

https://dspace.org/

The use of technology in public sector tertiary health facilities in South Africa

Cline, Gregory Bobby

2014-01-09
http://hdl.handle.net10539/13394

Downloaded from a DSpace repository. https://dspace.org/

The use of technology in public sector tertiary health facilities in South Africa

Dr Gregory B Cline

A research report submitted to the Faculty of Commerce, Law and Management, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Business Administration

Johannesburg, 2011

ABSTRACT

The South African public healthcare sector faces many challenges, including weak healthcare systems and under resourced facilities that deliver poor outcomes relative to total healthcare expenditure. Healthcare delivery, access to healthcare and cost containment has the potential for improvement through more efficient healthcare resource management. Global references demonstrate that information technology (IT) has the ability to assist in this regard through the automation of processes, thus reducing the inefficiencies of manually driven processes and lowering transaction costs. This study examines the impact of new systems implementations on service delivery, user adoption and organisational culture within the hospital setting in South Africa, as perceived by doctors, nurses and hospital administrators.

Limited research has been conducted in South Africa that focuses on end-user perceptions of health information systems. Ninety-four quantitative and qualitative interviews with doctors, nurses and hospital administrators were conducted in two public sector tertiary healthcare facilities (in two provinces) to record end-user perceptions. Structured questionnaires were used to conduct the interviews. Ordinal data was analysed according to a seven-point Likert scale and a distribution-fitting approach was applied to categorise the various criteria.

Doctors, nurses and hospital administrators recognise the role of technology as an enabler for improving access to healthcare services and reducing costs in the South African public healthcare sector. The research provides some insight into the reasons for investing in system automation, the associated outcomes, and organisational factors that impact the successful adoption of IT systems. In addition, sustainable success in these initiatives is as much a function of the technology as it is of the change management function that must accompany the system implementation.

DECLARATION

I, Gregory Bobby Cline, declare that this research report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

Dr Gregory B Cline

Signed at ……

On the …….. day of …… 2011

DEDICATION

To my darling wife who I love dearly, your unrelenting patience and encouragement over the past three years ensured that my time taken away from you never felt as if we were apart. Your support was fundamental to the process and will always be greatly appreciated. I love you.

To my son Jack who will only understand the impact of this degree in years to come, but whose smiling face is my inspiration to the next big thing.

To my father, my hero, who was the first person to advise me to get an MBA long before I went to medical school.

Lastly to my mom who always encouraged me no matter what I did, and who asked me every week how my presentation went (regardless of whether there was a presentation or not).

ACKNOWLEDGEMENTS

Sincere thanks to Professor John Luiz (my supervisor) for his time, guidance and support. I appreciate your valuable advice and patience demonstrated throughout the process.

Thank you to the staff of Health Systems Trust who assisted with the collection of data and to the doctors, nurses and administrators at Sebokeng and Inkosi Albert Luthuli Central Hospitals who contributed data to the study.

TABLE OF CONTENTS

ABSTRACT ..... **II**

DECLARATION ..... **III**

DEDICATION ..... **IV**

ACKNOWLEDGEMENTS ..... **V**

LIST OF TABLES ..... **IX**

LIST OF FIGURES ..... **XI**

LIST OF ABBREVIATIONS ..... **XII**

1 INTRODUCTION **1**

1.1 PURPOSE OF THE STUDY 1
1.2 CONTEXT OF THE STUDY 1
1.3 PROBLEM STATEMENT 3
1.3.1 MAIN PROBLEM 3
1.3.2 SUB-PROBLEMS 3
1.4 SIGNIFICANCE OF THE STUDY 4
1.5 DELIMITATIONS OF THE STUDY 4
1.6 DEFINITION OF TERMS 5
1.7 ASSUMPTIONS 6

2 LITERATURE REVIEW **7**

2.1 INTRODUCTION 7
2.2 RELATIONSHIP BETWEEN HEALTH OUTCOMES AND HEALTH SPEND 8
2.3 TRENDS IN INFORMATION TECHNOLOGY POLICY AND INVESTMENT 11
2.3.1 PUBLIC SECTOR HEALTHCARE IN SOUTH AFRICA 13
2.3.2 INFORMATION TECHNOLOGY AND SOCIAL HEALTH INSURANCE IN SOUTH AFRICA 14
2.4 FOCI AND BENEFITS OF WORKFLOW AUTOMATION 15
2.4.1 FOCAL AREAS FOR PROCESS AUTOMATION AND INFORMATION TECHNOLOGY INVESTMENT 17
2.4.2 INFORMATION TECHNOLOGY INNOVATION MATURITY IN HEALTHCARE 20
2.4.3 RESEARCH QUESTION 1 21
2.5 DETERMINING THE IMPACT OF TECHNOLOGY 21
2.5.1 MEASURING IMPROVEMENTS IN EFFICIENCIES 21

2.5.2 Costs and benefits realisations in mature and emerging markets 24
2.5.3 Research Question 2 27
2.6 Organisational influences on process automation 27
2.6.1 Barriers to adoption 28
2.6.2 Research Question 3 31
2.7 Conclusion of Literature Review 31
2.7.1 Research Question 1 32
2.7.2 Research Question 2 32
2.7.3 Research Question 3 32

3 RESEARCH METHODOLOGY 33

3.1 Research methodology/paradigm 33
3.2 Research design 35
3.3 Population and sample 35
3.3.1 Population 36
3.3.2 Sample and sampling method 36
3.4 Pilot study 37
3.5 Research instrument 37
3.6 Procedure for data collection 38
3.7 Data analysis and interpretation 39
3.8 Limitations of the study 40
3.9 Validity and reliability 40
3.9.1 External validity 41
3.9.2 Internal validity 42
3.9.3 Reliability 42

4 PRESENTATION AND DISCUSSION OF RESULTS 44

4.1 Introduction 44
4.2 Demographic profiles of respondents 44
4.2.1 Response rates by occupational and geographical category 44
4.2.2 Age distribution of respondents by occupational category 45
4.2.3 Occupational distribution according to years of service 46
4.3 Case studies: Inkosi Albert Luthuli Central Hospital and Sebokeng Hospital 47
4.3.1 Hospital profile: Inkosi Albert Luthuli Central Hospital 47
4.3.2 Hospital profile: Sebokeng Hospital 48
4.3.3 Presentation and discussion of observations 49
4.3.4 Hospital case study conclusion 54
4.4 Presentation and discussion of results pertaining to Research Question 1: Perceived reasons that influence the investment of automated systems within the hospital 55
4.4.1 Perceptions of manual processes 55
4.4.2 Perceptions of hospital information systems 57
4.4.3 Information security and patient confidentiality 59
4.4.4 Lowering costs 60

4.5 PRESENTATION AND DISCUSSION OF RESULTS PERTAINING TO RESEARCH QUESTION 2: OUTCOMES EXPERIENCED FROM AUTOMATING SYSTEMS IN HOSPITAL DEPARTMENTS 62
4.5.1 IMPACT ON SERVICE DELIVERY AND HOSPITAL REPUTATION PERCEPTIONS 64
4.5.2 PATIENT RECORD MANAGEMENT 65
4.5.3 HOSPITAL INFORMATION SYSTEM USER EXPERIENCE 66
4.6 PRESENTATION AND DISCUSSION OF RESULTS PERTAINING TO RESEARCH QUESTION 3: ORGANISATIONAL FACTORS THAT INFLUENCE THE SUSTAINED SUCCESSFUL ADOPTION OF HEALTHCARE SYSTEMS 68
4.6.1 EXECUTIVE SPONSORSHIP 68
4.6.2 TRAINING PERCEPTIONS 69
4.6.3 WILLINGNESS TO ADOPT NEW SYSTEMS 71
4.7 SUMMARY OF THE RESULTS 73

5 CONCLUSIONS AND RECOMMENDATIONS 75

5.1 INTRODUCTION 75
5.2 CONCLUSIONS OF THE STUDY 75
5.2.1 CONCLUSIONS RELATING TO RESEARCH QUESTION 1: PERCEIVED REASONS THAT INFLUENCE THE INVESTMENT OF AUTOMATED SYSTEMS WITHIN THE HOSPITAL 76
5.2.2 CONCLUSIONS RELATING TO RESEARCH QUESTION 2: OUTCOMES EXPERIENCED FROM AUTOMATING SYSTEMS IN HOSPITAL DEPARTMENTS 76
5.2.3 CONCLUSIONS RELATING TO RESEARCH QUESTION 3: ORGANISATIONAL FACTORS THAT INFLUENCE THE SUSTAINED SUCCESSFUL ADOPTION OF HEALTHCARE SYSTEMS 77
5.3 RECOMMENDATIONS 77
5.4 SUGGESTIONS FOR FURTHER RESEARCH 79

6 REFERENCES 80

7 APPENDIX A – RESEARCH INSTRUMENT 87

8 APPENDIX B – DISTRIBUTION-FITTING ANALYSIS 88

8.1 ALL RESPONDENTS (IALCH AND SEBOKENG HOSPITAL) 88
8.2 INKOSI ALBERT LUTHULI CENTRAL HOSPITAL RESPONDENTS 90
8.3 SEBOKENG HOSPITAL RESPONDENTS 92
8.4 ALL DOCTOR RESPONDENTS (FROM BOTH HOSPITALS) 94
8.5 ALL NURSE RESPONDENTS (FROM BOTH HOSPITALS) 96
8.6 ALL ADMINISTRATOR RESPONDENTS (FROM BOTH HOSPITALS) 98

LIST OF TABLES

Table 1: Healthcare metrics comparison between mature and developing countries, 2009 10

Table 2: Electronic Medical Record adoption model 19

Table 3: Profile of respondents 37

Table 4: Response rate of respondents per hospital 45

Table 5: Information security and confidentiality perceptions – IALCH and Sebokeng 49

Table 6: Perceived cost benefits – IALCH and Sebokeng 50

Table 7: Service delivery and reputation perceptions – IALCH and Sebokeng 51

Table 8: Electronic Health Record perceptions – IALCH and Sebokeng 52

Table 9: Management support for system utilisation – IALCH and Sebokeng 53

Table 10: Training perceptions – IALCH and Sebokeng 53

Table 11: Willingness to adopt new systems – IALCH and Sebokeng 54

Table 12: Reasons for investing in Hospital Information Systems – all respondents 56

Table 13: Perceptions of Hospital Information Systems – doctors, nurses and administrators 58

Table 14: Patient data confidentiality perceptions – all respondents 60

Table 15: Perceived cost benefit – all respondents 61

Table 16: Service delivery and hospital reputation perceptions – doctors, nurses and administrators 63

Table 17: Electronic Health Record perceptions – doctors, nurses and administrators 65

Table 18: Hospital Information Systems – user experience 67

Table 19: Management support for system utilisation – all respondents..... 68

Table 20: Training perceptions – doctors, nurses and administrators..... 69

Table 21: Willingness to adopt new systems – doctors, nurses and administrators 72

