The utilization aspect is not under scrutiny in

effectiveness and efficiency in going about health management tasks. The individuals considered by this theory refer to the users of the system. The term “user” in this research means an individual who either uses recorded organizational information personally in decision making, uses it to the extent of accessing it or passing it on to someone else who will use it in decision making or both, as it was defined by Davis and Olson (1985).

According to Goodhue (1998), at the heart of TTF is the assumption that information systems give value by being instrumental in some task or collection of tasks and users will reflect this in their evaluations of systems. This assumption places confidence in users' ability to fairly evaluate an information system, and relies on the individual's awareness of the gap between their tasks and technological capabilities of the system in order to accurately reveal the fit (appropriateness) of the system. TTF also assumes that no system provides perfect data to meet complex task needs without any expenditure of effort (Goodhue and Thompson, 1995). This assumption has a bearing on the utilization of the system where the change in the gap between the data provided and the task need will reflect the fit of the system. The wider this gap, the lower the fit and vice versa. A system that reduces this gap is assumed to have a direct impact on the user's effectiveness and efficiency. The researcher also notes that different fit models throughout literature make an implied connection between utilization and a system with a high TTF. This is to say that it is implied that if a system increases efficiency, quality and effectiveness it will inherently have high utilization. The behavioural (utilization) models advocate for other factors influencing usage behaviour that are independent of the system, such as the norms of behaviour amongst peers (Manstead and Parker, 1995), which will affect utilization. The researcher has taken this into account when analysing user assessments of the gap between data provided and task needs.

Two schools of thought of TTF have emerged over the years. Goodhue and Thompson (1995) initiated the first as an important concept in explaining IS success among individuals. Ziaurs and Buckland (1998) initiated the second by developing a profile for the task-

The theory of task technology fit has been selected as a theoretical underpinning for this research, but in order to fully apply it to the research, the notion of fit as evaluated by users must still be operationalized and measured. The ensuing section investigates various measurements of fit found in research which may be employed in this study.

3.2.3 Measuring user evaluation of fit

Performance impacts from information systems are difficult to measure directly. This is why many researchers and practitioners rely on surrogate measures of IS success such as user evaluations (Irick, 2008). The measurement of how satisfied a user is with his or her information system has become a pervasive measure of the success or effectiveness of an information system. This section investigates the different approaches to measuring user evaluation of satisfaction that are evident throughout literature.

User evaluation in the context of this research refers to an objective assessment of the identified characteristics of the underlying system. The working definition for this research shall be that adapted from Goodhue (2001) which identifies user evaluations as an assessment made by a user, along some continuum from positive to negative, about certain qualities of information systems. However, other measures of user evaluation approach measurement differently. Research is generally split between two approaches, the first approach opts to employ a single item measure of user evaluation while another stream of research employs multiple point measures of user evaluation. This means a number of variables are determined to affect user evaluation and the assessment of user evaluation is made on the aggregate findings of these variables.

Throughout literature, arguments exist for both approaches (single item versus multiple item measures of user evaluation). Where only a general indication of user satisfaction is desired, with no interest in particular causes and areas of dissatisfaction, it would be more appropriate to use single-item measures (Baroudi and Orlikowski 1988). Scarnello and

measure would suffice, however for more in-depth investigations and identification of the areas of poor fit, then a multiple-item measure would be more appropriate. As mentioned earlier, a key objective of this study is to find out the fit of health management information systems to the task needs of workers involved in community work in a bid to focus managerial action in increasing the effectiveness of these systems. Thus a multiple point measure of user evaluation would be worthwhile as it will help isolate areas of poor fit shown by negative user evaluations.

Table 4 summarises the findings of earlier studies measuring user evaluation, with user evaluation of satisfaction and fit (or a variant thereof) being the dependent variable. The studies selected show the different measurement methods used as far back as 1973 with the range of studies over time giving a hint as to how measurement methods may have evolved. Though the studies are dated, they have been included in this literature review for the purposes of performing a quick comparison of past and present measurement studies, and gaining insight into the measurement methods research is turning to or has turned to. Measurement methods in the selected studies appear to have moved from single item to multiple item measures.

Table 2: Summary of user evaluation measure studies

Author	Study	Key variable	Measurement method
Edstrom (1977)	User Influence and the Success of MIS Projects	Perceived success of IS	Single-item, Multiple raters IS bipolar scale
Franz (1979)	Contingency Factors Affecting the User Involvement Role in the Design of Successful Information Systems	Perceived success of IS	Multiple-item, most IS Likert-type scales
Gallagher (1974)	Perceptions of the Value of a Management Information System	Information satisfaction	15-item, semantic differential scale
Kaiser and	The Relationship of User	Information	Two-item, Likert-

	Information Service Department Personnel		
Swanson (1974)	Management Information Systems: Appreciation and Involvement	MIS appreciation	16-item, Likert-type
Maish (1979)	A User's Behaviour Toward His MIS	Feelings about IS	Five-item, bipolar scale
Olson and Ives (1981)	User Involvement in System Design: An Empirical Test of Alternative Approaches	IS quality	Four-item, Likert type scale
Barki and Hartwick (1994)	Measuring User Participation, User Involvement, and User Attitude	Feelings about IS	Multiple-item, most IS Likert-type scales
Doll and Torkzadeh (1990)	The Measurement of End-User Software involvement	User involvement	8-item measure
McHaney, Hightower, Pearson (2001)	A validation of the end-user computing satisfaction instrument in Taiwan	User satisfaction	Multiple-item measure

Evidently, the measurement method employed in user evaluation studies should involve either a single item or a multiple item scale. The multiple item scales seemingly have no limits on the number of items to include with studies having as few as two items and as many as 16 items. The most common research strategies for investigating user involvement are survey-based and are of two types. In the first, respondents are selected from among users of a variety of systems from multiple organizations. In the second strategy, users of a single system are surveyed. Typically, users are identified by the information systems manager and are administered a questionnaire containing either a single-item or multiple-item measure.

However, Olson and Ives (1984) contest that studies employing this survey-based approach tend to share methodological problems. These problems include bias in selection of participants where system managers select respondents, possibility of survey questions may

considered to be a single construct, though they should actually be seen as a measurement technique. It is the researcher's belief that user evaluations can serve as reasonable diagnostics of information systems, and because they are sourced from the actual users they can in turn be used as a guide for managerial action in improving organisational capacity.

3.3 TTF applied to the domain - Technology fit to health information management tasks

Currently there is an emphasis on productivity, efficiency and increased organisational capacity to contribute to the fight against HIV/AIDS. In the context of health information systems research, the theory of task technology fit suggests that improving the fit between technology capabilities of health information systems and the task requirements and individual abilities will lead to better performance of the organisation as a whole. Goodhue provided empirical evidence to support of Task Technology Fit through surveys of users of database driven systems. Goodness of fit was measured by the ability of users to find the "right data" (Goodhue and Thompson, 1995). The TTF theory is applicable in this research context as it is applied to a group of users utilizing a central data store, despite the multiple data input options available. Dwyer (2007) argues that though still relevant, TTF needs to be adapted to include the expanded scope of computer supported tasks that has emerged as a result of the internet and internet usage (such as social networking), that do not necessarily rely on a database.

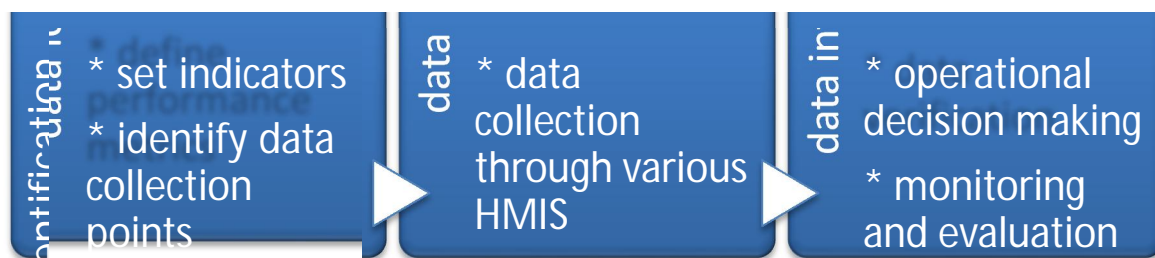
3.3.1 TTF profile for the health care sector

Pendharkar et. al. (2001) identified three factors that determine user evaluations of IS; namely technology, task characteristics and individual characteristics. Emphasis is placed on the technology characteristics as it is identified as the most complex factor to measure in health care. Technology in health care is used for reporting information, information sharing and staff scheduling (Pendharkar et. al., 2001). This study aims to contribute to research by placing greater consideration on the task characteristics affecting user evaluations of

criticality is defined as the importance with which a task needs to be performed promptly. Finally, the individual characteristics factor is measured by the level of IT education and orientation. It is also assessed by investigating the users affect (general feelings and attitudes) towards the system.

3.3.2 Task domain

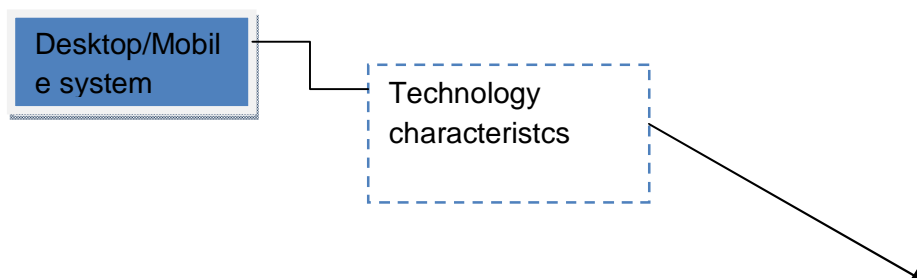
Goodhue (1995) argues that in order to fully defend the arguments made for the impact of TTF for information systems on performance, it is necessary to select a specific task domain that allows for more explicit and testable arguments for the impact of fit on performance. The task domain for this study is the use of quantitative information for operational tasks in healthcare settings. Operational tasks are short duration tasks that contribute to the day to day operations of the organisation. These operational tasks are not restricted to management only (as espoused in literature; Gebauer 2005, Goodhue 1995) but also include field workers and project managers. Operational tasks in a health care setting consist of day to day tasks performed by health care workers, for consistent but short periods of time that allow them to make operational decisions on how to deliver care/service to their target communities (or patients). Goodhue recommends identifying a rough process model of information use within the task domain that will focus research efforts. The process model depicted in figure 4 follows the general process identified by Goodhue which consists of three linked and sequential steps; *identification of data*, which is followed by the *acquisition of data* and finally the *integration and interpretation of data*.



For the healthcare organisations observed in this study, the process model is as is depicted above. The identification of data is performed at a high level by program managers and funding agencies and is dependent on the indicators they wish to measure. Once the correct indicators and data points have been identified the next phase is to initiate data collection through the fieldworkers and programme managers. Data collection is aided by the various information systems that are the focus of this research. Finally, integration and interpretation of the data is performed once it has been collected. Interpretation of the data occurs at different levels of the organisations; with program managers and donors performing this function in order to monitor and evaluate progress made. Some interpretation of data also occurs at the fieldworker level as they use the data they would have collected to make assessment and recommendations to program managers on possible focus areas of their work that emerge from the data.

3.4 Research Theoretical Model

From the concepts and models presented in this chapter, a theoretical model is chosen that has evolved with new research findings and is most relevant to the characteristics and objectives of this study. The model used in this research is based on the basic model of task-technology fit (Goodhue, 1995) as presented in appendix A. The final high-level model used is represented diagrammatically in figure 4.



The model suggested in this research approaches the research problem using a similar approach to that prescribed by Goodhue (1995). This approach entails the development of a task model relevant to organisations in the South African HIV/AIDS sector, identification of the individual and technology aspects of IS support in the organisational context under study and finally application of the instrument by Goodhue (1995).

As in the basic model of task-technology fit, all three factors affect the overall user evaluations of task-technology fit. It is important to note that the model is not prescriptive. This is to say that though the model suggests that higher user evaluations will result where the system characteristics, individual abilities and task requirements are a fit, the conclusion of fit cannot be applied to all users who interact with the system. The same system could get very different evaluations from users with different task needs and abilities.

From the theoretical discussion presented in the literature section, the unit of measurement that is apparent in this study is the task needs of the users. Using the instrument developed by Goodhue (1995), this study will measure organisation managers' evaluation of what extent the information system meets their task needs in their efforts to manage HIV/AIDS efforts. If the system is adjudged to meet task needs then performance improvements should be evident, which in turn confirms a fit between the tasks and the technology.

The research model guiding this research allows the author to map out a process model of how information is used within the target organisations, then using the contextual sensitivity garnered from developing the process model, the task characteristics can be elicited based on the process model managers use to collect, share and use information. Finally, the research identifies aspects of IS support relevant to HIV organisations and then uses the measures of the Goodhue instrument to assess the extent these aspects of the information

Chapter 4: Research Approach

4.1 Research Objectives and Scope

In line with the aims of this study and based on the research gaps identified in the aforementioned sections of the literature, the research objectives of this study are:

- *To investigate the perceptions of the value and ability of information systems in meeting the task needs of healthcare data collection workers*
- *To observe the impact on perceived performance of using an information system in a healthcare field setting.*
- *To validate the instrument for measuring the extent to which users' information needs are met by an information system.*

Among the abovementioned core objectives, other sub objectives arose from a combination of the core objectives and the particular context this study will be performed in. These are:

- *Adapting the TTF instrument to encompass mobile technologies as they are increasingly pervasive in healthcare systems and are likely to have an impact on user evaluations of information systems, as suggested by literature.*
- *Explore potential areas of improvement in the way the information systems used in the research context are implemented, and utilized by their target user base to realise performance gains.*

4.2 Research Questions

This study aims to answer the primary research question;

What are users' evaluations of the extent to which information systems in organisations engaged in the management of HIV/AIDS information meet their task needs?

H2: User evaluations of an overall system do not differ between mobile and desktop environment use contexts.

H3: The level of task restrictions users have in a system will impact their perception of the fit of the system – with the more task restrictions there are on users resulting in more negative perceptions of fit.

H4a: Systems interface aspects do not affect overall user evaluations of fit.

H4b: Individual assistance given to users does not affect evaluations of the system's ability to meet task needs.

Other questions, arising from the question of what the perceived impact of the systems are, focused on the significance of this impact, namely:

Are the users' evaluations of information systems an accurate reflection of the impact of the system? If not, what other actors could be called upon for an evaluation?