LIST OF FIGURES

Figure 1: Hype Cycle for Health Provider Technologies 2009..... 2

Figure 2: GDP per capita and life expectancy at birth in 169 countries..... 8

Figure 3: Age distribution of respondents by occupational category 45

Figure 4: Occupational distribution according to years of service 46

LIST OF ABBREVIATIONS

CCD	Continuity of Care Document
CCOW	Clinical Context Object Workgroup
CCR	Continuity of Care Record
CDA	Clinical Document Architecture
CDSS	Clinical Decision Support System
CEN-EN	Commission for European Normalisation
CPOE	Computerised Physician Order Entry
CPR	Clinical Prediction Rule
CRM	Customer Relationship Management
EHR	Electronic Health Record
EMR	Electronic Medical Record
GDP	Gross Domestic Product
GDSN	Global Data Synchronisation Network

GNI	Gross National Income
GRCM	Governance, Risk and Compliance Management
GS1	Global Standards One
HCO	Health Care Organisation
HIE	Health Information Exchange
HIMMS	Healthcare Information and Management Systems Society
HIS	Hospital Information System
HITECH	Health Information Technology and Clinical Health Act
HL7 v.3	Health Level Seven International version three
HST	Health Systems Trust
HVD	Hosted Virtual Desktop
ICD-10 CM	International Classification of Diseases, Tenth Revision, Clinical Modification
ICT	Information and Communications Technology
IALCH	Inkosi Albert Luthuli Central Hospital

IHE	Integrating the Healthcare Enterprise
IT	Information Technology
KP	Kaiser Permanente
NHS	National Health Service
PACS	Picture Archiving and Communication System
PC	Personal Computer
PKI	Public Key Infrastructure
RFID	Radio Frequency Identification
ROI	Return on Investment
SMS	Short Message Service
SNOMED-CT	Systematized Nomenclature of Medicine- Clinical Terms
UK	United Kingdom
UMDB	Universal Medical Device Bus
US	United States
VA	Veterans' Affairs

VistA	Veterans' Health Information Systems and Technology Architecture

1 INTRODUCTION

1.1 Purpose of the study

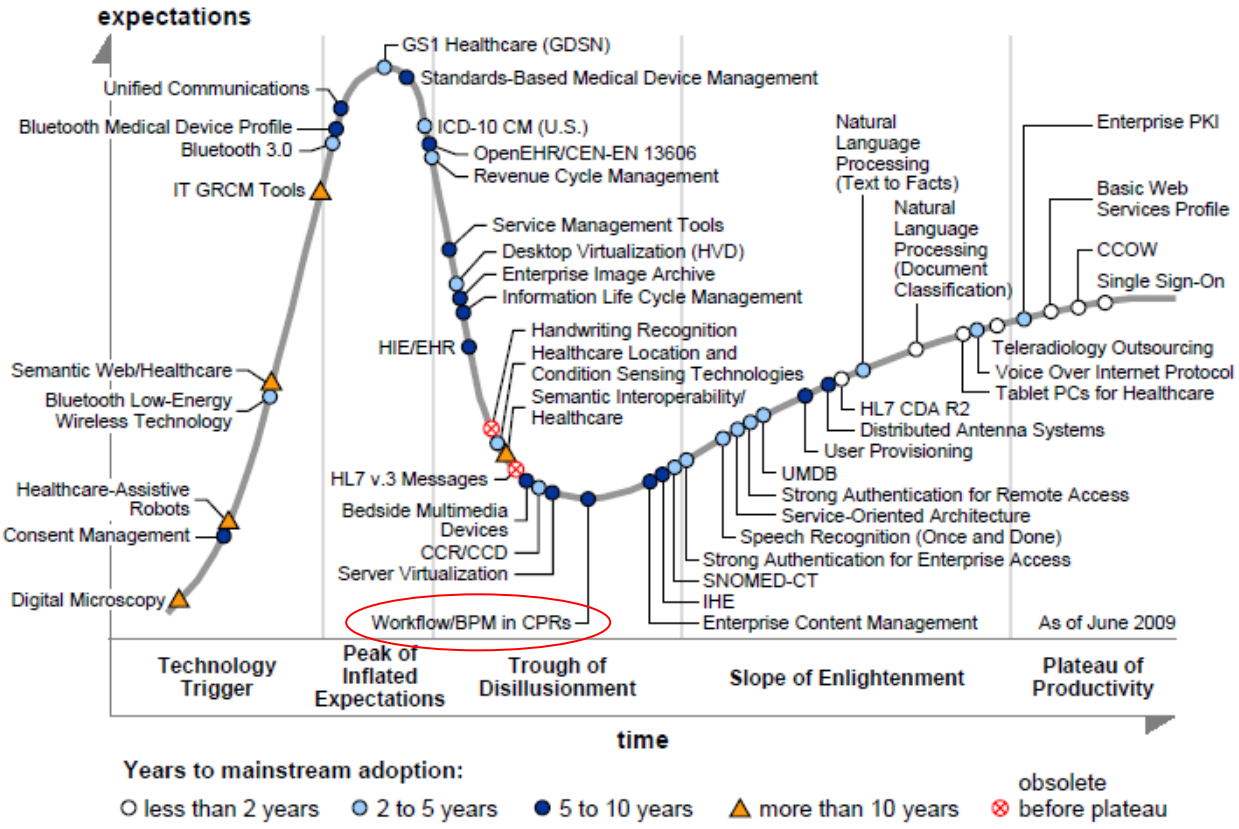
The purpose of this research is to investigate how access to healthcare by large population bases could be improved through more efficient healthcare resource management. To this end, the research examines the role of Information Technology (IT) and how it can be leveraged to introduce efficiencies into everyday processes. The research identifies the qualitative and quantitative factors associated with manual paper-driven processes that contribute towards the cost of healthcare delivery in a hospital or clinic setting and identifies the efficiencies that may be introduced into the system through technology. Furthermore, the research determines the systemic and workflow-related strategic and cost benefits that result from automating healthcare systems in South Africa.

1.2 Context of the study

IT has significant potential to contribute to improving access to care, lowering overall costs, and streamlining operational efficiencies in the health system. Clinical automation and business process management are major global trends affecting both mature and developing healthcare markets, as confirmed by the 2009 Gartner Hype Cycle for Healthcare Provider Technologies and Standards (Runyon, 2009). The motivation behind these trends lies in the potential to reduce the complexity of multiple legacy and paper-based systems, improve capacity of health systems to manage patients and their data, increase compliance with health regulations, ensure availability of information to support more efficient care, and enhance security around patient confidentiality and information. Gartner's Hype Cycle provides a predictive forecast of the progression of technology through the various stages of adoption in specific industries (Fenn, Raskino and Gammage, 2009). These stages of adoption are identified as the emergence of the technology, initial over-enthusiasm, the period of disillusionment, and eventual understanding of the technology's relevance and role

in the market. According to the Hype Cycle (Figure 1), Electronic Health Records (EHRs), Workflow and Business Process Management in Clinical Patient Records, and Enterprise Content Management are all placed in the “Trough of Disillusionment”, meaning that while each of these technological advances has had selective successes, the value proposition is not clear, preventing these technologies from achieving widespread adoption (Runyon, 2009).

Figure 1: Hype Cycle for Health Provider Technologies 2009



In the United States (US), The National Progress Report on eHealth, published in 2010, confirms that 61% of stakeholders (healthcare providers, consumers and health authorities) were satisfied with the successful adoption of IT from 2007 in the sector, but 67% of study participants believed that the value of health information exchange and Electronic Medical Records (EMRs) was poorly understood (eHealth Initiative, 2010). In emerging markets such as South Africa, primary and secondary clinics are often located in rural areas with poor road networks and interrupted services such as electricity and water. Manual paper-driven processes are relied

upon for delivering patient care and fulfilling administrative tasks. Patient records are paper based, and health statistics are recorded in log books which are sent infrequently to a regional office for data capturing of metrics (e.g. infant mortality rates) into a centralised database (Garrib, Stoops, McKenzie, Dlamini, Govender, Rohde et al., 2008). In South Africa, the value of automation within the healthcare system is poorly understood as the investment in IT is often considered against the opportunity cost of improving basic infrastructure for the clinic, hiring additional health worker resources, or purchasing medicines or consumables required to improve access to care.

1.3 Problem statement

1.3.1 *Main problem*

Assess the value of information systems to national healthcare by identifying the reasons for investing in system automation, the impact of automation and the organisational influence on successful system implementation in South African public sector health facilities.

1.3.2 *Sub-problems*

The first sub-problem is to identify the reasons for investing in system automation within public sector hospitals or clinics in South Africa.

The second sub-problem is to determine the impact of automation in terms of cost and strategic value in public healthcare facilities in South Africa.

The third sub-problem is to assess the organisational influence on successful system implementation in South African public sector health facilities.

1.4 Significance of the study

The study addresses a need in that there is currently limited research that identifies and qualifies the benefits of workflow automation in hospital systems in South Africa. The significance of this study lies in the context of understanding the value of and the obstacles to technology adoption as perceived by doctors, nurses and hospital administrators. There are numerous studies assessing the clinical and financial outcomes in hospitals that have implemented a Hospital Information System (HIS) in the US and Europe (Amarasingham, Plantinga, Diener-West, Gaskin and Powe, 2009; McCullough, Casey, Moscovice and Prasad, 2010; Zheng, Haftel, Hirschl, O'Reilly and Hanauer, 2010); however, similar studies have not been located for South African public health facilities.

Ruxwana, Herselman and Conradie (2010) and Ruxwana, Herselman, Pottas and Ouma (2010) conducted studies in the Eastern Cape where automated healthcare systems had been implemented in rural hospitals, but were not utilised owing to lack of knowledge regarding e-health solutions. This suggests that the barriers to adoption lie beyond the actual solutions themselves, and that the true challenge lies in change management, i.e. through the training that is required to re-educate health workers on how to integrate considerations of systems into daily workflow. The economic value of technology is therefore not dependent solely on the technology itself, but rather on the user's ability to leverage the technology to optimise processes and introduce cost and time efficiencies into the healthcare system. Thus, the study assesses the level of training that has been provided to assist healthcare workers and administrators to utilise the technology and reduce dependence on paper-based processes. To date, there is no significant study in South Africa evaluating the success of change management in the hospital or clinic environment.

1.5 Delimitations of the study

The study assesses the effectiveness of automating business processes in the public healthcare sector as determined by healthcare workers, patients and administrators. Private sector stakeholders and facilities have been excluded.

The functionality and design of vendor-specific healthcare system automation technologies are not described in the research.

1.6 Definition of terms

- Computerised Physician Order Entry (CPOE): A CPOE refers to the design (or redesign) of clinical processes that integrates technology to optimise physician ordering of medications, laboratory tests, and the like. The integration into a clinical decision support system may be adapted by the hospital to include formularies and/or guidelines that assist physicians in their decision making. CPOE is distinguished from other applications by the requirement that the prescribing physician is the primary user (Ormond and Portland, 2005).
- Customer Relationship Management (CRM): This refers to a strategic approach aimed at developing relationships with key customers and customer segments and is an approach that provides enhanced opportunities to use data and information both to understand customers and to create value with them (Payne and Frow, 2005).
- E-prescribing: This refers to electronic prescriptions and generally relates to five main functions: 1) computerised prescribing associated with clinical decision support (such as drug-drug and drug-allergy interaction checking), 2) pharmacy benefit eligibility checking, 3) formulary compliance, 4) medication history reporting, and 5) prescription routing to a retail pharmacy or mail order pharmacy (Halamka, Aranow, Ascenzo, Bates, Berry, Debor et al., 2006).
- Electronic Medical Record (EMR) or Electronic Health Record (EHR): The Healthcare Information and Management Systems Society (HIMSS) defines EHR as “a longitudinal electronic record of patient health information generated by one or more encounters in any care delivery setting. Included in this information are patient demographics, progress notes, problems, medications, vital signs, past medical history, immunizations, laboratory data and radiology reports. The EHR automates and streamlines the clinician's workflow. The EHR has the ability to generate a complete record of a clinical

patient encounter – as well as supporting other care-related activities directly or indirectly via interface – including evidence based decision support, quality management, and outcomes reporting." (Kasiri and Sharda, 2009:3).

- Hospital Information System (HIS): This refers to the socio-technical subsystem of a hospital, consisting of enterprise functions (back office and front office), business processes, software application, managed care processes and physical data processing systems (Winter, Haux, Ammenwerth, Brigl, Hellrung and Jahn, 2011).

1.7 Assumptions

The following assumptions have been made regarding the study:

a. The data provided by respondents is accurate.
b. Respondents have adequate knowledge of the hospital systems and healthcare delivery work processes to be deemed valid for the study.
c. Respondents are able to share information openly and truthfully. False data will have a detrimental effect on the study's results.

2 LITERATURE REVIEW

2.1 Introduction

As the automation of healthcare systems references a broad spectrum of potential technologies that are applicable to the hospital or clinic domain, the literature review considers the components of traditional back office enterprise resource management applications, customer resource management, as well as the hospital or clinical information system components in the public health sector. As the users may refer to doctors, nursing staff, community health workers, and/or administrative personnel, each of these user groups plays an active role in the daily business processes that are contained within healthcare facilities, and are inherent to healthcare service delivery. The journals, publications and online sources that are referenced in the literature review may be applicable to specific user groups but are also relevant to total system considerations.

The “automation of healthcare systems” is a broad-reaching term that describes the process whereby the end state is crystallised as the implementation of end-to-end EHRs, meaning that all actors, be they patients, healthcare providers, or administrators, are uniquely identified, tracked and potentially managed within the healthcare IT system.

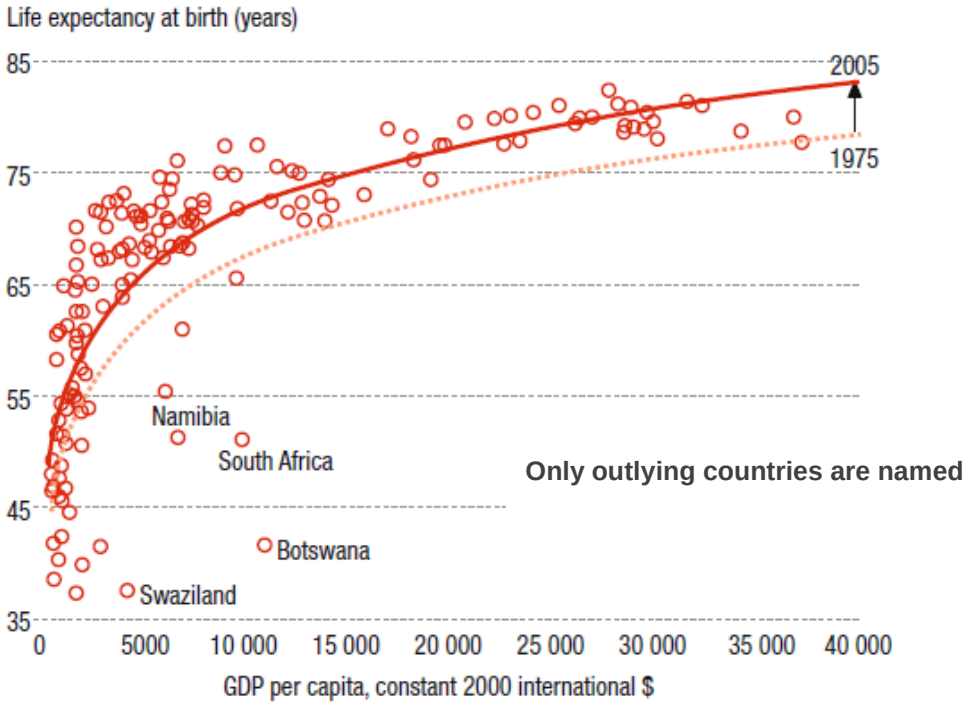
The literature review begins by evaluating the relationship between health outcomes and health spends in countries across the globe and moves on to discuss trends in IT policy, with a particular focus on the SA public healthcare system. The role of automation and its potential benefits are then discussed, followed by a consideration of cost-benefit outcomes as a result of the technology. Finally, the organisational influences with respect to technology implementation in healthcare environments are considered. The literature review determines and frames the research questions of the study.

2.2 Relationship between health outcomes and health spend

The healthcare challenges that accompany communicable and non-communicable diseases, increasingly high rates of chronic diseases and ageing populations present formidable difficulties for middle- and low-income countries, especially where resource availability is limited.

An unmistakeable relationship exists between health and wealth, where countries with higher gross domestic products (GDPs) are associated with improved life expectancies and lower childhood mortalities (Preston, 2007). The Preston curve below (Figure 2) indicates that while an income per capita of $1,000 in 1975 was associated with a life expectancy of 48.8 years, the same income in 2005 resulted in a life expectancy of almost four years higher (Van Lerberghe, 2008). This suggests that improvements in health technologies, education and in "society's ability to translate this knowledge into effective health and social action, allow for greater production of health for the same level of wealth" (Van Lerberghe, 2008:4).

Figure 2: GDP per capita and life expectancy at birth in 169 countries



Roemer's law states that there is a direct correlation between capacity and utilisation, or, put more succinctly, the supply of healthcare services induces demand (Boutsioli, 2009). This correlation offers a partial explanation for the continuous fuelling of healthcare costs in a country such as the US, where the GDP percentage of healthcare spend is growing disproportionally to other comparable countries due to unexpected supplier-induced demand.

The US spends more on healthcare compared to any other country, yet its health outcomes (life expectancy, infant mortality rate, mortality amenable to healthcare) are mediocre in comparison to other developed economies, with more than 45 million Americans not covered by any form of health insurance. In 2009 the Center for Medicare and Medicaid Service reported that healthcare spend accounted for 17.3% of the US economy (Truffer, Keehan, Smith, Cylus, Sisko, Poisal et al., 2010). According to world development indicators and global development finance data produced by the World Bank (Table 1), countries such as the Netherlands and South Korea have a higher life expectancy and better childhood mortality rate when compared to the US, even though their health expenditure is 60% and 20%

respectively in comparison. In addition, when compared to the United Kingdom (UK), Australia, the Netherlands or South Korea, the US has the same life expectancy with worse childhood mortality metrics (Worldbank, 2011). As access to scientific medicine in terms of providers and pharmaceuticals is similar within these countries, the structure of each respective health system and delivery of services may therefore account for the variation in healthcare outcomes.

It is not surprising that Nigeria, Kenya and India have the lowest gross national income (GNI) per capita of countries listed, the highest infant mortality rates, and life expectancies ranging from 48 to 55 years (Table 1). This suggests that while the workforces in mature markets have the potential to grow GDP, the workforces in developing countries on average are not even reaching retirement age.

Table 1: Healthcare metrics comparison between mature and developing countries, 2009

Country Name	Population, total (million)	GNI per capita, Atlas method (current US$)	Health expenditure, total (% of GDP)	Health expenditure, public (% of govt expenditure)	Life expectancy at birth, total (years)	Mortality rate, infant (per 1,000 live births)	Rural population (% of total population)
United States	307	$ 46,360	16.2	18.7	78.7	6.8	18.0
United Kingdom	62	$ 41,370	9.3	15.1	80.1	4.6	10.0
Australia	22	$ 43,770	8.5	17.1	81.5	4.3	11.1
Netherlands	17	$ 48,460	10.8	16.2	80.5	3.7	17.6
South Africa	49	$ 5,760	8.5	9.3	51.6	43.1	38.8
Nigeria	155	$ 1,190	5.8	6.4	48.1	85.8	50.9
Kenya	40	$ 760	4.3	5.4	54.9	54.8	78.1
India	1,155	$ 1,220	4.2	4.1	64.1	50.3	70.2
China	1,331	$ 3,650	4.6	10.3	73.3	16.6	56.0
Brazil	194	$ 8,070	9.0	6.1	72.6	17.3	14.0
Korea, Rep.	49	$ 19,830	6.5	12.3	80.3	4.5	18.3

Source: www.worldbank.org

Highest indicator
Lowest indicator

Thus, in alignment with Preston's argument concerning the role of technology in healthcare in order to promote economic upliftment, automated systems can be seen as a means of delivering healthcare in resource-constrained environments (Preston, 2007).

Investments in system automation have yielded improved labour productivity and better utilisation of hospital resources, reduced duplication of manual tasks, minimised paperwork, decreased unnecessary treatments and lowered medication errors (Hillestad, Bigelow, Bower, Girosi, Meili, Scoville et al., 2005). Reforming health systems in order to contain costs and enhance service delivery requires increasingly effective utilisation of resources within the health system, improved policy formation and decision-making capabilities, and a developed system that enables enhanced delivery of healthcare services that leverage knowledge management systems and efficient processes.

2.3 Trends in information technology policy and investment

Several countries have developed policy, committed investment and initiated programmes targeting IT as an enabler for optimised national health services. Germany initiated a national health information technology network in 1993 and has implemented smart cards as a means of capturing patient and provider data (Anderson, Frogner, Johns and Reinhardt, 2006). Canada established the Advisory Council on Health Infrastructure in 1997 and in 2001 launched the Canada Health Infoway tasked with making electronic health records available to 50% of Canadians by 2010 (Webster, 2011).

On 17 February 2009, US President Obama signed into law the Health Information Technology and Clinical Health Act (HITECH) as part of the American Recovery and Reinvestment Act – a $787 billion economic stimulus package. Of this money, $19.2 billion was reserved to promote the adoption and use of health IT. The Act stipulates a significant investment in IT, recognising that “only 17% of U.S. physicians and 8 to 10% of U.S. hospitals have at least a basic electronic health record system” (Steinbrook, 2009: 1059). This measure was taken as part of the effort to control costs of federal and state-funded healthcare in the US. From 2011, the programme will provide financial incentives over a number of years of up to $65,000 per physician and up to $11 million per hospital for making reasonable use of health IT such as electronic exchange of data, e-prescriptions and automated reporting tools (Steinbrook, 2009). HITECH initiatives will be focused on increasing quality of care,

lowering costs and improving access through better methods of storing, analysing and sharing health information (Buntin, Jain and Blumenthal, 2010).