How unique are the information needs of the health sector and can resultant evaluations be applied to similar systems?

The following section discusses how the research was operationalised in order to answer the questions posed here.

4.3 Research Design

4.3.1 Paradigm

The objectives of this research, as stated in the introductory chapter, are to investigate the perceived appropriateness of an information system for satisfying the information needs of workers in the healthcare industry – focusing on community workers in the HIV/AIDS sector.

In terms of the research paradigms used, Mingers (2001) notes that the main IS journals

According to Shanks and Parr (2003) the positivist paradigm has the following positions, which are inherently assumed in this study;

1. An objective reality is assumed which can be systematically and rationally investigated through empirical investigation, and is driven by general causal laws that apply to social behaviour. This is sometimes called naïve realism (the ontological position) (Guba and Lincoln 1994). In the context of this study it is assumed that a fit can exist between user tasks and systems.
2. The researcher and the phenomena being investigated are assumed to be independent, and the researcher remains detached, neutral and objective. Any reduction in independence is a threat to the validity of the study, and should be reduced by following prescribed procedures (the epistemological position).
3. General theories are used to generate propositions that are operationalised as hypotheses and subjected to empirical testing that is replicable. Hypotheses should be testable and provide the opportunity for confirmation and falsification. This is the essence of the scientific method (the methodological position).

Mingers (2001) argues that each paradigm and research method reveals something new about the world, and it is thus desirable and feasible to combine different methods to gain richer and more reliable results from research. Because this study is investigating user opinions, the human aspects of the responses need to be considered outside of what the instrument can measure. A multi-method study would allow for the inclusion of the social and political context of the users responses to the instrument.

4.3.2 Research Methodology

Various methods have been used in different contexts and research questions within information systems research. The choice of research methodology has to be influenced by the research context, the research objective and the research question (Avison et al, 1999).

aspects are explored first through the survey instrument and only after these have been exhausted are the qualitative aspects of the research be explored. The research instrument was administered to a target sample of health care sector workers and the results of the survey analysed. From the findings from these results, structured interview questions were created and asked to a small subset of survey respondents so as to corroborate the findings of the instrument as well as to capture any other socio-political contextual elements affecting the users' evaluations of fit. The interview questions are derived from an analysis of the correlations of the responses to the survey instrument, and the researcher uses a standardised and open-ended interview approach wherein the same questions are used for all interviewees. Analysis of interview material follows the 'content analysis' approach (Ritchie and Lewis, 2003) in which both the content and context of the interview documents are analysed. This approach is deemed appropriate as the themes and constructs are prescribed by the survey instrument, and the qualitative interview material is only used to augment the survey findings by focusing on how the constructs are presented in interview responses and how frequently this happens.

The next section describes the theoretical model employed which governed how Goodhue's instrument was adapted for the purposes of this research study.

4.3.3 Strategy and Approach

As mentioned earlier, this is a confirmatory study and thus employs the survey technique. According to Trochim (2006), surveys can be broadly categorised into either questionnaires or interviews. For this study, the questionnaire technique was used to administer the survey, specifically a mail survey. Given the busy nature of managers involved in IS planning that were approached for this study as well as the large number of respondents required to improve the statistical significance of this study, a mail survey was deemed appropriate as it increased the reach of data collection efforts.

The relative strengths and weaknesses of the survey approach (Barribeau et. al., 2005) are

Table 3: Advantages and disadvantages of survey approach to research.

Advantages	Disadvantages
<ul style="list-style-type: none"> • Surveys are relatively inexpensive • They can be administered from remote locations using mail or email • Consequently, very large samples are feasible, making the results statistically significant even when analysing multiple variables • Many questions can be asked about a given topic giving considerable flexibility to the analysis • Standardized questions make measurement more precise by enforcing uniform definitions upon the participants • Usually, high reliability is easy to obtain--by presenting all subjects with a standardized stimulus, observer subjectivity is greatly eliminated 	<ul style="list-style-type: none"> • Surveys are inflexible in that they require the initial study design (the tool and administration of the tool) to remain unchanged throughout the data collection • The researcher must ensure that a large number of the selected sample will reply • It may be hard for participants to recall information or to tell the truth about a controversial question.

Fraze, Hardin, Brashears, Smith and Lockaby (n.d.) found that while there were no significant differences in reliability of responses, there were significant differences in response rates based on mode of collection. Thus the mode of collection used in this study was bi-modal as recommended by Fraze et. al. The two modes of administration used were paper-based mail surveys and electronic mail surveys. Paper-based surveys were mailed out to contacts supplied by Cell-Life with the electronic mode being used as an alternate option. Follow-up phone calls were made to some of the manager contacts four weeks after the initial mailings in order to encourage them to complete the questionnaire.

4.4 Data Collection

This study lends itself to a survey approach. The survey approach is deemed appropriate as

observer role was adopted for this study, collecting information from survey respondents in a passive role as opposed to an interactive one.

4.4.2 Respondent profile

In order to test the hypotheses of this study a survey was sent out to a group of organisations fitting the profile described here. The organisations had to be involved in either direct patient care or community based health care work. Organisations involved in these types of activities would fit the task profile for HIV-specific community healthcare providers required to investigate appropriateness (fit) in this study. In order to allow for comparison between organisations, the organisations used in this study must all utilise the same health management information system. As such, the organisations targeted for this study use the EMIT data collection system developed by Cell Life at some stage of their health information management processes. These organisations were surveyed on their experiences with the EMIT system and their opinions on its capabilities to improve the execution of their tasks.

The survey was sent out to the following organisations:

Table 4: List of Targeted Organisations

Organisation	Number of eligible participants	
	fieldworkers	managers
ABC Ulwazi	0	2
CADRE	0	2
CMT	46	5
DramAidE	45	2
HDA	0	2
JHHESA	0	4
Lesedi	15	2
Life Line	5	3
Matchboxology	10	3
One Voice	15	3
Mindset	0	3

- Treatment Literacy Practitioners or fieldworkers – workers who use systems to administer health information and HIV/AIDS education and training directly to communities.
- Monitoring and Evaluation Managers – organisation managers who collect and report on monitoring and evaluation activities.
- Project Managers – general managers involved in the running of organisations providing health care services

4.4.3 Survey Instrument

Goodhue (1998) developed a user evaluation instrument aimed at an organisational assessment of information systems. Goodhue's instrument was chosen as the basis for this study's instrument as it had been tested in 10 companies and exhibited strong reliability and measurement validity. This instrument bases its theoretical foundations on the Task Technology Fit theory discussed in the literature review and forms the conceptual basis for the survey instrument used in this study. The constructs of Goodhue's instrument are preserved in this instrument with the survey questions being adapted to suit the study of Cell-Life's EMIT system. Additional questions not conceptualised by Goodhue are added to incorporate the mobile aspects of the EMIT system, as well as capture demographic information of the respondents. The survey instrument ends with open ended questions that may assist in capturing user opinions on possible areas of improvement. The resultant instrument contains 41 questions based on the constructs of Goodhue's original instrument, nine demographic questions and three open ended questions.

4.4.4 Survey Implementation

As mentioned earlier, the **Dillman method** was used to implement the survey. This method is adapted from the Total Design method (Dillman, 1978) and involves the following process;

Step 1. Send out first mailing (cover letter, questionnaire and reply-paid envelope)

Step 2. Send thank you reminder/thank you postcard or e-mail 10 days after the 1st mailing to thank those participants who have already responded and to remind those who have not of the importance of the study. The card indicated where people can obtain another copy of the questionnaire if they had mislaid their original copy.

4.4.5 Sampling Design

The sampling technique used in this study is a hybrid of purposive and simple random sampling. This involves selecting health care organisations that are known to use a specific health care information system that employ mobile phones, and using contact lists from within selected organisations to get individual participants within the organisations to participate in the survey. Sampling was purposive in that the health care organisations were selected from a pool of organisations running the Emit health information system. This enables the study to make comparisons of evaluations across organisations. The organisations fit a particular profile as is characteristic of purposive samples. The simple random aspect of the sampling approach was employed in selection of survey candidates from the individual organisations. For each organisation a list of key system stakeholders was supplied by cell-life and the key stakeholders were contacted to complete as well as distribute the questionnaire within their organisations accordingly. This meant the survey was distributed differently depending on the respondents' access to different media. The media used was mostly email, with a combination of printed surveys.

Combining random and non-random sampling techniques may be a point of contention for the statistical validity of this study; however Huggins, Rivers and Slotwiner (2003) advocate for a way to combine these techniques while maintaining statistical validity. Though their technique is not employed in this research, the researcher supposes the combination of these approaches to be plausible (as illustrated by Huggins et al's possible approach) and necessary given the location of the organisations and the nature of the jobs of health care workers and managers which makes it difficult to get an audience with them. The sampling leverages on the relationships built between the organisations and the implementing company which the researcher is affiliated with.

4.4.6 Response Rate

The response rate of a survey is simply the number of completed, usable surveys obtained divided by the number of people who were asked to complete a survey. In order to increase

4.5 Ethical Considerations

The researcher took every possible measure to ensure that the information gathered for the purpose of this study strictly remained for the purpose of this study alone. The participants, their organisations, and the information and opinions expressed by them, remain completely anonymous. An ethics form was submitted to the Faculty's "Ethics in Research" committee.

Regarding the storage and security of data collected during the study, data collected was kept in electronic form in password encrypted files by the researcher. The researcher ensured to adhere to the rules set out in the ethics form.

4.6 Challenges and Limitations

The challenges and risks to the study are listed in table 7;

Table 5: Risks and challenges to study

Description	Priority	Mitigating Actions
Responses not received in the time available for the study	High	Allow buffer periods in project timeline
Insufficient response rate	High	Send surveys out to more individuals/organisations
Monetary costs of conducting research could grow beyond anticipated level	Low	Budget will not be fixed or inflexible allowing for reallocation of resources where necessary
Individuals in geographically sparse areas e.g. different provinces could increase response times	Low	Allow for different means of administering the survey such as email in addition to post
Security of research data collected	Low	Ensure consistent security measures as committed to in ethics application.

Chapter 5: Case Presentation

The case presented here has been used to assist in the collection of empirical evidence to test the theoretical hypotheses made in this research, in addition to augmenting the survey approach detailed in the research strategy section.

This research follows aspects of the instrumental case study approach. The case presented of the implementation of the Cell-Life EMIT system plays a supportive role to the broader survey study that aims to determine the appropriateness of mobile technologies for use in health management information systems.

This case was inspired by the researcher's experiences during the implementation a mobile version of an existing HMIS by Cell-life, and the subsequent roll out of the mobile implementation to organisations countrywide. This case description builds on an initial study conducted by Cell-life on the implementation of the EMIT system for Community Media Trust (CMT), with a focus on the suitability of the mobile implementation for the organisational tasks across different organisations. At the time of writing some information on the Cell-life's CMT case can be found on the EMIT website (www.emitmobile.co.za). Additional background information for this case description was gathered from project resources (Cell life business analysts, organisation program managers) working on the implementation as well as the researcher's own observations. A first hand observation of the implementation process, the organisations affected and the technical aspects of the EMIT system contributed to a greater understanding of the project dynamics of using mobile phones in health care systems. This understanding will be of great value in the analysis and interpretation of the survey data collected in ensuing sections.

5.1 The EMIT system by Cell-Life

Cell-Life is a not for profit company that started as a research project at the University of Cape Town in 2001. Cell-Life is based in Cape Town South Africa and aims at using technology-based applications to address different challenges of HIV/AIDS such as

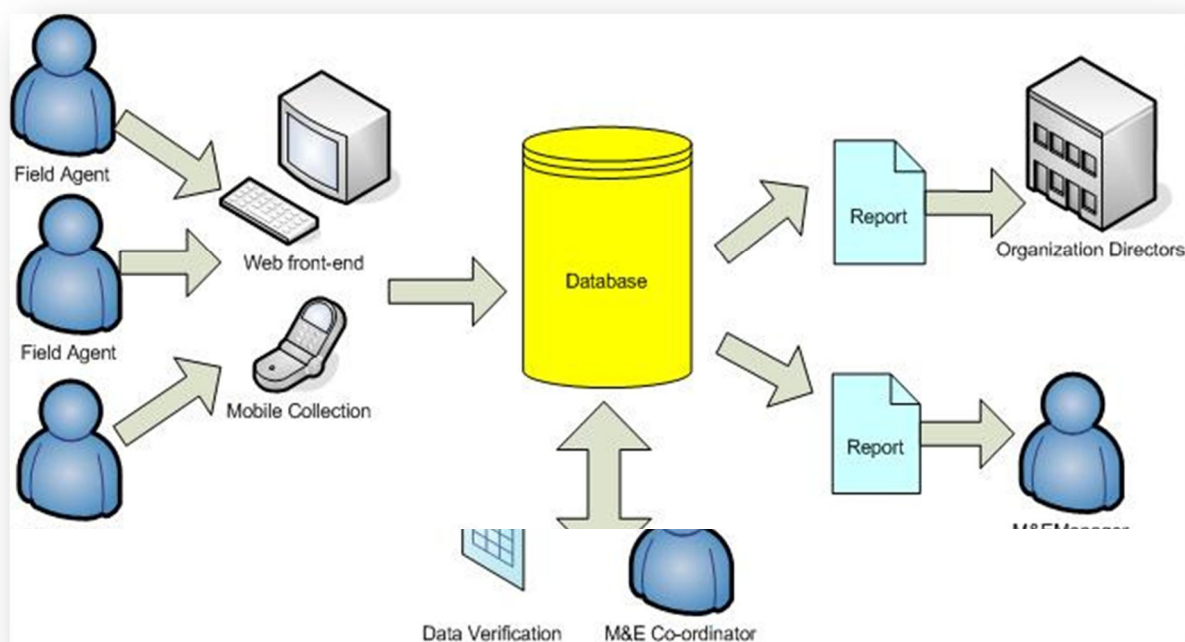
A description of the case under consideration is provided in this section. It is divided into the technical aspects of the system, and the background information on the project.

5.1.1 System under consideration

This research focuses specifically on an HMIS system used by community-based organisations, and this section will detail the typical components of this HMIS.

The research observed the users of a system called EMIT. The EMIT system is a data capture and analysis system developed by Cell-Life. The system was developed to allow data capture from different devices into a central database, then from this database analysis of data would be performed to produce operational information used by the program managers of the community-based organisations.