The UK prioritised system automation as far back as 1998, when the National Health Service (NHS) Executive set a target for EHRs to be operational by 2005. In 2002, the Treasury Wanless report confirmed that this target would not be met, and identified two main reasons for this: 1) local health authorities were allocating the IT budget to other areas where they were feeling financial pressure, and 2) central IT standards were inadequate (Hendy, Reeves, Fulop, Hutchings and Masseria, 2005). In June 2002, the UK Department of Health published its policy document for a national strategic programme focusing on the deployment and use of IT in the NHS (United Kingdom Department of Health, 2002). The programme outlined delivery in the following areas:

- Connectivity for all staff;
- Core national services throughout the NHS;
- Universal standards for data quality and data interchange;
- Systems for critical local applications;
- Effective communications for knowledge management; and
- Management of finances.

The UK government budgeted $4.4 billion for the programme, with the objective of implementing electronic patient records across the UK by the end of 2007. By 2006, the NHS estimated the total costs of the programme to have exceeded $10 billion (Anderson et al., 2006).

In South Africa, health information strategy and system development has developed in different directions when comparing the public and private sectors. Government has largely focused on achieving a comprehensive and integrated health information system; health information standards; access to Information and Communications Technology (ICT) infrastructure for all healthcare facilities; a national telemedicine programme; an integrated health promotion strategy; an EHR strategy; and the promotion of research and development in e-health (South Africa National Department of Health, 2008). The private sector has concentrated more on the

commercial aspects of reimbursement and on the clinical and managed care interventions (Matshidze and Hanmer, 2007).

In 2004, the South African national Department of Health issued the “Strategic Priorities for the National Health System: 2004-2009 policy”, which identified HIS as a key enabler for planning, budgeting, monitoring and evaluation. This, in conjunction with the National Health Act (Act 61 of 2003), mandated the implementation of information systems at national, provincial and local levels to create a comprehensive national health system. While the national Department of Health has prioritised the implementation of a national health electronic system, the path from legislation to implementation has been stalled as the 2009/2010 Annual Report confirms that the design phase of the project is 90% complete (i.e. the project is in its initial phase). In addition architecture to support national data sets has been developed and tested and is to go online within the next year.

2.3.1 *Public sector healthcare in South Africa*

The South African public healthcare sector is burdened with many challenges, including the consequences of HIV/AIDs, tuberculosis and malaria; weak healthcare systems; under-resourced provider networks; and low staff morale. These challenges have translated into poor health outcomes relative to total health expenditure (Harrison, 2010). The key challenge facing the sector is inefficient distribution of resources, rather than lack of funding as South Africa’s total healthcare expenditure is higher than other countries of similar level of economic development (Table 1).

The human resource challenge is also limiting the sector’s ability to improve overall healthcare performance. There is an absolute shortage in the number of health professionals available to deliver service, with 0.77 physicians for every 1,000 of the population (the ratio in the US is 2.56 and in the UK is 2.30) (Shona, 2008). The nursing statistics are equally discouraging, with 4.08 nurses for every 1,000 of the population. (The US ratio is 7.28 and the UK is 12.12.) This is in part due to healthcare professionals seeking careers outside of South Africa. In fact, in 2006 the

Department of Health reported that 23,000 (19% of total) South African healthcare professionals were working in the UK, US, Canada, New Zealand and Australia.

In a 2007 policy document, the Department of Health lists the quality issues that plague the public healthcare sector (South Africa National Department of Health, 2008):

- Inadequate diagnosis and treatment of patients;
- Inefficient utilisation of services and resources;
- Insufficient resources, including human capital;
- Inconsistency in service delivery;
- Poor information;
- Inadequate referral system;
- Drug shortages;
- Poorly kept medical records;
- Avoidable errors; and
- Disregard for human dignity.

These failings threaten patients' health, introduce unnecessary costs into the health system and negatively impact on productivity. The report identifies the need to invest in information systems as a required intervention in order to lower transactional costs, co-ordinate care, improve human resource management and measure improvements.

2.3.2 *Information technology and social health insurance in South Africa*

In South Africa, Smith, Solanki, Lalloo, Myburgh and Cornell (2008) investigated the likelihood of employed South Africans contributing, by way of a 4.5% tax, towards a national health fund that would provide hospital cover to all employed individuals at public sector hospitals. Individuals wishing to continue accessing private sector hospitals would be required to subscribe to additional private health insurance. Of more than 1,000 employees interviewed in a variety of employment sectors including

government and parastatal organisations, formal and informal sectors, only 11% indicated that they would support the scheme if public hospitals stayed as they were. An overwhelming 87% responded positively in support of the scheme if public hospitals were improved. These improvements were qualified as not having to queue for medical treatment, the ability to make appointments, being treated first, guaranteed medication, television sets in rooms, and cleanliness of facilities. Thus, social health insurance delivery is not likely to meet consumer expectations without, amongst other interventions, an investment in IT systems for workflow optimisation, quality assurance of healthcare delivery and functional back office billings and collections.

2.4 Foci and benefits of workflow automation

According to Sutherland and van den Heuvel (2006:1), “the only thing that kills more people every year than inpatient medical error is heart disease and cancer.” The demand for effective and efficient healthcare services necessitates innovative ways of relooking core hospital processes. Workflow automation ensures that the appropriate person obtains accurate information in a timeous manner concerning the procedure or process under consideration. It speaks to the provision of information required to support each step of the business cycle. The optimisation of workflow processes is achieved through automation. This usually implies business process reengineering, which requires an analysis of current business processes, comparing these with proposed more efficient processes (usually with the assistance of technology) and then mapping the ‘As Is’ state to the ‘To Be’ desired end point, given budget and resource constraints (Carmichael, 1994). The primary driver is associated cost savings through more efficient processes, but successful implementation also delivers improved customer satisfaction and a reduction in rework and errors (Capgemini, 2004). Song, Hwong, Matos, Rudorfer, Nelson, Han et al. (2006) defined six types of workflows within the hospital environment, illustrating the interaction between providers, patients and, potentially, systems:

1. Administrative – aimed at managing patients and the healthcare organisation, with the goal of improving administrative efficiency;

2. Financial – aimed at improving management of revenue, with the goals of increasing profits, reducing financial errors and speeding up reimbursements;
3. Clinical Operational – aimed at streamlining diagnosis and treatment tasks, with the goals of improved quality of care, optimal patient safety and better training;
4. Clinical Decisional – aimed at improving patient assessments and treatment plan development, with the goals of better outcomes and more efficient clinical trials;
5. Clinical Therapeutic – requiring the input of Clinical Operational and Clinical Decisional, with the goals of improved service quality, better care outcomes and efficiency of devices; and
6. Laboratory – aimed at acquiring data that supports diagnosis, with the goals of improved efficiency and service quality in the laboratory.

Aside from the provider-patient interaction workflows, the enterprise workflows associated with the various departments of the hospital or clinic include supply chain management, logistics, human capital management, stock keeping, ordering, procurement, invoicing and payment, to name a few. The complexity of modern healthcare has created silos of information within the hospital environment, which has deemed manual and paper-based operations inefficient. In addition, institutional behaviours, conflicting incentives and cultural issues often result in a healthcare organisation becoming resistant to the adoption of new technologies (Sutherland and van den Heuvel, 2006). Cultural resistance to innovation is intense where new processes are thought to be disruptive and where workflows are most inefficient. Sutherland et al. (2006) propose that in order to overcome this situation, incremental innovation is required to gain support of the providers who adopt these new technologies into their daily workflow, resulting in a gradual integration or subconscious cycle of continuous improvement of workflow.

2.4.1 *Focal areas for process automation and information technology investment*

Two specific areas of process-supporting IT have been identified as areas of focus for process automation: clinical decision support (Collen, 1991; Jaspers, Peute, Lauteslager and Bakker, 2008; Amarasingham et al., 2009; Ammenwerth and Spotl, 2009; Borzekowski, 2009; Devine, Hollingworth, Hansen, Lawless, Wilson-Norton, Martin et al., 2010; Furukawa, Raghu and Shao, 2010; Longhurst, Parast, Sandborg, Widen, Sullivan, Hahn et al., 2010) and Computerised Physician Order Entry (CPOE) (Poon, Blumenthal, Jaggi, Honour, Bates and Kaushal, 2004; Ormond and Portland, 2005; Westbrook, Ampt, Kearney and Rob, 2008; Devine et al., 2010; Longhurst et al., 2010). Funding and attention have been given to these areas as improved decision making and reduced medication errors are quick wins that translate into immediate cost benefits and improved quality of care (Wears and Berg, 2005). According to Gartner's Hype Cycle for Healthcare Provider Applications and Systems 2009, clinical decision-making technologies are in the "Technology Trigger" part of the cycle (Fenn et al., 2009). This means that even though the technology is on the uptake, mainstream adoption is anticipated after ten years.

In South Africa, very little has been carried out in terms of computerising managed care pathways. Doctors decide on treatment protocols and are incentivised according to agreed diagnosis and procedure associated fees (Broonberg, 1990). A past trend in managed care was to outsource the service, which indirectly resulted in payers having to balance the cost benefits against increasing or retaining membership as managed care was understood as denial of benefits instead of the wellness of members. Various managed care initiatives have been piloted in South Africa, but without success. A good example is referenced in Weiner, Famadas, Waters and Gikic's (2008) analysis of UnitedHealth Group. UnitedHealth identified South Africa as an ideal target country and formed a joint venture with Southern Life (a major health insurance company at the time), and Anglo American Corporation (a global mining house). Despite careful planning and the implementation of a new information system, the joint venture failed. One of the main reasons for failure was the lack of support gained from the healthcare provider community (Weiner et al., 2008). Today,

health insurance companies have capped limits relative to the standard medical scheme rate that is negotiated with Board of Healthcare Funders each year (Doherty and McLeod, 2003). Health providers are not incentivised to seek ways of optimising healthcare delivery costs as their rates are either pre-negotiated with health insurance companies, billed directly to patients, or both (i.e. patients co-pay the shortfall if the provider charges above health insurance rates) (Matisonn, 2000).

CPOE has been identified in Gartner's Hype Cycle as being on the "Slope of Enlightenment" and has been tagged as being two to five years away from mainstream adoption. The Healthcare Information and Management Systems Society (HIMSS) is a not-for-profit organisation exclusively focused on providing global leadership for the optimal use of IT and management systems for the betterment of healthcare. The HIMSS 2009 Analytics report (HIMSS Analytics, 2010) identifies funding challenges and infrastructure requirements (ability to integrate CPOE into pharmacy and nursing medication applications) as key factors that limit the implementation of CPOE systems. CPOE adoption by physicians will be driven by an application design that minimises the disruption to workflow. While all enterprise healthcare IT vendors have CPOE application products, HIMSS estimates that vendors with the largest EMR applications will become the largest CPOE vendors after 2010.

HIMSS has recognised that the adoption of EMR requires a staged progression approach that is dependent on service infrastructure, IT infrastructure, connectivity, people, training and culture. The HIMSS EMR Adoption Model (Table 2) describes seven stages of cumulative capabilities (HIMSS Analytics, 2010). The early stages require the implementation and operation of laboratory, radiology and pharmacy modules, with the middle stages focusing on automating clinical documentation and CPOE, and with operational EMR described as an advanced stage capability.

Table 2: Electronic Medical Record adoption model

Stage	Cumulative Capabilities
Stage 7	Medical record electronic; HCO able to contribute CCD as by product of EMR; Data warehousing in use
Stage 6	Physician documentation (structured templates), full CDSS, full RIS PACS
Stage 5	Closed loop medication administration
Stage 4	CPOE, CDSS (clinical protocols)
Stage 3	Clinical documentation (flow sheets), CDSS (error checking), PACS available outside radiology
Stage 2	Clinical Data Repository, Controlled Medical Vocabulary, Clinical Decision Support System (CDSS), may have Document Imaging
Stage 1	Ancillaries – Laboratory, Radiology, Pharmacy – All Installed
Stage 0	All three ancillaries not installed

Source: HIMSS Analytics Database

Aside from the clinical-targeted systems, the other back end processes that require automation relate to the traditional service industry-related solutions, such as Customer Relationship Management (CRM). Healthcare CRM is a process in which health service providers manage patient expectations, ensure continuous relationships and align their service provision with changing patient healthcare needs (Hung, Hung, Tsai and Jiang, 2009). The extent to which CRM is practised in hospitals and clinics in South Africa is limited. Purpose-specific clinics would benefit greatly from CRM tools that enable improved access to care. For example, paediatric clinics in South Africa are dependent on Road to Health Cards (Tarwa and De Villiers, 2007). These paper-based cards are issued to improve compliance with childhood vaccinations and identification of growth indicators. Tarwa et al. (2007) investigated some of the reasons why Road to Health Cards were not utilised in all paediatric clinic visits. The most common reason discovered was that the card was simply not asked for by the health professional or that no information could be provided by the respondent (parent). Some children's cards were lost or burnt and others had never been issued a card. In addition, many health workers do not ask to see or update the card. As a result, the monitoring of childhood indicators such as mortality rates, growth rates and immunisation coverage is restricted by the poor availability of data. This not only impacts on the parameters of access to and quality of care, but also affects the health ministry's ability to form policy and effect decision

making around resource planning for the allocation of medicines and healthcare workers. This has a direct impact on Millennium Development Goal 4, which is to reduce mortality in children younger than five years by two-thirds between 1990 and 2015 (Houweling, Tripathy, Nair, Costello and Prost, 2010).

In the commercial world, the relevance of CRM arose from the fact that it is more costly to acquire new customers than to retain existing customers. Relating this back to healthcare, it is more costly to perform first-time assessments than to treat a patient where the history is known (Benanti, 1988). One of the fundamental tenets underpinning relationship marketing is the importance of creating "a relationship between the company and the customer that stretches over many transactions, and manages the relationship to the benefit of both the customers and the company" (Kohli, Piontek, Ellington, VanOsdol, Shepard and Brazel, 2001:172). The design of a CRM tool for the healthcare market is thus the electronic patient record, with elements of communication and relationship marketing that empower patients to manage their health proactively. This includes the logistics of monitoring and managing treatment plans that effectively transition downstream from the doctor, and into the workflow of the outpatient clinic where patients are often seen by community healthcare workers and nursing staff.

2.4.2 *Information technology innovation maturity in healthcare*

Goldzweig, Towfigh, Maglione and Shekelle (2009) examined new trends in health IT innovation that impact on costs and benefits and came to the conclusion that although technology has the potential to make a dramatic impact on healthcare cost and delivery, the empirical evidence justifying new IT investment is limited. The common feature set shared by organisations which have implemented automated systems in healthcare include local development of systems, years of investment in terms of time spent developing and implementing systems, and ensuring local health IT champions drive development, implementation and evaluation of the IT solution. The authors reviewed five studies from Vanderbilt (Goldzweig et al., 2009) that evaluated the efficiency of CPOE and found mixed results, confirming that while IT systems have a part to play in achieving quality improvement, the dynamics of the

healthcare system rely on the users of the system to make it a success. Goldzweig et al. (2009) reviewed a number of standalone applications and determined that while innovation is widespread, these interventions have yet some distance to go before reaching maturity. Evaluated applications included telemedicine innovations, e-health systems linking patients with providers, video conferencing applications, short message service (SMS) systems targeted for appointment reminders, and electronic devices aimed at improving patient care.

With specific reference to emerging markets, the lack of basic infrastructure that novel/innovative technology such as internet workflow, wireless technologies, Radio Frequency Identification (RFID), location-based sensors, and the like are dependent on, often presents a risk (Williams and Boren, 2008:140). Thus, many projects based on the aforementioned technologies fail to gain support as the infrastructure investment requirement is limiting.

2.4.3 *Research Question 1*

What are the perceived reasons that influence the investment of automated systems within the hospital?

2.5 Determining the impact of technology

The impact of technology is measured by assessing improvements in business process and productivity efficiencies, and by determining the benefits that may present as either strategic or cost realisations.

2.5.1 *Measuring improvements in efficiencies*

The automation of systems is a timeous but costly investment that poses challenges in terms of successful evaluation. The desired efficiencies are often unknown and difficult to measure. Poissant, Pereira, Tamblyn and Kawasumi (2005) proposed that clinicians would consider a system to be efficient if it improved their documentation time, thereby allowing them to spend more time with patients. This meant that

physicians would consider a system as beneficial if it saved them time, regardless of whether the system improved patient care. The researchers analysed physicians and nurses in two workflow areas: 1) working shift time-based settings, and 2) patient encounters.

While the researchers recognise the benefits of system automation as evidenced by the increasing deployment of EHRs within healthcare organisations as a means of improving quality of care, they found that nurses and physicians differed in their incentives to utilise the system and in their speed of adoption. Nurses were more likely to be dedicated to single locations whereas physicians regularly moved between hospital facilities (Poissant et al., 2005).

The researchers found that nurses had a need to communicate care protocols between nursing teams (e.g. handover between shifts) and the use of computers reduced the time devoted to generate an end-of-shift report. In contrast, physicians measured automation adoption success against patients as sampling units, and were mostly negatively impacted as there were little time gains experienced (Poissant et al., 2005). The study found that nurses experienced time savings allocated to documentation activities per shift of 24.5% at bedside terminals and 23.5% at central stations, respectively. Conversely, physician documentation time increased by an average of 17.5% and CPOE increased physician workflow processes up to 328.6% in some cases (Poissant et al., 2005). Nursing efficiency improvements are also explained in the study by the fact that nurses often document according to standardised care plans and protocols while physicians rarely use standardised templates to capture clinical notes. A surprising but common occurrence related to the improved documentation time efficiencies that were experienced shortly after implementation, followed by compromised documentation times as time passed, suggests that the more clinicians used the system, the more inefficient they became (Poissant et al., 2005).

Poissant et al.'s (2005) research suggests that the implementation phase experienced considerable direct support (in terms of hands-on training provided during the pilot), which was phased out once the project had been operationalised.

The above results suggest that user-related characteristics and training regimens are important determinants of successes that lie outside of the immediate technological capabilities that automated systems offer.

In addition to time efficiencies, other metrics of success relate to improvements in direct patient care time, increased user satisfaction, accuracy of information, completeness of data entered into the system and the impact on overall workflow. The reason that efficiencies are stressed is that this is the first potential point of failure that users review when deciding to adopt new technologies.

Chen, Garrido, Chock, Okawa and Liang (2009) examined the impact of implementing an EMR on outpatient care within a health system at Kaiser Permanente (KP). KP is a US-based not-for-profit healthcare organisation that comprises 8.7 million members in eight regions. Members receive the full spectrum of medical care and services, including preventative care, outpatient and hospital services, and ancillary services such as radiology, laboratory and pharmacy services. In 2004, KP implemented an EHR with comprehensive documentation across care settings (including real time connectivity to pharmacy, laboratory, radiology and other systems). The researchers conducted a four-year study in one region to determine improvements in efficiencies in the outpatient setting for a patient population of more than 225,000 members. The study findings were conclusive:

- Total office visits per member reduced by 26.2% ($p<0.001$).
- Scheduled telephone visits per member increased ninefold.
- After EMR implementation, the total number of patient contacts via office and telephone visits and secure email increased 8.3%, from 5.18 contacts per member per year in 2004 to 5.61 contacts per member per year in 2007 ($p<0.001$).

The study excluded other reasons for the decreased usage of outpatient facilities, but enrolment rates and the proportion of members over 65 years with at least one chronic condition were constant during this time. The study concluded that

technology-enabled modalities of care enabled an overall increase in patient contact (Chen et al., 2009).

At the Department of Veterans' Affairs (VA), Byrne, Mercincavage, Pan, Vincent, Johnston and Middleton (2010) researched the impact of technology to quantify and qualify the benefits of the VA's IT investment. The VA had invested significantly in hospital IT systems from 2001 to 2007 in order to ensure high quality of care for its patient population. The system at the VA is known as "VistA" (the Veterans' Health Information Systems and Technology Architecture) and comprises EMR, digital radiology, digital pathology capabilities, CPOE and automated administration systems. The VistA system has enabled a national infrastructure to deliver evidence-based care to more than one million veterans (Wilson, 2009).

Byrne et al. (2010) developed modelling tools to examine the efficiency measures across the EHR, the Picture Archiving and Communication System (PACS), the medication barcode, and the laboratory systems. Benefits were realised from reducing utilisation and eliminating redundant processes that had existed within the paper-based system, which resulted in reduced utilisation of consumables (e.g. radiology film). In addition, reduced staff time committed to paper processes resulted in more time with patients and less time spent on administrative tasks (Byrne et al., 2010).

2.5.2 *Costs and benefits realisations in mature and emerging markets*

The impact of technology in terms of costs and benefits is difficult to measure. Unlike other investments, workflow improvements within the hospital address inefficiencies, but struggle to demonstrate additional direct revenue or billable services (Otieno, Hinako, Motohiro, Daisuke and Keiko, 2008). Otieno et al. (2008) propose a conceptual framework that allows for comparative analysis of EMR implementations against four vectors (system quality, information quality, use, and user satisfaction) in order to measure the effectiveness of EMR solutions. Most IT is implemented as a supporting service, to improve process rather than to enable a new billable product or function. Thus, accurate Return on Investment (ROI) is difficult to quantify, especially

when the improved process or service may benefit the patients or health insurance companies which do not necessarily pay for the service. Menachemi and Brooks (2006) investigated the challenges around measuring the ROI of IT investment in hospitals and noted that the incentives for adopting information systems were misaligned. Providers were paid the same regardless of the quality of care that was delivered and in some situations error-prone inpatient care actually led to increased bills from additional hospital events and longer stays. In the outpatient setting, the researchers noted that the financial benefits of IT were advantageous to the funders and purchasers of care, despite the physicians making the initial investment. The question remains: how does one quantify the benefits of health IT when reduction in medical errors or improved patient safety is the desired outcome?