The information flow in this HMIS is depicted in figure five;



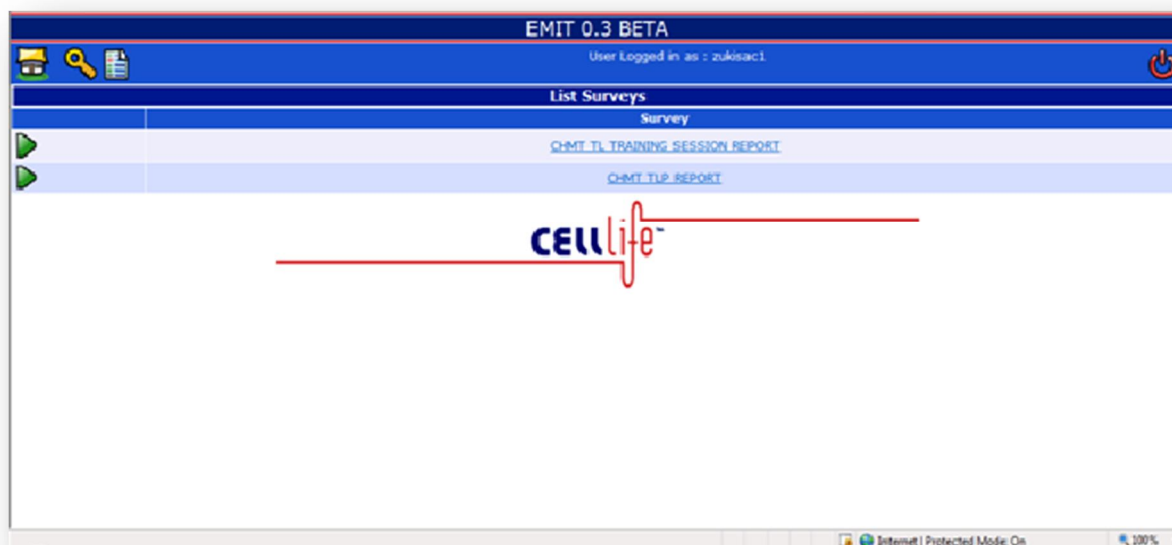
standard defines the way in which form data collected is transmitted across the internet. The xforms standard also determines the formatting of questions in a web form. The application stores the forms on the device and as such the number of completed and uncompleted forms the fieldworkers can store is limited by the memory capabilities of the mobile phone. On the mobile EMIT system the xforms are transmitted to the database on the central server through GPRS.

The system can be used in two different ways;

- Through Internet access
- J2ME, a store and forward mode which allows data to be entered and saved on a mobile phone and later sent when there is GPRS network coverage

The two input modes of the system are depicted in figures 6, 7 and 8.

Desktop data capture



CHMT TREATMENT LITERACY SESSION REPORT

This is the M&E form for treatment literacy sessions.
If you experience any technical problems please contact:
surveys@cell-life.org.za or call (021) 469 1111

Group: Literacy Session Basics
Basic questions about the treatment literacy session

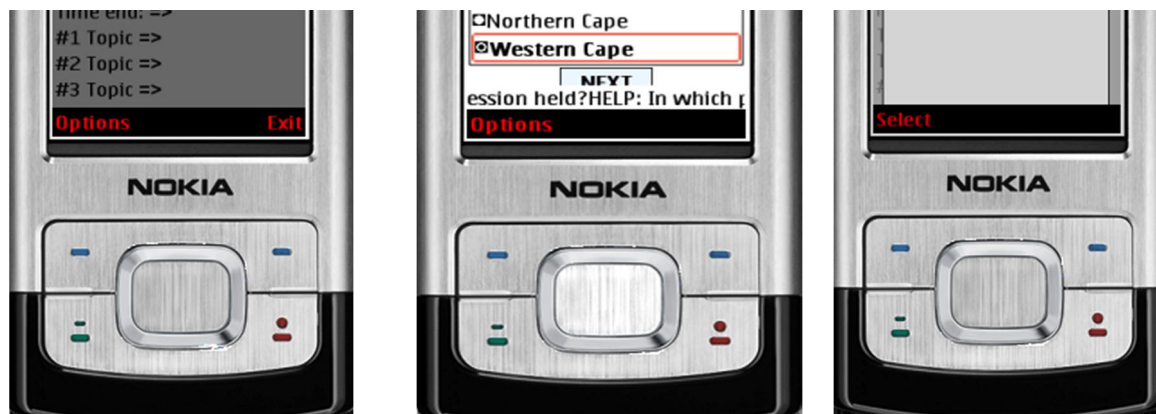
*On what date was the session held?
2009-05-05
Format: YYYY-MM-DD
(eg: 2003-12-25 for Christmas day)

*Which Province?
Choose one of the following answers

- Eastern Cape
- Gauteng
- Free State
- KwaZulu Natal
- Limpopo

Figure 7: EMIT desktop data capture - sample web survey

Mobile data capture



A core design objective of this system was to ensure that there would be a consistent look and feel between the desktop and mobile instances of the application. The reasoning was that the more consistent the look and feel the easier it would be to train people who had been using the desktop system first. This would result in a higher take up and utilisation of the mobile system if it was familiar to the users. The mobile and desktop systems thus follow similar workflows and the basic functionality of the data capture system is common to both input types. Another objective was that of ease of use. This objective was intended to augment the design consistency of the applications described above. The need to create an easy to use system was identified during the design of the system as it emerged that there were varying levels of technical proficiency amongst the field workers and other potential users of the system. It is however interesting to note a comment made by a business analyst at Cell Life that, after distributing the cellphone application to some of the fieldworkers during the pilot stage they took to the cellphone application quicker than they had to the desktop system earlier because they interact with cellphone applications on a daily basis and so they displayed an obvious familiarity with navigation and general use of cellphone applications. This is not surprising in a country where 60% of the households own a cellphone with over 41% of adults owning or using a cell phone (Markettree, 2005). The ubiquity of cellphones in South Africa can thus be attributed to the apparent higher aptitude when using cellphone applications. The ease of use of the system was also ensured by constant interaction with the users of the system during the design stage to ensure their requirements and needs were understood and incorporated into the final system.

The EMIT HMIS also places emphasis on security and audit capabilities as it has the capacity to capture and store sensitive information pertaining to HIV and other health information which is regarded as private. Thus the system employs password authentication on both the desktop and mobile system, with the passwords being stored on a central server as opposed to on the actual input devices. The ability to audit data captured is a requirement placed on the system by program coordinators and funders. The system

(field agents) through either mobile devices or desktop computers. The desktop and mobile data collection devices transmit their data over the internet to the database, though it is important to note that the data collection is performed through a set of electronic forms. The forms differ between the desktop and mobile device interfaces, as the mobile forms are custom designed to suit the device constraints of the mobile device. Gebauer, Shaw and Gribbins (2006) work on mobile information systems and task-technology fit comprehensively list the considerations that are to be made when developing mobile information systems that result in the best fit. Considerations to be made include accounting for the reduced display size on mobile devices when compared to the desktop systems that users may be used to. Also, considerations should be made to include measures to account for the limited quality of network connection (e.g., limited bandwidth requirements, indicators of network quality) which is a key differentiator between mobile systems and desktop systems. Other considerations are to be made regarding system elements such as processor and battery performance, storage capacity, bandwidth requirements, menu structures, setup requirements, system performance and user dialogue. Even though special considerations need to be made for mobile information systems, new developments are constantly reaching the market and improving the capabilities of mobile devices (Computerworld 2003, Yuan and Zhang 2003).

The second entity constituting a HMIS is that of data analysis. In the EMIT system, a server side application provides the data analysis capabilities of the system. The application allows users to securely login through a desktop and access information regarding data collected such as descriptive statistics on raw data submissions, as well as more detailed analysis of responses to individual submissions.

5.2 Project implementation

For this research, experiences with the system were recorded for the implementation of the EMIT system for 20 organisations funded by Johns Hopkins Health Education South Africa (JHESA). The system was piloted at Community Media Trust (CMT), a community based

more process mature would be provided with training on the EMIT system from the onset. The technology aptitude of the fieldworkers was determined through a brief questionnaire and if the field workers were adjudged to be proficient they would be moved onto the mobile version of the EMIT system. Upon completion of the roll out, the organisations utilising the EMIT system have users using a mix of the desktop and mobile versions of the system across South Africa.

The project has recorded significant success since its inception having resulted in 20 025 forms being submitted over the first nine months of the project. These submissions were from 312 web users and 70 mobile users (source: cell-life business analyst). This is quite a significant number of submissions as each form submitted represents a single training and/or literacy session delivered by a field worker on HIV/AIDS. The forms thus represent the number of messages delivered to various communities pertaining to HIV/AIDS treatment and prevention. The use of a mobile and web HMIS would have greatly enhanced the organisational capacity of the participating organisations as they are able to reduce the turnaround time in processing information captured by the forms.

However, despite these successes the study still aims to investigate the fit of the mobile application to the task needs of the fieldworkers and healthcare workers on the JHHESA project, and thus determine if the successes recorded in this project are as a result of the good fit between the information system and the task needs.

5.3 EMIT System Challenges and Benefits

As this is an on-going project, the challenges and benefits from this system continue to emerge. The key challenges and benefits of the system that have been identified so far are listed below. These were gathered from observations, as well as comments from the business analysts from Cell Life and users at one of the implementing organisations in Cape Town.

Amongst the challenges experienced during this project includes:

- Accessing the web system over the web is dependent on the availability and quality of internet speeds in those areas. The organisations taking part in the implementation of EMIT are provided with internet access by the funding partner JHHESA. In some areas this is slow and is a source of great frustration for the users as they try to submit data.
- There is a low usage of the data analysis capabilities of the system. Most usage is focused on the data collection and population of the HMIS.
- Field workers are at higher risk of theft as they have to carry certain cell phone types into public areas as they conduct their literacy campaigns
- Training on the system is difficult where computer and cellphone (general IT) literacy is low. This has typically resulted in low usage of the system in some organisations. A business analyst from Cell Life had this to say:

“Utilisation of the system has been admittedly low at first in some of the organisations and gradually increasing as they get closer to their reporting deadlines. This is probably due to a lack of understanding of what the system is for. When it comes to training though we find it easier to train the cellphone version users as there is high literacy there. It’s quite a leap to using the same system on a computer...”

- There is an added cost to organisations, however minimal, of submitting data across the mobile phone network via GPRS. Individual data submissions are observed to cost between two cents and five cents and even though this is very low, it still requires organisations to ensure their field workers always have airtime.
- The application running on the mobile device is also subject to memory issues. This means that for the lower end mobile devices, the memory is quickly filled up with submitted forms and these have to be deleted periodically. The application is also unable to run on the cheapest J2ME enabled cellphones which restricts the reach of

- The turnover time between data collection and reporting on the data has reduced. This is due to the fact that the data is available for analysis in an electronic form upon submission by the field workers. This is as opposed to the paper-based system that was in use in most of the organisations prior to the implementation of EMIT.
- There is increased satisfaction amongst the fieldworkers using the mobile system as they no longer have to travel distances in order to submit data collected during their field work. In the absence of a mobile version of the system, field workers would have to travel to the organisation's base to submit form data to a central internet-enabled computer.

Chapter 6: Results and Data Analysis

In this chapter the response data is subjected to an array of statistical analyses to determine if the model has successfully captured the users' perceptions of fit of the EMIT system. The analysis will follow the logical flow of first determining the validity of the model, then analysing the raw responses to get a feel of the data, then analysing the survey instrument variables from different perspectives before finally making conclusions on what has been learned from the models. Three follow up interviews were held, one with a program manager and two with fieldworkers. As discussed in the research methodology section, the interviews will be used to augment the analysis of perceived fit.

6.1 Respondent data reliability and validity

This section will analyse the reliabilities of the individual constructs measured by the instrument and also briefly discuss the validity of the survey results before proceeding to interpret these results. The investigation into the reliability and validity of the results will inform the researcher's sensitivity to the statistical results obtained and how far the conclusions made can be generalised.

Often the terms validity and reliability are used in conjunction with each other. Colosi (1997) defines reliability as the consistency of a measurement, or the degree to which an instrument measures the same way each time it is used under the same condition with the same subjects. This lends itself as a measure of how repeatable a measure is. This is especially important for further research into fit of technology to tasks in the health care sector where the same instrument can be applied to information systems outside of this study. Validity is concerned with the questions of whether the means of measurement are accurate, and whether they are actually measuring what they are intended to measure. Thus it is defined as the best available approximation to the truth or falsity of that it is intended to describe, explain or theorise (Winter, 2000; Cook and Campbell, 1979). Validity is thus the strength of the inferences and /or conclusions derived from the study.

ensure that parallel questions were not adjacent to each other. This made it unlikely for respondents to refer back to their past answers and make adjustments.

Table 6 shows the final cronbach alphas for the constructs in the questionnaire with a note on whether questions were dropped from the construct.

Table 6: Table of Cronbach alphas

Dimension	Number of Questions	Overall Cronbach Alpha	Managers	Fieldworkers	Dropped Questions
Accessibility	2	0.77	0.61	0.78	-
Accuracy	2	0.236	1.4	0.25	-
Affect	3	0.88	0.86	0.88	-
Assistance	1	-	-	-	-
Authorization	3	0.696	0.7	0.98	q15
Compatibility	2	0.32	0.6	0.29	-
Confusion	3	0.621	0.07	0.63	q3
Current	2	0.101	0.97	0.13	-
Ease of use	2	0.501	0.38	0.5	-
Flexibility	3	0.653	0.74	0.64	q10
Meaning	3	0.59	0.85	0.78	q25
Presentation	2	0.71	0.63	0.71	-
System reliability	2	0.07	1.05	0.12	-
Task type	2	0.578	0	0.59	-
Training	2	0.43	0.1	0.44	-
Overall	3	0.815	0.6	0.82	q35

For the purposes of analysis, the reliability was considered for the whole response set. The table also shows the difference in reliabilities between the manager and fieldworker responses; though there are only 7 responses from managers it was interesting to attempt to test the reliability of their responses. From the alphas listed, it is apparent that manager alphas are not as high as the fieldworker alphas. However, there is too little data to

6.1.2 Validity Analysis

To determine the validity of the TTF instrument applied to the EMIT system users, the researcher examined the evidence for construct validity. A table showing the item to latent variable correlations is given in the appendix K. Correlations were analyzed firstly to see how well each individual instrument item correlates to the latent variable it supposedly represents and lastly to see the correlations between latent variables. The instrument items all positively correlate to their latent variables at levels greater than 0.5, after dropping the unreliable items.