Despite the aforementioned challenges, a number of studies (Wang, Middleton, Prosser, Bardon, Spurr, Carchidi et al., 2003; Barlow, Johnson and Steck, 2004; Menachemi and Brooks, 2006; Goldzweig et al., 2009; Byrne et al., 2010; Furukawa et al., 2010) have successfully demonstrated positive ROI associated with health IT projects. Wang et al. (2003) demonstrated a positive ROI associated with an EMR system, attributing savings to a reduction in drug expenditure, improved radiology utilisation, improved charge capture and reduced billing errors. Barlow et al. (2004) also demonstrated positive ROI metrics as a result of reduced spending and increased revenue. The reduced spending was ascribed to lower transcription expenses, a reduced need to generate patient charts and fewer space requirements (fewer full-time employees are required to assist with charting) while revenue growth was realised from increasing patient volumes. According to Menachemi et al. (2006), the potential to improve revenues lies in three domains:

1. Improved charge capture and decreased billing errors: the timely capture of charges for consultations, procedures and consumables together with correct coding ensures no potential revenue is lost owing to poor administration practice. Mildon and Cohen (2001) report that between 3% and 15% of practice revenue is lost each year owing to incorrect coding;
2. Improved cash flow, realised from reducing days outstanding in accounts receivable; and

3. Revenue growth realised from improving patient visit rates through automated reminders and chronic visit schedules.

Byrne et al.'s (2010) research concluded that between 2001 and 2007 the net benefit projections to the VA's Health IT systems were in excess of $3 billion, with breakeven reached by end of 2003 and the VA accruing a net positive value from years 2004 through 2007. While the gross value of the VA's investment was projected to be $7.16 billion, focusing on the reduction of drug-event-related hospital admissions and unnecessary outpatient visits saved more than $4.65 billion, with the EHR system contributing a further $1.92 billion in savings through the reduction of unnecessary workflows (Byrne et al., 2010).

Goldzweig et al. (2009) reviewed the impact of implementing a commercially available application within a healthcare practice in upstate New York. The case study considered vendor selection, stages of EHR implementation, impact on job responsibilities and financial impact. The study revealed an 11% increase in revenue in the first year, with a 20% increase in the second year, with charge-capture ratios increasing 65 to 70% through improved billing practices. The healthcare providers were surveyed three years after the fact and reported "the practice was quite satisfied with the new system. …While [it] had a positive financial impact, its main benefit was on supporting the core mission of providing care" (Goldzweig et al., 2009:286). An interesting finding in the study refers to the implementation of an EHR resulting in the creation of perceptions of increased hierarchy within the organisation. This reaffirmed the notion that a complex dynamic drives the interaction between an organisation's culture and the implementation of IT systems.

Williams et al. (2008) conducted a systemic review of EMR implementations in developing countries and found encouraging evidence of technology-enabled efficiencies. In Cameroon, a locally designed EHR demonstrated a significant decrease in coding time and consultation, and better management of patients (e.g. making data from previous contact visits readily available). Another example was highlighted in Kenya, where the Moi University School of Medicine developed a

medical record system that improved the quality of care, research and training delivered.

2.5.3 *Research Question 2*

What are the outcomes (in terms of perceived cost and strategic benefits) experienced from automating systems in hospital departments?

2.6 Organisational influences on process automation

Notwithstanding concrete evidence proving that EHRs have the potential to improve workflow efficiencies and quality of medical care, the majority of health workers continue to follow manual processes within the clinical setting (Simon, Kaushal, Cleary, Jenter, Volk, Poon et al., 2007). Simon et al.'s (2007) research identified three areas of concern that health workers acknowledged as barriers to moving away from understood, manual processes towards automated systems. These were 1) start-up financial costs, 2) ongoing financial costs, and 3) loss of productivity. Health providers working in hospital settings were more likely to adopt EHR systems, particularly where the hospital covered the financial costs or the facility served as a teaching facility associated with a university. Aside from the cost concerns stemming from the lack of financial incentives or understood ROI associated with EMR adoption, health workers cited "inadequate technical abilities and the need for concurrent workflow adaption" (Simon et al., 2007) as organisational cultural barriers. Simon et al. (2007) speculate that the success of new system inheritance into daily workflow is dependent on how effectively the workplace culture emphasises quality and innovation, as well as the characteristics of the health workers involved, together with technology-related factors (in this regard, offices with EHRs were more likely to be using email, computerised scheduling systems and e-prescribing). Thus hospital staff more familiar with email and internet usage would have less difficulty adapting to an EMR system. Other considerations regarding moving to an electronic system centred on privacy and security concerns.

2.6.1 *Barriers to adoption*

The health system of Limpopo Province in South Africa comprises 42 hospitals, including eight regional hospitals and 32 district hospitals. In 1997, an HIS tender was awarded by the Department of Health and Welfare to IBM, in response to a national strategy to restructure healthcare after South Africa's first democratic elections in 1994. The HIS was intended to support strategies such as the shifting of resources from tertiary to secondary care and to primary care; the redistributing of resources according to geographical and social need; and the optimising of processes for clinical, managerial and administrative functions (Littlejohns, Wyatt and Garvican, 2003). By 2000, only components of the original system had been implemented in some of the hospitals. Doctors and nurses were not trained on the new system, nor were they incentivised to adopt it, and, as the original implementation contract had ended, there was no executive mandate to move over to the partly functioning HIS.

Littlejohns et al. (2003) examined the reasons for failure of the implementation of the HIS in Limpopo Province from 1997 to 2000. The researchers found that while provincial management championed the project, local authorities did not view themselves as integral to the initiative, and as a result did not prioritise training and education of the healthcare provider user base. Thus, the end users received insufficient education and training before the system was introduced. Littlejohns et al. (2003) further noted that provincial healthcare management teams are subjected to frequent job changes, meaning that many senior individuals who supported the original project at the beginning were no longer associated with the project two or three years later. Lastly, the researchers noted the fragmentation of responsibility between managers (who are more proficient at monitoring costs and contractual obligations) and academics/health economists (who assess the intangible worth of the effort).

Other systems, such as those dealing with CPOE, are usually the first electronic systems to be implemented in hospitals or clinics owing to their impact on reducing medication error rates, which are acknowledged as the most common cause of preventable injuries in hospitals (Leape, Brennan, Laird, Lawthers, Localio, Barnes et

al., 1991). Poon et al. (2004) further researched the barriers to implementation of CPOE and identified them as 1) physician and organisational resistance, 2) high cost of CPOE and lack of capital, and 3) product or vendor immaturity.

1) Physician and organisational resistance: The research revealed a perceived negative impact on physician workflow, with one hospital reporting a 20% loss in efficiency compared to paper-based processes, which were thought to be faster. In this facility, community-based physicians were not motivated to learn how to use the system as they spent very little time in the actual hospital. In addition, nearly all vendor-solutions required extensive customisation to fit the workflow of clinicians.
2) High cost of CPOE and lack of capital: Technology system implementation projects carry high costs and often lack a tangible business case with bottom line benefit impact. The research found that hospital officials often prioritised other projects, such as the building of a new hospital wing, against IT spend where the ROI was apparent and easy to quantify.
3) Product or vendor immaturity: One of the reasons that extensive customisations were required in order for hospital workflow to be accommodated was that most current vendor products did not meet specific needs of the hospital and required localisation to match desired workflows.

Goldzweig et al. (2009) also studied the cultural barriers to system implementations in hospital and confirmed that 77% of practices without an EHR are resistant to EHR systems, 72% of physicians believe that moving towards an electronic system will result in frequent downtime, 64% believe that the system will increase the physicians' work time, and 60% fear that they do not have sufficient computer skills. The authors' research also confirmed that 22% of physicians perceived automated systems to support current workflow, and 37% of physicians believed that CPOE systems are faster than handwritten orders. Despite all the cultural and organisational issues cited, the number one barrier noted by the authors was cost. The business case is a challenge, as it is not clear who benefits from the investment. One recommendation from the research is to pursue a model where the funders subsidise some of the

costs as it is they who benefit substantially from the financial aspect, more so than the health providers or patients.

Littlejohns et al. (2003) found that introducing technology initially increased the workload for the clinicians, who were expected to adapt their workflow to the new systems without appreciating why they should commit additional effort to perform effectively the same job function. This highlighted to the researchers the need to ensure that users understand the reasons for implementation from the beginning together with the complexity of the healthcare task that is being automated (Littlejohns et al., 2003).

Poon et al. (2004) echo the understanding that the perceived negative impact on the physicians' workflow is a primary barrier to adoption. Poon's team's research revealed that some hospitals reported up to a 40% loss of efficiency, with physicians stating that paper-based ordering was faster. The problem was compounded by the fact that community-based physicians spent little time in the hospital and were not motivated to learn the CPOE system efficiently. Poon et al. (2004) suggested four strategies for overcoming physician resistance:

1. Ensure that strong leadership within management supports the project, as "Leadership is as important as the quality of the technology" (Poon et al., 2004: 186);
2. Identify physician champions as they not only understand the impact on workflow, but also are able to obtain mindshare from the broader user group to accept the technology;
3. Address workflow concerns by ensuring adequate customisation is done to adapt the technology to the clinicians' workflow within reason, and not vice versa;
4. Leverage hospital staff to be involved in the project and to provide feedback to improve design and address concerns.

In the UK, Hendy et al. (2005) similarly concluded that strategies to improve communication with, and to gain the co-operation of hospital staff were critical to the success of the NHS Connecting for Health programme. The short-term benefits alone

were insufficient in convincing users to adopt the system, as the socio-cultural challenges were more complex than the technical or logistical ones (Hendy et al., 2005).

2.6.2 *Research Question 3*

What organisational factors influence the sustained successful adoption of healthcare systems?

2.7 Conclusion of Literature Review

Public sector hospitals and clinics in South Africa are devoid of basic IT and communications infrastructure to enable delivery of high quality healthcare services. While the literature suggests that there are definite advantages to adopting HIS, the barriers to implementation include cost considerations, organisational and cultural issues, the need for a project champion in each region where a system is to be implemented and executive buy-in from the provincial and national ministry of health. The implementation of healthcare systems need not be approached as a holistic endeavour, but can be approached as contained areas within the hospital or clinic, where IT systems can be implemented in a step-wise fashion.

System implementations within healthcare need to be assessed by the various user groups (doctors, nurses, patients and administrators) in order to qualify the strategic and cost value benefits. By introducing the efficiencies described in the literature review, the collection and analysis of data will ultimately enable improved access to healthcare (as health authorities will be empowered with the right data to treat patients appropriately), inform decision making, empower policy formation and improve resource allocation of medicines and health care providers to meet the needs of the communities which they serve.

2.7.1 *Research Question 1*

What are the perceived reasons that influence the investment of automated systems within the hospital?

2.7.2 *Research Question 2*

What are the outcomes (in terms of perceived cost and strategic benefits) experienced from automating systems in hospital departments?

2.7.3 *Research Question 3*

What organisational factors influence the sustained successful adoption of healthcare systems?

3 RESEARCH METHODOLOGY

This chapter describes the methodology that was followed to construct the research design. The chapter provides a review of research methods, with specific focus on the research questions raised in Chapter 2, which form the basis of this study.

The description of the research design includes an explanation of the methodological approach adopted for the study and provides reasons as to why this approach was followed.

Following this, the population for the research is described, including sampling detail and methods. In addition, the research instrument is described, along with how the instrument was used. The latter half of this chapter focuses on the procedures for data collection, data analysis and interpretation; outlines the limitations of the study; and provides explanations of and steps taken to ensure validity and reliability.

3.1 Research methodology/paradigm

A mixed method approach was followed that consists of a quantitative approach to comparatively analyse user perceptions and experiences from various user groups, and a qualitative approach to unpack the reasoning behind user attitudes toward system automation. The mixed method approach is described by Creswell (2003), who submits that in this approach open-ended and closed-ended questions are posed, emerging and predetermined approaches are followed, and both quantitative and qualitative analysis is performed.

Creswell (2003) maintains that quantitative data is elicited through surveys and experiments by asking respondents closed-ended questions through a structured, pre-determined process. The quantitative approach identifies variables in the study and enables the researcher to relate these variables. Statistical procedures are used to observe and measure information numerically. The quantitative approach allows the researcher to test a hypothesis by gathering data via surveys or questionnaires, but holds the risk of missing the contextual detail that the study is trying to determine. Quantitative analysis can only be conducted if the researcher knows beforehand what

questions need to be answered, and thus is conducted in the latter phases of a research study.

For the quantitative approach as followed by the current study, the survey research method was adopted as the method of primary data collection, based on communication with a representative sample of individuals. According to Pinsonneault and Kraemer (1993), survey research methodology is defined by three characteristics: 1) survey analysis is concerned with the relationships between variables (it is a quantitative methodology that requires information to be standardised about the subjects under study); 2) collection of information is facilitated by asking people structured, predefined questions; and 3) information is collected from a representative sample that can be extrapolated back to the population as a whole.

The authors further contend that survey research follows systemic, representative sampling methods; requires a high response rate; and imposes statistical weighting procedures in order to be representative. The survey design includes open- and closed-ended questions. The disadvantage of closed-ended questions is that respondents are limited to a set number of answers and tend to feel pressurised to make a selection even if their preferred response is not listed (Krosnick, 1999). This limits the effectiveness of closed-ended questions to the range of answers that are provided.

Qualitative data is obtained by following a strategy of enquiry that incorporates ethnography, case study, and narrative. This method allows for the researcher to understand personal values in the context of the study or setting of participants, and collects participant meaning. The downside of qualitative research is that it requires the researcher to conduct field work, as the subject's interpretation of events is important. Qualitative research is gathered by observation, in-depth interviews or focus groups. The time required to complete field work is usually lengthy, and data is in the form of words or pictures. The design tends to emerge as the study unfolds and the researcher often becomes immersed in the subject matter.

The qualitative approach for this study consisted of open-ended questions that were included in the survey design. Krosnick (1999) submits that open-ended questions hold a risk of poor response with survey participants who are inarticulate. This risk was mitigated through the use of face-to-face interviews, where respondents were given the opportunity to clarify potential misunderstandings relating to the survey or the process.

3.2 Research design

The survey research method forms the basis of the research design. A mixed method approach was followed, consisting of both closed-ended and open-ended questions in order to capture both causal (quantitative) and interpretive (qualitative) data. Structured interviews were conducted, as a combination of ordinal data, closed-ended and open-ended questions, with three hospital population groups (nursing staff, doctors and hospital administrators). While the research instrument was applied to all respondent sample populations, not all questions were applicable to all user groups as hospital administrators, whose daily workflow depends on systems that are not involved with direct patient care, were limited in answering patient-centric questions. Results from the three user groups were collated and cross-checked to provide a richer, more complete understanding of system automation within public sector hospitals in South Africa.

Survey-based interviews were conducted in person with hospital personnel across two hospital locations. The interviews consisted of closed-ended and open-ended questions. Conducting face-to-face interviews provided the respondents with an opportunity to clarify any follow-up questions they may have had, improving the richness of the process. In addition, interviews conducted in person were more likely to elicit a higher response rate whereas surveys conducted via indirect means were at risk of the respondents not understanding or misinterpreting the questions asked.

3.3 Population and sample

This section describes the population and sampling method employed for the study.

3.3.1 *Population*

The population consists of all doctors, nurses, and hospital administrators employed at Albert Luthuli Hospital in KwaZulu-Natal Province and Sebokeng Hospital in Gauteng Province. Both facilities are public sector hospitals that have implemented various components of automated systems.

3.3.2 *Sample and sampling method*

For the qualitative research component, purposive sampling was conducted, which ensured an intentional non-random selection of data sources (Leedy and Ormrod, 2009). These data sources consisted of doctors, nurses and hospital administrators working in public sector hospitals where automated systems had already been implemented, as specific experience in the healthcare sector and with healthcare systems was required in order for these respondents to contribute meaningfully to the research.

The quantitative research component followed a non-probability sampling design as the sample is not representative of all doctors, nurses and hospital administrators working in the public healthcare sector. As there are fewer than five healthcare facilities that have effectively integrated automated workflow into daily business processes, the majority of the healthcare worker population in South Africa is familiar only with manual-based paper-driven processes. The design also followed a stratified convenience sampling methodology, which meant that the hospital staff that was readily available at the nominated hospitals was allocated to participate in the study and made up the representative samples of doctors, nurses and hospital administrators for the research (Leedy and Ormrod, 2009).

Respondents were required to have been exposed to the system for at least a year in order to indicate familiarity with the dynamics of workflow associated with technology. A total of 94 interviews were conducted (including three pilot study interviews) with the total sample population (Table 3).

Table 3: Profile of respondents

Description of respondent type	Number sampled
Doctors	21
Nurses	41
Hospital administrators	31
EMR implementation managers	1

3.4 Pilot study

An initial pilot study was conducted to identify critical items that had been unintentionally omitted during the design of the research instrument. The pilot study consisted of unstructured interviews with:

- The CEO of Amethyst – the company responsible for the systems implementation at Sebokeng Hospital;
- A hospital administrator at Sebokeng Hospital;
- A nursing sister at Sebokeng Hospital; and
- A medical doctor at Sebokeng Hospital.

The results of these interviews were analysed for recurring issues and checked against the literature reviews to determine how best to strengthen the credibility of the questionnaire.

3.5 Research instrument

In accordance with the research survey method, the research instrument consists of a combination of a series of statements and open-ended questions (see Appendix A – Research Instrument). The first section of the instrument (referred to as the "questionnaire") consists of questions relating to demographic data of the respondent. The second section of the questionnaire consists of 41 statements relating to various system technologies that are part of daily workflow; the impact of automation in terms of cost and strategic value in healthcare facilities; and the degree to which organisational culture influences the implementation of new workflows and processes

within the hospital. The third section of the questionnaire consists of seven open-ended questions used to assess the qualitative factors associated with automated workflow and perceived benefits or pitfalls.

3.6 Procedure for data collection

A non-probability convenience sampling method was employed to collect data from structured interviews conducted with 94 respondents on site at the predetermined hospitals in KwaZulu-Natal and Gauteng. Permission was obtained from the relevant provincial authority and hospital CEO to conduct face-to-face interviews with hospital staff. A list of instructions accompanied each questionnaire to ensure that the integrity of the interview as required by the research study was followed.

The questionnaire covered five broad areas: questions relating to respondents' experiences and perceptions before system installation; respondents' experiences and perceptions after system installation; organisational influences relating to end-user adoption; barriers to effective functioning of the system; and the overall satisfaction with the computerised information system.

In addition, an interview guide was developed and used during in-depth interviews with the respondents. The questionnaire covered areas related to the positive and negative effects of the system as well as the respondent's perception of the costs and benefits of the system.

Research was conducted from 2 to 5 February 2011 at Sebokeng Hospital in Gauteng, and from 8 to 11 February 2011 at Inkosi Albert Luthuli Central Hospital (IALCH) in KwaZulu-Natal. A mobile phone-based research software application was utilised for data collection and recordings. Health Systems Trust (HST), an independent non-government organisation with extensive expertise in South African public sector health systems research, assisted with data collection at the two sites. HST performs research on behalf of the South African Department of Health and World Health Organisation amongst other local and global health organisations. Three HST researchers were trained on the research instrument before travelling to

the two sites. All four researchers conducted interviews together for the first day at Sebokeng Hospital (2 February, 2011) and at IALCH (8 February) to ensure the research was consistent, valid and replicable. The same three HST researchers assisted at both hospitals.

3.7 Data analysis and interpretation

Ordinal data obtained from the respondents was classified and subjected to analysis according to a Likert scale consisting of seven response categories plus a category for responses where the answer was not known. A distribution-fitting approach as developed by Stacey (2005) was applied in order to analyse the collected data and categorise the various criteria.

Completed questionnaires were categorised according to the number of responses and the categories into which they fitted. It was unnecessary to merge categories as the number of responses per category was sufficient.

When analysing the results of the distribution-fitting analysis performed on the survey data, Stacey's (2005) statistical methodology implies that the following interpretations needed to be made to identify factors as very important, important and less important in order to interpret the data meaningfully:

- If the mean for a factor response was appreciably greater than zero (μ as determined by the hypothesis test) then that factor is statistically significantly more important than the overall average importance of all the factors and can hence be interpreted as being very important relative to other factors.
- If the mean for a factor response was very close to zero (μ as determined by the hypothesis test) then that factor is statistically no more and no less important than the overall average importance of all the factors and can hence simply be interpreted as being important (the average) relative to other factors.
- If the mean for a factor response was appreciably less than zero (μ as determined by the hypothesis test) then that factor is statistically significantly

less important than the overall average importance of all the factors and can hence be interpreted as being less important relative to other factors.

3.8 Limitations of the study

1. The study focuses on healthcare professionals and administrators who have at least one year experience working in a public sector health facility where components of HIS have been implemented.
2. As information systems have been implemented in a limited number of health facilities in South Africa, a limited number of respondents qualified for the study.
3. The samples were predetermined and included stakeholders as identified by the researcher.
4. The research may have been exposed to biased selection techniques as public sector employees may have various reasons for participating or not participating in the study. The relationship between public sector employees and the state can be described as tenuous, as health officials have in the past been disciplined for speaking negatively regarding the Department of Health in the public domain.
5. While the sample is non-random, the standardisation of interpretation of results assumes that the frequency of responses reflects the significance of what is being measured. To minimise this risk, a wide spectrum of respondents was selected.