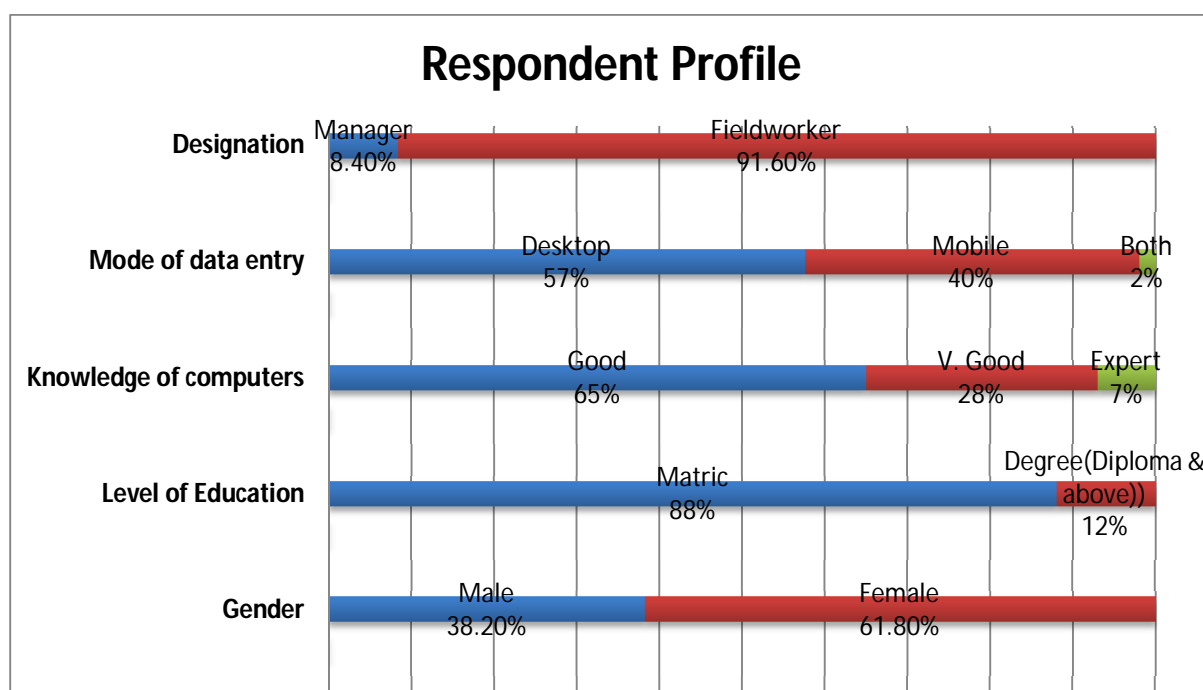
Correlations between latent variables tell a different story with positive and negative correlations being observed. The strongest positive correlation was observed between accessibility and the task type with the strongest negative correlation being between meaning and users' affect towards the EMIT system. The correlation between meaning and affect is rather unexpected as it means users' affect towards the system can increase the less they understand about the system. The users' task type is expected to strongly correlate with accessibility as access to information from the system is determined by the tasks the users are expected to perform (managers performing more information tasks than fieldworkers). The weakest correlation was observed between the confusion users experience while using the system and how current they thought the data from the system was. A further analysis of the relationship between latent variables is performed in the analysis section.

6.2 Preliminary analysis

Survey responses were received mostly from paper based surveys that were sent out with a very low response rate on the online survey link. This is due to the lack of access to internet services that most of the fieldworkers experience. Their main source of internet is the desktop machine supplied at their respective field office headquarters, however this is only available for fieldwork-related tasks such as data capture. As a result only 12 responses were received online and the remaining received via paper-based survey questionnaires that

deletion was used throughout the statistical testing for any missing test item responses. The respondents to the survey were split between fieldworkers and managers, with 8.4% of the respondents being managers. The average length of time while using either incarnation of the EMIT system (mobile or desktop) was found to be eight months. All respondents indicated that they were working for community based organisations (hence non from patient care organisations) with 67% working for an organisation of 41 or more people, 25% working in an organisation of 15-30 people and the rest in smaller organisations.

In order to answer the core research question and subsequent sub questions arising, four hypothesis were formulated which will be presented in the hypothesis testing section using the data collected from these survey responses. From the 83 responses received, the table below summarises the respondent profile for the survey questions in section A of the instrument (additional to Goodhue's instrument) that were designed to be used to inform the hypothesis testing.



into more concise options (sub-types), necessitated by the low frequencies of responses to these options. The condensed frequency table for the individual questions is provided in Appendix J

Descriptive statistics (Number of valid responses, minimum, maximum and standard deviation) were calculated for each of the numerical variables measured by the 7-item likert scale, after dropping unreliable questions. A summary of these values is included as Appendix I.

A further analysis of the responses reveals that most of the users who responded to be knowledgeable with computers (either good or very good) are women below the age of 30. 35 women and 18 men indicated that they are knowledgeable with computers. As for those who considered themselves experts with computers, 16 are males and 13 are females. Combining the knowledgeable and expert users, more than half of the respondents (48) are below 30 and as such it would be of interest to observe the impact the age has not only on overall perceptions of fit but also its relation to the knowledge of computers. The instrument also recorded whether users of the EMIT system were using the desktop or mobile input modes. Of the 47 desktop users, 62% are below 30 years old while only 55% of the mobile users are below 30. This should make it interesting to observe the impact of age on the perceptions of fit for the desktop system in comparison to the mobile system – it is expected that users below the age of 30 would have higher perceived overall fit for the mobile system as opposed to the desktop version of the system.

6.3 Full data set analysis

The data analysis was first performed on the entire respondent data set so that any inferences to be made from the data could be generalized for all users of the EMIT system who responded to the survey. The TTF instrument must, for each dimension, ascertain the degree to which users believe their personal task needs have been met by the information

Summary regression results

	b*	Std.Err. (of b*)	b	Std.Err. (of b)	t(72)	p-value
Intercept			0.614	0.666	0.922	0.360
Affect	0.250	0.092	0.258	0.095	2.719	0.008**
Authorisation	0.062	0.162	0.060	0.156	0.383	0.702
Ease of Use	0.246	0.153	0.259	0.162	1.604	0.113
Meaning	-0.250	0.107	-0.213	0.091	-2.348	0.022*
Accessibility	0.102	0.158	0.104	0.162	0.642	0.523
Assistance	0.188	0.113	0.157	0.094	1.664	0.100
Presentation	0.366	0.100	0.552	0.151	3.656	0.000***
Confusion	-0.274	0.097	-0.281	0.100	-2.814	0.006**
Regression Summary for Dependent Variable: Overall (all responses excl) R= .82325117 R ² = .67774249 Adjusted R ² = .64193610 F(8,72)=18.928 p<.00000 Std.Error of estimate: .81800 N=81						

Figure 10: Full data set multiple linear regression results

The prediction model to be derived from these regression results has some validity since most of the variation in the data (64%) is explained by the model. The F-value is sufficiently high to infer that at least one of the variables is linearly related to the overall perception of fit. Multicollinearity between the variables may be a concern when looking at the coefficients as predictors of fit and the correlation matrix will be considered when discussing these results in ensuing sections.

The multiple regression results above will be used to inform the recommendations to management. The regression equation after exclusions is considered as it contains the reliable variables. For this equation only Presentation, Affect, Assistance, Ease of Use, Accessibility and Authorization are positively linearly related to the overall perception of fit; with Presentation having the greatest effect on overall perception of fit, when all other variables are held constant. In other words an improvement in the presentation of information in the system will have the greatest impact on the perceived satisfaction of task

overall fit only, while holding all other variables constant, and not for interpreting the coefficients. This does not provide much insight for confidently predicting the impact of a single variable on overall fit. Another look at the correlation matrix suggests multicollinearity is a concern in this data meaning the variation in overall fit as a result of the insignificant variables is accounted for by the significant variables. Authorisation, ease of use, accessibility and assistance exhibit high correlations (see extract from correlation figure below). The factor analysis will show that these variables group together and perhaps analysing these variables as a combined variable will give a better prediction of overall fit as they are not significant as separate variables in this model- this is done in the next section.

Authorisation	1			
Ease of use	0.747	1		
Accessibility	0.718	0.799	1	
Assistance	0.739	0.642	0.484	1
	Authorisation	Ease of use	Accessibility	Assistance

Figure 11: Full data set mini correlation matrix

The multiple regression equation only shows the impact of the variables on overall user perception of fit. It is also of interest to the researcher to discover any interactions between the variables, given the influence of multicollinearity on this prediction model. The observed correlations between variables were also taken into account while forming the conclusions presented in the hypothesis discussion section.

Item to latent variable correlations were calculated between the task technology fit variables from Goodhue's instrument (Appendix K). Significant positive correlations ($p < 0.05$) were found between the overall perception of fit and all the independent variables except the compatibility and confusion variables. Correlations between independent variables were also considered, and it is important to note that these, along with the latent variable factor analysis results in the next section, were used to inform the follow-up interviews with the organisation managers. Surprisingly low correlations between presentation and assistance,

selective perception as it were. Factor analysis was used to unearth patterns in the data, anticipated or not, prior to inferences being made so as to let the data speak for itself. Darlington (2010) asserts that the purpose of factor analysis is to discover simple patterns in the pattern of relationships among the variables.

The objective is to determine if observed variables can be explained largely in terms of a smaller set of variables (otherwise referred to as factors). The table below shows the summary of the factors and factor loadings at the 0.5 level of the response set after dropping unreliable questions. A complete breakdown of the factor loadings and total explained variance is provided in appendix H. The factor analysis was run on all the questionnaire items excluding the dependant variable question items. The results of the factor analysis were compared to the cronbach analysis results and it is apparent that those variables that were 'dropped' by the cronbach analysis do not load well on a single factor which further justifies their exclusion from the analysis. There is the exception with the task-type and flexibility variables which were found to be valid constructs under cronbach alpha analysis but whose individual question items do not load heavily on the same factor. This may be as a result of poor operationalisation of these constructs in the questionnaire resulting in inconsistent data responses.

Table 7: Table of emergent factors

Factor	Description of factor	Valid variables contained in factor	Proportion of Total sample explained by factor
System Security	The individual features of the system that impose restrictions on what the users can accomplish with the system	Authorisation, Ease of Use, Accessibility, Assistance	22%
Data layout	The display of data in the system and how it affects perceptions of	Presentation, Confusion	13%

note that it is possible for other factors to exist that have not been captured by the instrument. This is a limitation of the quantitative approach to analysis and it is for this reason that a follow up interview was conducted to corroborate the observations from the data with the interpretations of the interviewee – a program manager at one of the implementing organisations.

A multiple regression analysis of the factors (Appendix L) was also conducted to see if a model of the identified factors could be used as a predictor of perceived fit. The regression reveals that each factor is linearly related to the overall fit variable, holding all other factors constant, except for factor three. Factor three is the “User sentiment” factor and consists only of the affect item variables. This is not surprising though as the item-total correlations clearly show that the affect variable has high linear correlations with all other variables with the exception of presentation and assistance. This points to an influence of multicollinearity wherein much of the variation in perceived fit as a result of user sentiment is explained by the remaining four factors. With an R-square of 0.76 there is 24% residual variability and the model explains most of the variation in the data. At the 5% level “system security”, “data layout” and “relevance” are linearly related to perceived fit. These results are consistent with the regression of individual items though a further study focused on the emergent factors would be warranted.

The multiple regression by factor explains more variance in the data in comparison to the full sample valid item regression. The prediction model from the factor regression provides broad focus areas for organisations looking to improve the fit of the EMIT system to their workers’ task needs, however this model does not fully reflect the influence of the mobile implementation of this system on the perceived fit. In addition to investigating the overall perceptions of fit of the EMIT system on workers’ tasks, a core objective of this study was to adapt Goodhue’s instrument so that the mobile aspect of the system could be observed to see if a mobile implementation of a system had any influence on perceived fit when compared to another implementation of the same information system. The following section

Unlike the analysis of the complete data set, the focus for the analysis of mobile versus desktop data subsets was to determine any differences in perceived fit between the two groups of respondents. In addition to differences in perceived fit, differences between responses to individual variables will be analysed as well as whether the two groups of respondents have the same prediction model for the predicting overall perceived fit.

Further to the simple analysis of the difference in means between the variables of the full data set, the variables in the desktop and mobile data subsets were also analysed by way of a student t-test to see if there were any significant differences in means for the Age, Gender, Level of Education and Knowledge of computers characteristics of the respondents. The results of this analysis are summarised in the results matrix below;

Table 8: Student t-test results matrix

Means difference for:	Desktop?	Mobile?
Age	No	No
Gender	No	No
Level of Education	Yes	No
Knowledge of computers	No	No

From the table 8 above, significant differences in means were registered for the level of education amongst the desktop users. For the age, gender and knowledge of computers characteristics, it is likely that any differences observed in responses to these questions are due to a coincidence of random sampling. Based on the means the desktop users who have more than matric education (MM) seem to have higher ratings of overall perceived fit than those with a matric or less (ML).

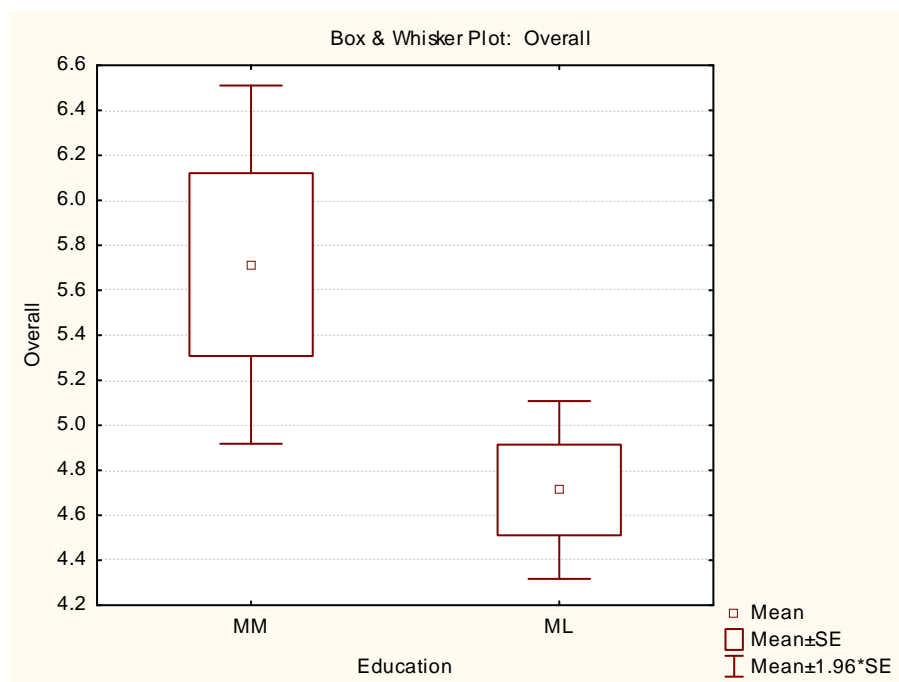


Figure 12: Box and whisker plot of education level t-test for desktop users

The program managers are typically desktop users of the EMIT system thus differences in education levels are likely to be greater in the sample of desktop users. The responses received were mostly from fieldworkers, whose task characteristics are simple and restricted to data entry into the EMIT system with very little analytical tasks required, hence the simplicity of the tasks implies that the requisite educational level is much lower. This may be the reason why there are no significant differences in the assessment of fit among mobile users. In the case where tasks are largely repetitive and simple, the education level does not greatly influence the users' ability to use the system and as such will not be a factor in their assessment of system fit. In a follow up interview with one a program managers from a Cape Town organisation it emerged that for their organisation the objective was to *“reduce disruptions to the fieldworkers work when our data collection requirements change”* and as such their tasks remain as *“simple and repetitive as possible because obviously over time*

mobile users but not for the desktop users – each variable holding all other variables constant. For the desktop user data subset, ease of use, accessibility and assistance are significant predictors of overall fit for desktop users but not for mobile users. Affect is significant and Authorization is insignificant for both respondent data subsets.

	Desktop			Mobile	
	b	p-value		b	p-value
Intercept	0.877819	0.299651		-0.15853	0.881597
Affect	0.51087	0.003681		0.219976	0.050367
Authorisation	-0.26896	0.269507		0.157685	0.439534
Ease of Use	0.902649	0.001391		0.089245	0.69389
Meaning	-0.1931	0.10005		-0.27809	0.044022
Accessibility	-0.63409	0.029047		0.355984	0.072771
Assistance	0.497963	0.001642		0.083507	0.51238
Presentation	0.263859	0.346795		0.708585	0.001758
Confusion	-0.26291	0.302012		-0.2935	0.005063
	Regression Summary for Dependent Variable: Overall (desktop) R=0.83130339 R ² =0.69106533 Adjusted R ² =0.62426864 F(8,37)=10.346 p<0.000			Regression Summary for Dependent Variable: Overall (mobile) R= 0.90928067 R ² =0.82679134 Adjusted R ² =0.76905512 F(8,24)=14.320 p<0.000	

Table 9: Side-by-side comparison of regression results: desktop vs. mobile

Juxtaposing the regression models it is apparent that the two subsets of data have contrasting results showing that the two groups of users' perceptions of fit are influenced by different sets of variables. Ease of use, accessibility and assistance were identified as constituents of the "System security" in the factor analysis. These three variables would be a concern for desktop users as the desktop computers are located in a central location and often shared amongst fieldworkers with usage restrictions imposed for this context. In a follow up interview, one fieldworker reiterated that

" before the cellphones we all had to come to the office on Fridays and take turns to

small form factor of the mobile device. Gebauer and Shaw (2004, 2006) identified the user interface and functionality of mobile devices to be significant influences on technology fit.

Given the differences between the significant variables for the desktop and mobile users, it was necessary to perform an analysis of the difference in means for each instrument variable, comparing any significant differences between desktop and mobile users' responses. No significant differences in means for the instrument variable items were found for both desktop and mobile user sub groups.

6.6 Other findings

In addition to the questions measuring the overall fit variable, general questions were asked in the instrument asking users to make a comparison of the desktop and mobile system and communicate a preference. A look at the mean of responses to question 36 along with extracts from the follow up interviews imply that those who have used both implementations convey positive evaluations of the system with mobile users believing that the mobile system is a better fit than the desktop system. The means of the responses from the mobile users to this question are shown below.

Question	Mean	Mode	Standard Deviation
I prefer the mobile implementation of the system to the desktop system (N=32)	5.347	6.0	1.3992

On average, respondents to these questions strongly agree with the sentiment that the mobile system is preferable to the desktop input system.

The reason for this evaluation could be that those users who were later moved onto the mobile system felt that using the mobile system was a form of reward for having done well with the desktop system. An interview with a fieldworker revealed that there was a sense of

mobile data collection version of the EMIT system was dependent on the level of process maturity of the organisations. As such being asked to move to the mobile system was an acknowledgement of more mature data collection processes and more capable staff. It is plausible that the users' perception of the system would change as they would be under the impression that since the use of the mobile system was an advanced step then the mobile system must be better which in turn would influence their evaluations. A constant criticism coming through from literature is that task technology fit places a lot of value on the users perceptions of fit and trusts that users are qualified to make an evaluation of fit. Given the scenario described above where user perceptions can be influenced by how the technology is presented, researchers and implementers should also consider the context of the technology application in interpreting perceived fit.

The feedback from the qualitative interviews also revealed some new information as well as raised new questions that could be investigated. During an interview with a programme manager it emerged that the definition of the data the fieldworkers collect and the managers analyse is subject to regular change. This may have an impact on the meaning variable, and even the task characteristics. According to the manager;

“Every now and again we get new indicators to monitor which requires us to change the content of the information we are teaching in the community. As managers we always make sure the fieldworkers don't have to worry about that and they just have to know about the new content not the indicators behind them.”

Data definition changes are not uncommon in the health care sector, and for a system like EMIT the flexibility of the system becomes an important factor for improved performance as it would reduce the chances of disruptions to tasks. The same manager was also asked how she felt about the flexibility of the system and whether she thought having more options/features would be good for the EMIT system. She noted that a flexible system would reduce the need for staff re-training in the event of changes, but that since many of her

6.7 Discussion

In this section the implications of the statistical results described in the previous chapter are discussed.

The analysis of the full data set resulted in a prediction model, through multiple linear regressions, that found four variables (Affect, Meaning, Presentation and Confusion) to be significant predictors of users' perception of task-fit. Those four variables that were not significant (Authorization, Ease of Use, Accessibility and Assistance) were found to load on a single factor and their correlations were also sufficiently high to posit the influence of multicollinearity. By running a multiple regression of the emergent factors a prediction model that explains more variation in the data emerged (Figure 13).

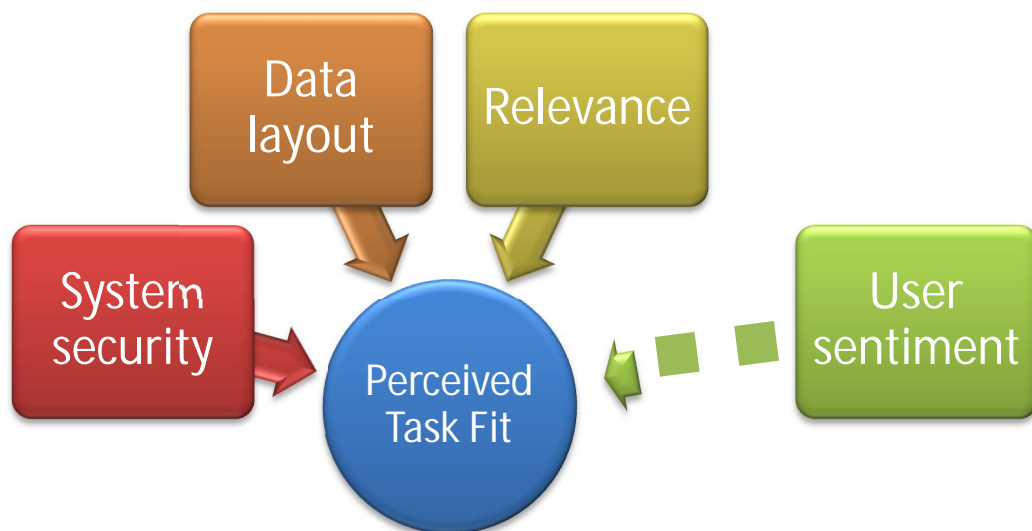


Figure 13: Factors influencing perceived task fit for EMIT users.

Using this model there is evidence to suggest that concentrating on improving the EMIT system security, holding all other factors constant, will result improved perceptions of fit. System security is made up of the authorisation, accessibility, assistance and ease of use variables. While gathering information on the case, the researcher noted that Cell-life

used to predict perceived task-fit in this model, it evidently influences task-fit, hence its inclusion in the model diagram, and should be a consideration for practitioners.

The data layout and relevance factors are also significant predictors made up of the presentation, confusion and meaning variables. These variables describe the influence of the system interface design considerations on overall task-fit. The two factors have negative coefficients and we could infer that reducing the confusion, lack of meaning and any data presentation problems would improve the perceived task-fit. This is especially true for the mobile system users who showed that the presentation, confusion and meaning variables were significant in predicting fit for their group than the desktop users.

Following on from the regression of the desktop and mobile user groups it emerged that these two groups have very different influencers of perceived fit. Affect was the only common variable influencing perceived task-fit for both groups. This is a very important result as it prompts implementers and future researchers alike to consider desktop and mobile system users separately when assessing fit.

At the beginning of the study, four main hypotheses were put forward regarding the users' evaluations of perceived fit.

Hypothesis 1: *Individual users' affect (general attitude/feelings about the system), where positive, will result in positive evaluations of the system's ability to meet task needs.*

The affect variable in the multiple linear regression analysis is statistically significant at the 5% level meaning we can conclude with 95% confidence that affect does have an impact on overall perception of fit, holding all other variables constant. The affect variable has a positive correlation to the task fit variable of 0.57 and recorded a mean score of 4.65 from all responses while the overall task-fit had a mean of 4.98. Also given the positive coefficient for affect, we can infer that an increase in user affect will likely increase the overall perception of fit. The participants in the follow up interviews all professed to have a positive attitude

Hypothesis 2: *User evaluations of an overall system do not differ between mobile and desktop environment use contexts.*

In a prior chapter it was noted that users of the EMIT system are initiated on its purposes and usage through the desktop system and only once their competency has been subjectively assessed by the project implementers are the users migrated onto the mobile input of the system. This means that users of the mobile system are typically past or concurrent users of the desktop system and as such these two groups of users cannot be treated as strictly independent.

The instrument made sure to include at least one question that would help separate users of the desktop and mobile systems and thereby facilitating the comparison of fit for the two groups of users. Statistical tests were then run on each sub set of users to compare their evaluations of fit for the different incarnations of the EMIT system. Analysis results do suggest that user evaluations of an overall system differ between mobile and desktop environment use contexts. Multiple regression models were developed for the desktop and mobile user subsets (Table 9) and the results show that different variables are significant for each user group. For the desktop users, Ease of use, Assistance, Affect and Accessibility were found to be significant factors. This is in contrast to Confusion, Presentation, Meaning and Affect which were significant for the mobile users only. The two groups of users' perceptions of fit are indeed influenced by different sets of variables and the physical aspects of the desktop and mobile systems appear to make users more conscious of the variables influencing their perceptions of fit. Desktop users are deemed to be influenced more by security variables while mobile users are influenced by variables that would be associated with the small form factor of mobile devices. For the overall fit variable in the combined data set, though there were more desktop users than mobile, the desktop users showed a mean score of 4.1 with mobile users having a mean score of 5.86. This would imply neutral responses to overall assessment of fit and more positive/confidence in the fit of the system amongst mobile users.

significant at the 5% level, and from that we can infer that holding all other factors constant system security does influence the perceived task fit. System security as has a considerable positive correlation to the overall task-fit, and a positive coefficient in the regression test so it is posited that any improvements in system security (by giving users access they require) will result in an improvement in perceived fit.

Hypothesis 4a: *Systems interface aspects (presentation of information, usability, and confusion experienced during usage) do not affect overall user evaluations of fit.*

Using the final factor regression model, the data layout is a statistically significant predictor of overall task fit and suggests that the interface aspects of the health system's interface do have an impact on the perceived fit of the system. Not only are the features and functionality important but their presentation as well. The presentation and confusion variables which constitute the data layout factor are also significant predictors at the 5% level in the instrument variable regression of the full data set. Citing the example of the IBM project in Limpopo, it is not only important to implement the requirements through system features, but the interface of these features is important in order to improve the fit of the system.

During the analysis it emerged that the desktop and mobile user groups had contrasting opinions on the significance of presentation and confusion in influencing their perceptions of fit. The mobile user group considers these variables to be significant predictors of task fit, so even though data layout can affect perceived fit practitioners could do well to focus system interface improvements on the mobile system. The reason for this is that the mobile system has a smaller form factor and more effort is required to adapt the system to mobile interfaces. Also it is likely that because desktop users can use alternative methods to analyse the data the presentation and confusion with data becomes less of a concern. In the follow up interviews conducted one of the managers was asked whether the layout of the information captured by the EMIT system impacted on their affect for the system. The manager conceded that even though the system captures all their task requirements and

Hypothesis 4b: *Individual assistance given to users does not affect evaluations of the system's ability to meet task needs.*

While looking into the impact of the information system's interface on the overall perceived fit of the system it is reasonable to assume that no system can be perfectly designed to capture all the requirements and present them in the exact way that results in a perfect fit for its users. Often users are trained and supported throughout the use of the system to mitigate any issues the system design might not cater for very well. With that in mind it was interesting to research also whether the additional assistance provided to users would have any impact on their perception of fit. Referring to the analysis of mobile versus desktop user groups, the assistance variable is a significant predictor for desktop users but not for mobile users. This is because mobile phones are a more familiar technology to fieldworkers as they use them in their daily lives and as such they require less training and assistance with the mobile system. The assistance variable is a component of the system security factor which was identified as a significant predictor of perceived task fit. From that we can infer that though individual assistance given to workers does affect their perceptions of system fit, it is more important to provide assistance to desktop users in order to influence their perceptions of tasks fit.

The following chapter will summarize what has been learnt through this study by taking a retrospective look at the objectives of this study juxtaposed with the inferences that came through the data analysis.

Chapter 7: Conclusions and Contribution

7.1 Conclusions

This research study set out to discover to what extent the users of a health information system believed the system was able to fulfil their on-the-job task requirements. The motivation behind this inquiry was rooted in the need to find out what made a good information system for healthcare workers, and in doing so make recommendations that would go some way in reducing the chances of technology project failure for similar system implementations in future. The assessment of how well task needs were satisfied was modelled using the TTF theory and operationalised using the 15 variable instrument adapted from Goodhue (1995). Univariate techniques were used to inspect the distributions for continuous variables, while multivariate techniques were used to identify relationships between the dependent and independent variables, as well as among the independent variables. Some unexpected observations were made from the data and a brief questionnaire produced to try and gain a better understanding of what had been observed

The TTF instrument has allowed the researcher to measure user evaluations of fit and it can be concluded that overall the EMIT system users perceive the system as an adequate fit for their task requirements. The Affect, Meaning, Presentation and Confusion variables were found to be most significant in influencing these perceptions from the multiple regression analysis of the overall data set. While Authorization, Ease of Use, Accessibility and Assistance were not significant in this regression model, a new model derived from the emergent factors identified System security, Data layout and Relevance as the most significant variables. These 'new' variables allowed grouping and inclusion of all the instrument variables, except Affect, as significant predictors of perceived fit. In addition to investigating the perceived fit of the system, the theoretical underpinnings of the study also link the perceived fit to positive performance impacts.

Subjective conclusions regarding performance impacts can be drawn from the comments the

the Cape Town organisation they piloted the system with, in particular the time associated with people uploading data. Also accuracy had increased dramatically which in turn has knock-on effects on the management time required to clean the data. This ultimately results in a quicker decision making as there is less time taken between receiving data, making sense of it and making operational decisions. Cell-life notes that the EMIT system is now in 26 sites across the country, so the performance improvements as a result of the system are apparent. The TTF theory then holds true where the users express positive evaluations of the ability of the system to fit their daily tasks, and these evaluations are supported by tangible evidence from the analysis.

The study also aimed to evaluate the fit of a system that incorporates both mobile and desktop inputs for the tasks of community healthcare. Respondent data analysis suggests that there is no difference in perceived fit between different incarnations of the same system. However, in order to make improvements to perceived fit it is necessary to approach the desktop and mobile user groups differently as different variables affect their perceptions.

The EMIT system is designed to fit the same set of user tasks regardless of whether it is used on a mobile or desktop computer. Gebauer's (2006) work suggests that special consideration needs to be given to systems that employ mobile technologies when determining fit. The results of this study are deemed to support this notion. For the desktop users, Ease of use, Assistance, Affect and Accessibility were found to be significant ($p < 5\%$) factors. This is in contrast to Confusion, Presentation, Meaning and Affect which were significant for the mobile users only. The contrasting results seem to point to different considerations being made by the two groups of system users for the same task requirements. There is thus room for a further analysis of the EMIT system which would involve investigating the perceptions of fit across a gradient of task complexities. To do this may involve incorporating more system stakeholders, other than just the fieldworkers and managers, to include the national program managers who interact with data from the system and the higher managers who are involved in setting monitoring and evaluation indicators for

healthcare information workers (EMIT system users) was produced from the analysis of literature and through conversations with users in the target sample. Organisations engaged in similar work can expect similar evaluations of fit and the management recommendations made in this study can be used as starting points for ensuring successful implementation of similar systems.

Finally, the study also helped answer some questions that were not initially asked pertaining to differences in perceived fit between different age and gender groups, levels of education, knowledge of computers and most notably between mobile and desktop user sub groups.

It is hoped that the findings from this study and the recommendations made will contribute to the delivery of systems better suited to information workers in the community based HIV/AIDS sector.

Based on the conclusions drawn from the hypothesis testing and discussion above, the following recommendations are made to Cell-Life management and implementers of the EMIT system;

7.2 Management recommendations

Based on the findings of this study, and supported by the simple linear regression results presented, it is the researcher's belief that focusing management efforts on improving the following areas will likely result in a better fit for systems with the workers they are targeted at:

- **Affect:** Affect in this study refers to the positive behavioural aspects that reflect how users 'feel' about the EMIT system. For the implementers and managers of users of the EMIT system investigating ways of improving the targeted users' general feelings and attitudes towards the system will contribute to improved fit of the application to users tasks. Improving feelings and attitudes towards the EMIT system can take the form of incentives or rewards to users that show progress while learning the system.

- **Authorisation:** By taking the time to gather feedback from the system's users about what data they need access to in order to perform, management can improve the fit of the system to the users tasks by ensuring that the users have the right level of access to perform their tasks. Information systems used in the health care sector place a great emphasis on privacy and security of patient data however this should not distract system implementers from focusing on ensuring a good fit between the tasks and the systems they develop.
- **Ease of Use:** Continued investment in improving the user interface of an application will go a long way towards improving the fit of a system to user tasks. This is especially true for mobile system interfaces which are subject to restrictions in size and application memory, as shown by the contrasting results for mobile and desktop user subsets. System implementers should take care in adapting systems to mobile interfaces to ensure that the fit of the application is not compromised.
- **Accessibility:** Increasing the ease with which users access the system may result in an improvement in the perception of fit amongst the users, though the impact appears to be not as high as the other factors. From the regression analysis, accessibility of the system represents the second lowest impact on overall perceptions of fit. This, however, does not mean access to the information system is not as important especially in the context of the EMIT desktop system where information entry and use are highly dependent on how much access users have to the physical system.
- **Assistance:** The more assistance afforded to the EMIT system users, the more likely the perceptions of fit will improve. Assistance should not only be restricted to training given to users at the time of implementation but should also encompass continued support while the system is in use.
- **Presentation:** Presentation emerged as a significant variable for predicting overall fit. This was true for the overall data set and the mobile user subset. This should hint to implementing organisations that presentation is a key consideration especially for

presentation of data should be a major focus area for improving the perceived fit of the EMIT system to user tasks.

- **Confusion:** Confusion showed a negative coefficient in the regression analysis implying that reducing the amount of confusion users experience while using the system or interpreting the data will improve the perception of fit. A further study may be necessary to gather more specific information on the kind of confusion and the areas where this confusion is experienced while using the EMIT system. The confusion observed in this study was generalised to confusion pertaining to the data the users encountered while using the system.

The above recommendations were made only for the variables that were deemed valid and reliable by the statistical tests. It should be noted that there may be other important variables which are not included in the analysis since they are not part of the theoretical TTF model. However, since 76% of the variance in TTF was explained, the impact of these unknown variables can be assumed to be less than 24%

7.3 Contribution

The following are considered to be the main contributions of this research study;

- a) Highlighting focus areas for management of organisations using the EMIT system. These focus areas discussed in the previous chapter emerged from the responses provided by the survey respondents. Action on these focus areas could improve user evaluations of fit.
- b) The study added further empirical evidence to the postulations of Goodhue and provided a local context for the TTF instrument.
- c) Application of the TTF instrument to a multiple input system; the study was able to employ the TTF instrument developed by Goodhue and investigate whether evaluations remain consistent for different implementations of the same system.

This study has been focused on specific research objectives, and as such the research scope has been limited to a project in the HIV/AIDS sector. The South African health sector as a whole presents numerous research possibilities for similar studies and this section will detail recommendations for future research areas that have emerged from observations made in this study.

Exploration of the potential for a full mobile health information system: With the pervasive use of mobile technologies in various industries (banking and advertising for example), the full potential of mobile technologies remains to be explored. Literature is awash with HIS projects which are augmented by mobile technology components. It would be of interest to investigate HMIS completely run on mobile technologies and to compare their effectiveness to that of traditional HMIS.

Exploration of the influences of adoption context on user evaluations of technology: Though this study was focused on using user evaluations as one of the key constructs to determine the fit of tasks to technology, little attention was paid to the influences on the overall user evaluations of the adoption context. Considering some of the criticisms of TTF theories, it would be important to investigate the differences in user evaluations where utilization is forced or voluntary.

Inclusion of mobile technology characteristics: A similar exploration of fit between technology and tasks in the health sector, though giving greater credence to the specific technology characteristics (such as connectivity, reduced interface and system mobility), would be of great importance. This is especially true where any such exploration would investigate whether the technology characteristic would alter the way in which the user would perform their tasks.

Exploration of possible new TTF variables: While analysing the data, four emergent factors were identified which could be considered as variables affecting the perceived fit of similar systems. Future research could look to validating the model of System Security Data

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Appendices

Appendix A: South Africa public health sector funding

Sources of Comprehensive Public Health Sector Financing, 1996/97-1998/99 (R million, real 1999/00 prices)

Sources of Finance	1996/97	1997/98	1998/99
Local authority revenue	845	963	996
User fees from households	499	418	340
Provincial Government own revenue	334	578	384
Donors	18	33	68
Total	30,941	32,963	32,695

Source: Thomas S. *et al*, 2000, p.133

Appendix B: Expenditure on health care as a percentage of GDP

Health expenditure % of GDP

Definition: Percentage of national Gross Domestic Product that is spent on health care.

	EC	FS	GP	KZN	LP	MP	NC	NW	WC	ZA
Health expenditure % of GDP [Definition]										
1998 Private sector	-	-	-	-	-	-	-	-	-	[1] 3.8
1998 Public sector	-	-	-	-	-	-	-	-	-	[2] 3.3
1998 Public sector NHA	-	-	-	-	-	-	-	-	-	[3] 4.1
2000 Total	-	-	-	-	-	-	-	-	-	[4] 8.8
2001 Private sector	-	-	-	-	-	-	-	-	-	[5] 5.1
2001 Public sector	-	-	-	-	-	-	-	-	-	[6] 3.6
2001 Total	-	-	-	-	-	-	-	-	-	[7] 8.4
2002 Total	-	-	-	-	-	-	-	-	-	[8] 8.4
2005 Private sector	-	-	-	-	-	-	-	-	-	[9] 4.6
2005 Public sector	-	-	-	-	-	-	-	-	-	[10] 3.5
2005 Total	-	-	-	-	-	-	-	-	-	[11] 8.1
2007 Private sector	-	-	-	-	-	-	-	-	-	[12] 5.0
2007 Public sector	-	-	-	-	-	-	-	-	-	[13] 3.5
2007 Total	-	-	-	-	-	-	-	-	-	[14] 8.5

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

Health as percentage of total expenditure

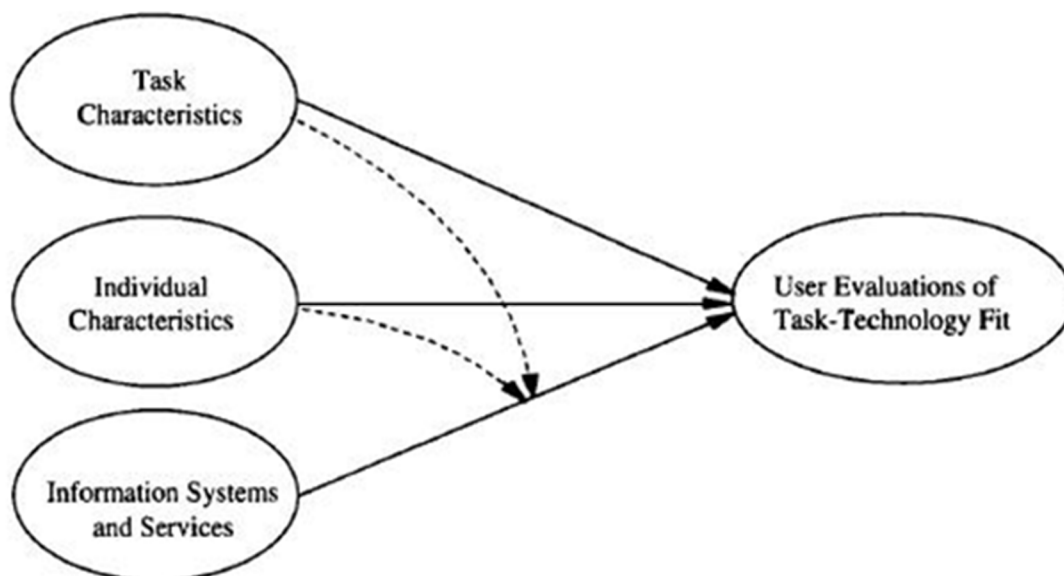
Definition: Percentage of total (government) expenditure on health.

Data are often reported for financial years, which may not correspond to calendar years. The year reported is the one with the most months in the given reporting period. Provinces with central hospitals have a higher share.

	EC	FS	GP	KZN	LP	MP	NC	NW	WC	ZA
Health as percentage of total expenditure [Definition]										
1997 Actual	18.8	24.2	34.0	25.0	17.0	17.4	15.9	17.8	27.7	[1] 23.4
1998 Actual	19.7	24.0	33.8	26.5	17.3	17.4	16.4	17.3	28.8	[2] 24.0
1999 Actual	21.5	23.9	33.3	26.6	17.5	17.6	17.4	16.9	29.1	[3] 24.2
2000 Estimated	20.9	24.2	32.7	26.7	17.8	15.9	16.7	17.0	30.0	[4] 24.0
2001 Medium term est.	19.6	22.8	33.3	26.7	17.1	17.4	17.4	17.6	29.5	[5] 23.9
2002 Medium term est.	19.0	22.6	32.8	26.0	17.1	17.1	17.2	17.7	28.7	[6] 23.4

Appendix C: Basic model of task technology fit

(Dotted lines show moderating interaction effects)



Appendix D: Research instrument

The aim of the study is to gather your evaluation of the information system in use at your organisation. Please keep the following terms in mind as you complete the survey.

System – the information capture system EMIT, as demonstrated and introduced by the implementers, whether mobile or desktop version.

Organisation – the primary organisation i work for, this excludes your parent organisation and/or funders

Data – Any kind of numeric or alphabetic fields currently stored on the computer or mobile device

Tasks – The responsibilities and duties i am expected to perform in my job

Remember that there is really no wrong or right answer; the most important thing is to attempt to respond to all questions. Even where it may seem that a question has been repeated, or sounds similar to an earlier question, please keep in mind that each question has an important function.

The survey will take approximately 20 minutes of your time. No personal questions have been asked.

A

Please **tick** the appropriate response for questions in this section

My organisation size is...

<10people 11-20 21-30 31-40 41-50 51-60 >60

My organization works in the following project category

Patient care Community based

My role in this organisation is at the level of (please tick all that apply)

Manager Field worker Org head Other

Std grade Matric A'level Diploma Undergraduate Masters Phd

What is your age group?

<20 20-25 26-30 31-36 37-40 41-45 >45

Gender

Male Female

My knowledge of computers is

Very poor Poor Good Very good Expert

B

Please answer all of the following questions

Please rate how strongly you agree or disagree with each of the following statements by placing a check mark in the appropriate box.		How much do you agree or disagree?						
The information system in use in your organisation impacts on your everyday duties and responsibilities. Each of the statements below touches on aspects of your work that the system interacts with, how do you feel about each of these?		Strongly Disagree	Disagree	Slightly Disagree	Neither agree nor disagree	Slightly Agree	Agree	Strongly agree
1.	Data is safeguarded from unauthorized changes or use.							
2.	It is easy to learn how to use the computer systems that give me access to data.							
3.	Frequently, after I see what data is available or what the data says, I change my view of the problem and of what data is needed.							
4.	Quantitative information is important to me in my job.							

C

Please answer all questions

Please rate how strongly you agree or disagree with each of the following statements by placing a check mark in the appropriate box.		How much do you agree or disagree?						
Each of the statements below seeks to gain an understanding of your <i>overall</i> opinion of the system, how do you feel about each of these?		Strongly Disagree	Disagree	Slightly Disagree	Neither agree nor disagree	Slightly Agree	Agree	Strongly agree
33	Overall, the system satisfies my work needs adequately							
34	The system helps me fully achieve my work goals and targets							
35	The system does not adequately address my work needs							
36	I prefer the mobile system to the desktop system							
37	I do not care whether i use the mobile system or the desktop system							
38	The quality of service/work i deliver has improved as a direct result of this system							
39	To be honest i prefer the manual or paper based system to the current system							
40	The system helps me achieve my work faster and more effectively							
41	This system is an improvement over the paper based system							

D

Do you have any suggestion on how to make the system better at helping you achieve your tasks?

Appendix E: Survey request covering letter



Department of Information Systems

Leslie Commerce Building
Engineering Mall, Upper Campus
OR Private Bag, Rondebosch 77001
Tel: 650-2261
Fax No: (021) 650-2280

Masters Dissertation Research Survey: Participant Consent Form

Dear Sir/Madam,

As an Information Systems Masters student at the University of Cape Town, I am completing a study entitled "*User evaluations of IT in healthcare: A study of the South African health sector*".

Your participation in this research will be greatly appreciated. Your input will allow us to understand the effectiveness of information systems used in the management of HIV/AIDS in South Africa by studying the user's evaluations of these systems, whilst also allowing me to complete my Masters degree successfully.

You have been selected as a target group for this study due to your direct interaction with an information system being used in the fight against HIV/AIDS. Your experiences in working in the sector and with the information system will hopefully contribute towards improving the usefulness and effectiveness of the information system and, by extension, your work.

We guarantee the confidentiality and anonymity of the details and comments you provide, which will strictly be used for the sole purpose of the aforementioned research report.

Alfred Mukudu
Masters Student
University of Cape Town
Email: mkdalf001@uct.ac.za
Cell no: +27726538517

Supervisor Prof Jean Paul Van Belle
E-mail: Jean-Paul.VanBelle@uct.ac.za
Department of Information Systems
University of Cape Town

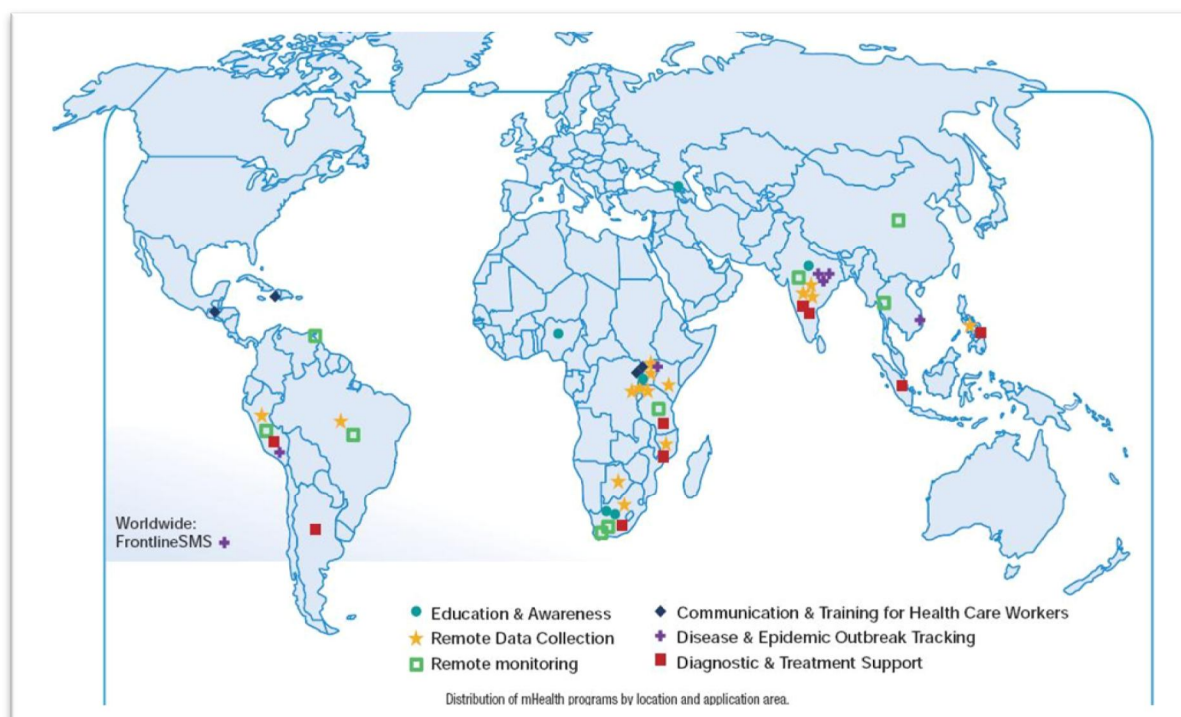
PARTICIPANT CONSENT

By signing this participant consent for, you are agreeing to participate in a research project entitled "*User evaluations of IT in healthcare: A study of the South African health sector*" conducted by Alfred Mukudu as a partial requirement for the course entitled Master's in Information Systems. The researcher guarantees the confidentiality and anonymity of the details and comments you provide, which will strictly be used for the sole purpose of the aforementioned research report. Should you wish to contact the researcher for any reasons whatsoever, please do not hesitate to email him at mkdalf001@uct.ac.za or call him on 072 653 8517

Signature: _____

Date: _____

Appendix F: Worldwide distribution of mHealth applications



Geographical Distribution of mHealth applications by application area. Vital Wave Consulting. 2008.

Appendix G: HIV/AIDS mobile phone application projects

Mobile phone application area	Example of mobile phone-based applications (Country, projects and HIV/AIDS focus)
Education and awareness	<ul style="list-style-type: none"> o South Africa, project Masikule: Promotion of testing and treatment via SMSs o Uganda (Text-to change (TTC) project: HIV/AIDS awareness through an SMS-based quiz o Gerorgia, HIV/AIDS awareness video distribution on mobile phone o India, Freedom HIV/AIDS project: HIV/AIDS awareness enhancement through mobile phone-based HIV/AIDS games
Remote data collection	<ul style="list-style-type: none"> o Rwanda, TRACnet project: Patients' HIV/AIDS information management, ARV distribution monitoring o South Africa, Dokoza project: Patient HIV/AIDS data, treatment and adherence
Remote monitoring	<ul style="list-style-type: none"> o India, Mobile Care, Support and Treatment Manager (MCST): Patients' HIV/AIDS Lab results access and medical history report; Nutritional planning and medication reminder o Peru, Colecta-PALM: ART adherence information and patient's behavioural actions that is potential to wide spread of HIV/AIDS o South Africa, Cell-Life's "AfterCare": monitoring of Patient medical status, medication adherence and other factors.
Communication and training for health care	<ul style="list-style-type: none"> o Uganda, Mobile HIV/AIDS Support: Provide training regarding clinical care, research and prevention of HIV/AIDS
Disease and epidemic outbreak tracking	<ul style="list-style-type: none"> o NO RECORDED PROJECT in this category. However TRACnet provides capabilities to track the HIV/AIDS pandemic
Diagnosis and	<ul style="list-style-type: none"> o South Africa, Dokoza project: HIV/AIDS Lab results

Appendix H: Factor Analysis Results

Overall model Factor loadings

	Factor (1)	Factor(2)	Factor (3)	Factor(4)	Factor(5)	Factor(6)	Cronbach alpha Dropped?
Affect01	0.17	0.27	0.84	0.07	-0.04	0.10	
Affect02	-0.03	0.25	0.89	-0.11	-0.18	0.07	
Affect03	0.28	0.38	0.77	-0.29	0.07	0.02	
Auth01	0.83	0.32	0.10	0.07	0.11	0.14	
Auth02	-0.47	-0.26	0.34	-0.15	0.69	-0.18	Y
Auth03	0.53	0.38	-0.03	0.58	-0.24	0.16	
EoU01	0.72	0.49	-0.05	-0.13	0.38	-0.09	
EoU02	0.67	-0.11	0.29	0.37	0.02	0.06	
TaskT01	0.87	0.18	0.22	0.07	-0.13	-0.29	
TaskT02	0.29	0.84	0.28	0.10	-0.03	0.17	
Compat01	0.20	-0.02	0.15	0.77	0.04	-0.12	Y
Compat02	0.13	-0.79	0.09	0.15	0.41	-0.14	Y
Accuracy01	0.23	0.66	0.16	0.29	0.42	-0.26	Y
Accuracy02	0.35	-0.04	0.68	0.13	0.06	0.03	Y
Flex01	0.03	0.27	-0.06	0.87	-0.09	-0.02	
Flex02	0.78	-0.18	0.23	-0.15	0.00	0.48	Y
Flex03	0.32	0.87	0.04	0.27	0.06	-0.03	
Current01	0.10	0.83	0.25	-0.14	0.35	0.08	Y
Current02	0.46	-0.27	0.74	-0.11	0.04	0.03	Y
Mean01	-0.12	-0.02	-0.32	0.85	0.04	0.13	
Mean02	0.71	0.29	0.09	0.23	0.26	0.13	Y
Mean03	0.05	-0.44	-0.07	0.82	0.03	0.06	
Train01	0.26	0.18	0.59	-0.36	0.27	0.45	Y
Train02	0.88	-0.10	0.19	-0.02	0.02	-0.11	Y
Access01	0.80	0.13	0.42	-0.06	-0.13	0.17	
Access02	0.62	0.56	0.22	-0.03	0.30	-0.12	
Assistance	0.66	0.22	-0.18	0.48	0.08	0.03	
Rely01	0.55	0.20	0.00	-0.19	0.60	0.40	Y
Rely02	0.07	0.40	0.41	0.40	0.21	0.64	Y

Appendix I: Descriptive Statistics

Summary descriptive statistics for valid numerical variables

	Mean	Std.Dev	Minimum	Maximum	N
Affect	4.650407	1.316668	1.333333	6.666667	82
Authorisation	4.353659	1.447620	2.000000	7.000000	82
Ease of Use	4.567073	1.290426	2.000000	7.000000	82
TaskType	4.268293	1.573694	1.000000	7.000000	82
Compatibility	4.750000	1.077978	2.500000	7.000000	82
Accuracy	5.280488	0.871700	3.500000	7.000000	82
Flexibility	4.658537	1.619476	1.000000	7.000000	82
Current	4.771605	1.196478	2.500000	7.000000	81
Meaning	3.839506	1.604344	0.500000	7.000000	81
Training	4.740741	1.272574	1.500000	7.000000	81
Accessibility	4.487805	1.381035	1.000000	7.000000	82
Assistance	4.317073	1.632071	2.000000	8.000000	82
Reliability	4.335366	1.149490	2.000000	6.000000	82
Presentation	4.597561	0.914354	3.000000	7.000000	82
Confusion	3.969136	1.333102	1.000000	7.000000	81
Overall	4.981707	1.368619	2.000000	7.500000	82

Appendix J: Frequency Tables

Frequency counts for condensed questionnaire variables

Frequency Table: Age range				
	count	cumulative count	percent	cumulative percent
<20	0	0		
20-25	19	19	23.17073	23.17073171
26-30	29	48	35.36585	58.53658537
31-36	22	70	26.82927	85.36585366
37-40	11	81	13.41463	98.7804878
>40	1	82	1.219512	100
Frequency Table: Knowledge of computers				
	count	cumulative count	percent	cumulative percent
very limited	0	0	0	0
limited	0	0	0	0
good	53	53	64.63414	64.63414
very good	23	76	28.04878	92.68292
expert	6	82	7.31707	100
Frequency Table: Mode of data entry				
	count	cumulative count	percent	cumulative percent
desktop only	38	38	46.34146	46.34146
mostly desktop	9	47	10.97561	57.31707
50-50 mobile and desktop	2	49	2.439024	59.75609
mostly mobile	0	49	0	59.75609
mobile only	33	82	40.2439	100

Appendix K: Questionnaire item total correlations

Item Total Correlations calculated for valid variables

	(Affect)	(Authorisation)	(Ease of Use)	(TaskType)	(Compatibility)	(Accuracy)	(Flexibility)	(Current)	(Meaning)	(Training)	(Accessibility)	(Assistance)	(Reliability)	(Presentation)	(Confusion)	(Overall)
Affect	1.000	0.237	0.259	0.532	-0.144	0.568	0.152	0.724	-0.408	0.548	0.545	-0.016	0.424	0.027	-0.268	0.568
Affect01	0.913	0.327	0.318	0.509	-0.015	0.600	0.213	0.610	-0.180	0.530	0.503	0.092	0.452	0.079	-0.254	0.496
Affect02	0.953	0.108	0.053	0.387	-0.140	0.444	0.075	0.601	-0.383	0.382	0.386	-0.112	0.320	-0.091	-0.352	0.437
Affect03	0.914	0.282	0.414	0.614	-0.212	0.578	0.169	0.806	-0.517	0.649	0.656	0.027	0.442	0.125	-0.121	0.662
Authorisation	0.237	1.000	0.747	0.804	0.067	0.538	0.702	0.406	0.247	0.485	0.718	0.739	0.534	0.081	-0.184	0.545
Auth01	0.323	0.848	0.838	0.764	0.042	0.508	0.445	0.554	-0.025	0.691	0.764	0.681	0.489	0.243	0.008	0.634
Auth03	0.117	0.904	0.511	0.661	0.072	0.445	0.757	0.198	0.412	0.213	0.524	0.624	0.454	-0.068	-0.299	0.355
Ease of Use	0.259	0.747	1.000	0.758	0.090	0.616	0.470	0.535	-0.067	0.690	0.799	0.642	0.413	0.371	0.178	0.675
EoU01	0.200	0.639	0.909	0.729	-0.091	0.532	0.441	0.607	-0.231	0.585	0.750	0.517	0.357	0.418	0.195	0.752
EoU02	0.248	0.610	0.728	0.486	0.352	0.495	0.320	0.191	0.232	0.572	0.543	0.576	0.330	0.137	0.076	0.263
TaskType	0.532	0.804	0.758	1.000	-0.166	0.668	0.660	0.692	-0.129	0.636	0.829	0.545	0.525	0.031	-0.285	0.844
TaskT01	0.352	0.710	0.748	0.831	0.129	0.527	0.376	0.405	-0.113	0.652	0.806	0.587	0.196	-0.031	-0.112	0.663
TaskT02	0.537	0.643	0.532	0.850	-0.394	0.594	0.724	0.749	-0.105	0.424	0.594	0.336	0.675	0.080	-0.360	0.754
Compatibility	-0.144	0.067	0.090	-0.166	1.000	0.114	-0.132	-0.140	0.550	0.100	-0.007	0.185	-0.151	0.340	0.530	-0.175
Compat01	0.052	0.406	0.204	0.241	0.653	0.347	0.409	0.065	0.653	-0.004	0.186	0.451	0.130	0.141	0.091	0.138
Compat02	-0.222	-0.185	-0.019	-0.377	0.862	-0.084	-0.445	-0.226	0.277	0.132	-0.134	-0.061	-0.283	0.347	0.628	-0.320
Accuracy	0.568	0.538	0.616	0.668	0.114	1.000	0.577	0.689	-0.014	0.487	0.670	0.399	0.474	0.354	0.129	0.749
Accuracy01	0.294	0.473	0.526	0.578	0.028	0.792	0.652	0.620	0.052	0.244	0.490	0.457	0.335	0.396	0.117	0.761
Accuracy02	0.583	0.329	0.394	0.419	0.153	0.712	0.186	0.405	-0.083	0.509	0.523	0.121	0.385	0.119	0.074	0.340
Flexibility	0.152	0.702	0.470	0.660	-0.132	0.577	1.000	0.352	0.377	0.043	0.416	0.567	0.465	0.106	-0.178	0.550
Flex01	-0.098	0.474	0.151	0.251	0.172	0.356	0.816	-0.083	0.696	-0.253	0.103	0.479	0.254	0.017	-0.064	0.089
Flex03	0.304	0.707	0.599	0.811	-0.329	0.605	0.900	0.597	0.046	0.256	0.552	0.499	0.513	0.148	-0.222	0.766
Current	0.724	0.406	0.535	0.692	-0.140	0.689	0.352	1.000	-0.369	0.661	0.693	0.124	0.598	0.344	0.000	0.814
Current01	0.491	0.341	0.429	0.620	-0.374	0.601	0.500	0.877	-0.305	0.379	0.510	0.153	0.574	0.351	-0.061	0.792
Current02	0.639	0.242	0.356	0.346	0.366	0.372	-0.148	0.534	-0.229	0.706	0.541	-0.013	0.232	0.098	0.107	0.296
Meaning	-0.408	0.247	-0.067	-0.129	0.550	-0.014	0.377	-0.369	1.000	-0.293	-0.277	0.374	0.096	0.127	0.136	-0.304
Mean01	-0.424	0.246	-0.064	-0.086	0.388	-0.025	0.441	-0.341	0.953	-0.347	-0.292	0.346	0.138	0.120	0.048	-0.274
Mean03	-0.308	0.202	-0.059	-0.171	0.696	0.006	0.210	-0.342	0.887	-0.156	-0.204	0.348	0.016	0.113	0.246	-0.294
Training	0.548	0.485	0.690	0.636	0.100	0.487	0.043	0.661	-0.293	1.000	0.743	0.285	0.543	0.266	0.056	0.527
Train01	0.655	0.190	0.393	0.370	-0.110	0.398	-0.050	0.710	-0.431	0.791	0.500	-0.050	0.631	0.324	0.033	0.397
Train02	0.229	0.579	0.705	0.642	0.263	0.381	0.117	0.354	-0.045	0.808	0.685	0.496	0.245	0.106	0.056	0.445
Accessibility	0.545	0.718	0.799	0.829	-0.007	0.670	0.416	0.693	-0.277	0.743	1.000	0.484	0.532	0.194	-0.035	0.724
Access01	0.549	0.667	0.672	0.735	0.029	0.528	0.258	0.522	-0.250	0.761	0.920	0.436	0.518	0.004	-0.132	0.529
Access02	0.432	0.633	0.785	0.772	-0.047	0.699	0.514	0.751	-0.252	0.572	0.892	0.442	0.441	0.374	0.084	0.804
Assistance	-0.016	0.739	0.642	0.545	0.185	0.399	0.567	0.124	0.374	0.285	0.484	1.000	0.352	0.218	0.075	0.408
Reliability	0.424	0.534	0.413	0.525	-0.151	0.474	0.465	0.598	0.096	0.543	0.532	0.352	1.000	0.373	-0.032	0.390
Rely01	0.129	0.414	0.636	0.398	-0.008	0.444	0.115	0.525	-0.145	0.642	0.555	0.385	0.659	0.622	0.422	0.441
Rely02	0.458	0.375	0.034	0.376	-0.195	0.271	0.524	0.369	0.245	0.203	0.258	0.156	0.795	-0.007	-0.383	0.163
Presentation	0.027	0.081	0.371	0.031	0.340	0.354	0.106	0.344	0.127	0.266	0.194	0.218	0.373	1.000	0.757	0.297
Present01	0.120	0.263	0.346	0.062	0.429	0.394	0.121	0.292	0.231	0.350	0.275	0.324	0.525	0.846	0.577	0.195
Present02	-0.044	-0.062	0.321	0.004	0.217	0.262	0.076	0.319	0.030	0.159	0.102	0.103	0.199	0.927	0.747	0.314
Confusion	-0.268	-0.184	0.178	-0.285	0.530	0.129	-0.178	0.000	0.136	0.056	-0.035	0.075	-0.032	0.757	1.000	-0.011
Confus02	-0.243	-0.056	0.303	-0.088	0.209	0.236	0.006	0.182	-0.041	0.103	0.086	0.129	0.090	0.811	0.883	0.238
Confus03	-0.211	-0.281	-0.031	-0.433	0.751	-0.045	-0.345	-0.222	0.308	-0.019	-0.171	-0.014	-0.171	0.447	0.820	-0.311
Overall	0.568	0.545	0.675	0.844	-0.175	0.749	0.550	0.814	-0.304	0.527	0.724	0.408	0.390	0.297	-0.011	1.000
Overall01	0.415	0.556	0.704	0.792	-0.227	0.686	0.563	0.742	-0.271	0.461	0.669	0.425	0.388	0.387	0.098	0.956
Overall02	0.678	0.479	0.576	0.817	-0.102	0.744	0.481	0.810	-0.309	0.545	0.712	0.350	0.354	0.169	-0.130	0.948

Appendix L: Regression Analysis

Full data set regression analysis

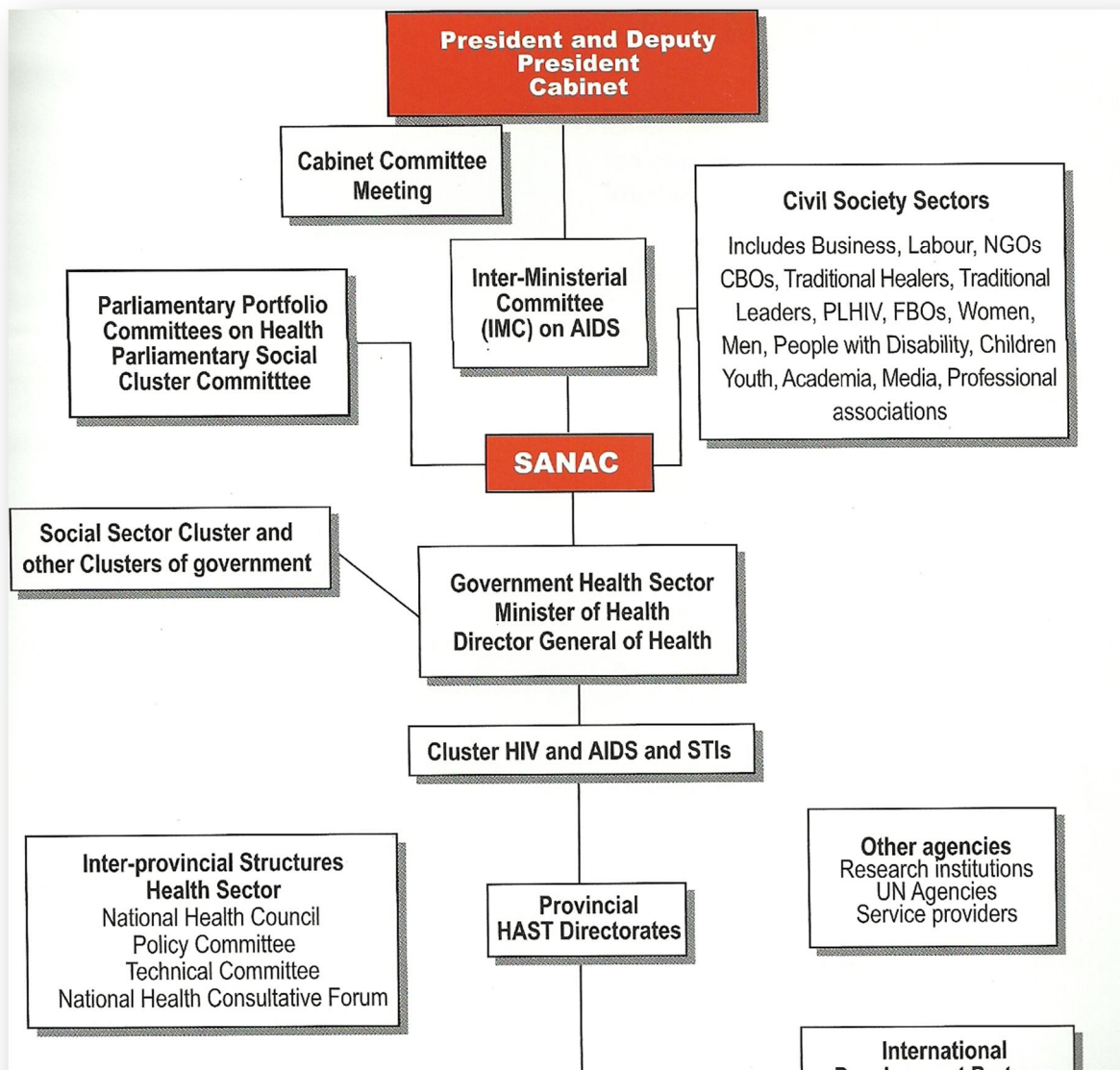
	b	Std.Err. (of b)	t(72)	p-value
Intercept	0.614	0.666	0.922	0.36
Affect	0.258	0.095	2.719	0.008
Authorisation	0.06	0.156	0.383	0.702
Ease of Use	0.259	0.162	1.604	0.113
Meaning	-0.213	0.091	-2.348	0.022
Accessibility	0.104	0.162	0.642	0.523
Assistance	0.157	0.094	1.664	0.1
Presentation	0.552	0.151	3.656	0
Confusion	-0.281	0.1	-2.814	0.006
Regression Summary for Dependent Variable: Overall (all responses excl) R= .82325117 R ² = .67774249 Adjusted R ² = .64193610 F(8,72)=18.928 p<.00000 Std.Error of estimate: .81800 N=81				

Emergent Factor regression analysis

	b	Std.Err. - of b	t(74)	p-value
Intercept	1.255924	0.55728	2.25367	0.027179
FACTOR1	0.370702	0.084073	4.40926	0.000035
FACTOR2	0.929273	0.134043	6.93265	0
FACTOR3	0.065836	0.078587	0.83774	0.404874
FACTOR4	-0.30766	0.066412	-4.6326	0.000015
FACTOR5	-0.20482	0.090052	-2.27444	0.025838
Regression Summary for Dependent Variable: Overall (factors) R= .87271290 R ² = .76162781 Adjusted R ² = .74552158 F(5,74)=47.288 p<.00000 Std.Error of estimate =0.69377 N=81				

Correlations (factors)						
	FACTOR1	FACTOR2	FACTOR3	FACTOR4	FACTOR5	Overall
FACTOR1	1	0.650734	0.349357	0.32233	0.097179	0.67224
FACTOR2	0.650734	1	0.448054	0.254656	0.358877	0.764194
FACTOR3	0.349357	0.448054	1	-0.20971	-0.13223	0.559044
FACTOR4	0.32233	0.254656	-0.20971	1	0.012568	-0.05111
FACTOR5	0.097179	0.358877	-0.13223	0.012568	1	0.099234
Overall	0.67224	0.764194	0.559044	-0.05111	0.099234	1

Appendix M: Structural Organisation of South Africa HIV Health Care sector



Appendix N: Follow up interview questions

General questions

These questions mostly investigate further the assumption from literature that users are able to reliably evaluate the system fit to task requirements

- Do you collect feedback about how fieldworkers are coping with the system? What are the general results?
- Do you think the fieldworkers fully understand their tasks? (do you think there is a gap between workers understanding of the system and their use of it)
- Do you frequently make changes to tasks/responsibilities or processes? When was the last change? (points to reliability of sampled workers evaluation of fit)

Questions arising from correlation analysis

- Do fieldworkers ever ask for more access to the data they collect? (Auth-Access)
- Do workers ever experience confusion about what the fields mean? Do they ever question why they ask those questions and not different ones? (Compatibility-confusion-meaning)
- Do you think if the workers participated in the design of the system they would like it more? (meaning-overall) Expected high correlation between like of system and what it means to them but low. Perhaps meaning of tasks is what should be the determinant of affect
- Why is there a low correlation here? Do the workers not like a system with options? How do they feel about the number of input options on the system? Would a less flexible system make it more relevant to them? (flexibility-meaning)
- Does the layout of the data influence your like for the system? Do you use a third party app (like excel, pentaho) to analyse and present your data? (Presentation-affect)
- How important is the currency of the data for your work? What is an unacceptable time period between data capturing and reporting? (overall-current) Has the highest correlation
- Do you ever experience reliability issues with the system? Has it ever gone down? Who/what are the issues attributed to? Is it user error, network issues or the system providers who are blamed? (reliability-affect) Low correlation here could imply people