3.9 Validity and reliability

According to Morse, Barrett, Mayan, Olson and Spiers (2002), the concepts of validity and reliability are embodied in the essential “trustworthiness” of the data, which consists of four domains: credibility, transferability, dependability, and confirmability. The authors propose that in order to maintain reliability and validity there should be a focus on the process of verification during the study. “Validity” refers to the congruence between the research design, evidence obtained and conclusions drawn.

Kirk and Miller (1986) propose that social science relies on techniques for assuring reliability because perfect validity is not attainable. The objectivity of qualitative research can be gauged in terms of the reliability and validity of its observations, but non-qualitative research methodologies have had the necessary checks done for reliability, but none for validity.

The essential foundation of good research is objectivity. It is the main reason the reader would have for accepting the conclusions of the researcher and is "the simultaneous realisation of as much reliability and validity as possible" (Kirk and Miller, 1986:20). In terms of research findings, "reliability" refers to the degree to which findings are independent of accidental circumstance of research, and validity is the degree to which findings are interpreted correctly.

3.9.1 *External validity*

"External validity" refers to the ability to generalise the study to a large population, across different measures, persons, settings and times (Calder, Phillips and Tybout, 1982). The concept of external validity asks in what context the findings can be applied. To ensure that different perspectives were obtained for the research, the sample base was drawn from healthcare provider/administrator populations in public facilities, across two provinces and was indiscriminate of race or gender. Drawn samples consisted of doctors, nurses, and healthcare administrators who had varied experience in interacting with healthcare systems at the designated facility. Owing to the limited number of automated systems in public sector hospitals in South Africa, samples were drawn from the two available facilities that had already implemented systems to some degree.

Steps taken to improve external validity during the study consisted of drawing a large pool of respondents who had adapted to an information system-based workflow for at least one year. The healthcare professionals employed at the chosen hospital sites were expected to be familiar with the challenges and limitations of healthcare delivery in the public sector. Respondents were drawn from at least two provinces, Gauteng and KwaZulu-Natal, but were limited to healthcare facilities where components of

information systems had been implemented. To further ensure consistency, a mixed method approach was followed to consolidate qualitative feedback with the quantitative survey data.

3.9.2 *Internal validity*

Calder et al. (1982) define internal validity as whether or not the observed covariation should be considered as a causal relationship. Internal validity describes the extent to which the research in terms of its design and its data allows "the researcher to draw accurate conclusions about cause-and-effect and other relationships within the data" (Leedy and Ormrod, 2009:97). For the purposes of this research, the respondents were considered according to the workflow and hence hospital department that they had experience with. Thus, the perceptions and experience of each respondent were collated to represent responses from similar workflow and system experiences.

To ensure that internal validity was preserved, respondents were considered according to three population groupings: doctors, nurses and administrators. A pilot study was conducted to ensure that the research instrument questionnaire was easy to understand and elicited the intended information from respondents. The research instrument was standardised and consistent for each group of respondents.

3.9.3 *Reliability*

"Reliability" refers to the inherent ability of the research to yield the same results of the measure each time the research is conducted, provided there has been no significant change in the variable being measured (Ruane, 2004). Reliable measures do not fluctuate, but rather yield consistent results. Ruane (2004) suggests that the simplest way of determining reliability is to follow the test-retest strategy, which requires the procedure or research to be conducted twice to ensure consistency of results. To ensure reliability of the study, a standardised research tool was developed and administered in a consistent manner with all respondents such that the steps followed in the research could be repeated in a duplicate study. The questions included in the survey focused on the personal experience and perceptions of each

respondent. Interviews were conducted in privacy, with care taken to ensure that respondents did not influence answers amongst themselves.

4 PRESENTATION AND DISCUSSION OF RESULTS

4.1 Introduction

The results are reported and discussed using quantitative and qualitative data and are presented in five sections:

1. Demographic profiles of respondents;
2. Case studies: Inkosi Albert Luthuli Central Hospital (IALCH) and Sebokeng Hospital;
3. Presentation and discussion of results pertaining to Research Question 1: Perceived reasons that influence the investment of automated systems within the hospital;
4. Presentation and discussion of results pertaining to Research Question 2: Outcomes experienced from automating systems in hospital departments; and
5. Presentation and discussion of results pertaining to Research Question 3: Organisational factors that influence the sustained successful adoption of healthcare systems.

4.2 Demographic profiles of respondents

The demographic profiles of respondents were considered according to occupational and geographical category, age distribution by occupation, and occupational distribution according to years of service. “Occupational category” was defined as doctor, nurse or administrator, and “geographical category” refers to hospital where respondent was working at the time of the survey.

4.2.1 *Response rates by occupational and geographical category*

A total of 100 respondents were invited to participate in the study, comprising 15 doctors, 20 nurses and 15 administrators at each of the two hospitals chosen for the research. At IALCH, all 15 doctors were included in the study; however, only five doctors at Sebokeng Hospital agreed to be interviewed. All 30 administrators and 40

nurses invited to participate at both hospitals were included in the study. The response rate for the study is as shown in Table 4.

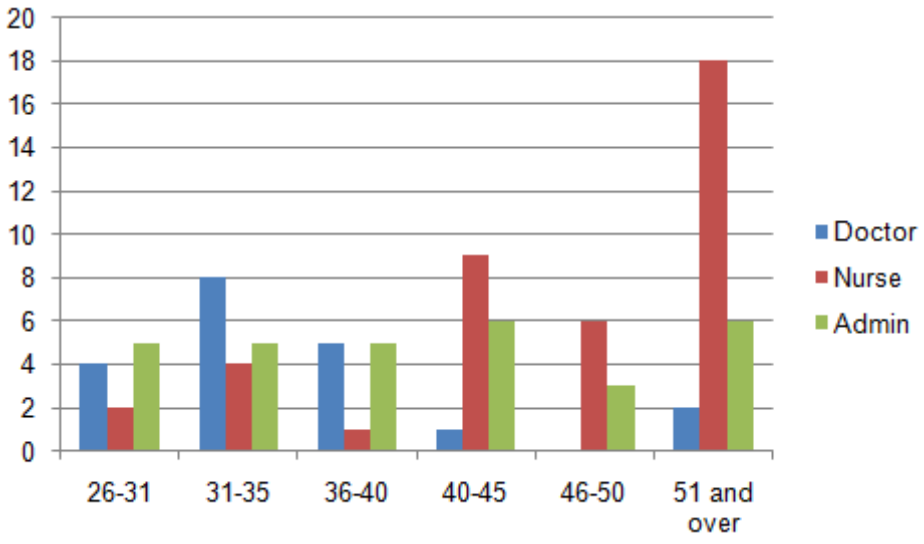
Table 4: Response rate of respondents per hospital

Occupation	IALCH		Sebokeng Hospital	
	Respondents	Rate of Response	Respondents	Rate of Response
Doctors	15	100%	5	33%
Nurses	20	100%	20	100%
Admininistrators	15	100%	15	100%
Total	**50**		**40**	

4.2.2 *Age distribution of respondents by occupational category*

The age distribution of respondents confirms that 60% (n=12) of doctors surveyed were between the ages of 26 and 35; 60% (n=24) of nurses were older than 46 years of age; and administrator respondents were distributed fairly evenly across various age groupings as shown in Figure 3.

Figure 3: Age distribution of respondents by occupational category



As IALCH and Sebokeng Hospital are public health teaching facilities, the doctors interviewed were mostly in training posts for specialisation or medical office posts, with the intention of applying for admission to a specialisation programme. Thus, 75%

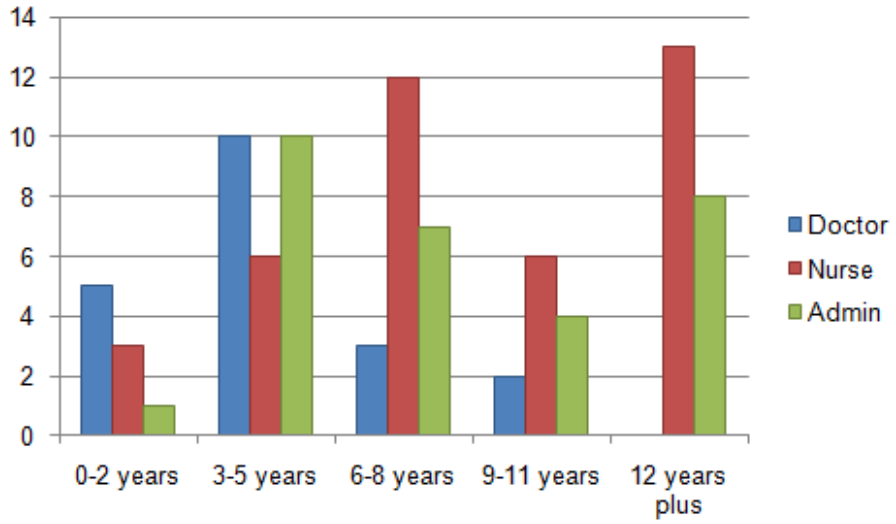
of doctors interviewed had been employed at the respective facility for five years or less.

In 2010, Health Systems Trust reported a 46.3% vacancy rate of nursing posts in the public sector (Health Systems Trust, 2011), and, according to the 2011 SA Nursing Council Age Statistics Report, 29% of registered nurses are between the ages of 50 and 59, and 16% of registered nurses are over 60 years old (SA Nursing Council, 2011). A total of 60% of nurses who participated in the study were older than 46, and 78% had been employed for more than six years at the respective facility. This was in keeping with expectations, given that there is a high percentage of experienced nurses in the public sector.

4.2.3 *Occupational distribution according to years of service*

Some 75% of doctors interviewed (n=15) had been employed for five years or less at the hospital at which they worked. Seventy-eight per cent of nurse respondents (n=31) had worked at the hospital for more than six years, with 33% (n=13) having been employed at the facility for more than 12 years. A total of 57% of hospital administrators had been employed by the hospital for between three and eight years.

Figure 4: Occupational distribution according to years of service



4.3 Case studies: Inkosi Albert Luthuli Central Hospital and Sebokeng Hospital

Significant data variants were observed at the two hospitals. The reasons for this variance relate to the nature of the IT project (extent to which the system had been implemented, the timing of the project and user experience) and political forces in each province. The profiles of each hospital are described below.

4.3.1 *Hospital profile: Inkosi Albert Luthuli Central Hospital*

IALCH is an 840-bed tertiary facility in the city of Durban, South Africa, and is one of the few digital hospitals in the country. This has been assisted by a public private partnership, whereby in 2001 the Impilo Consortium was awarded the contract for the provision of medical equipment service (Siemens Systems), IT systems (AME), and facilities management (Drake and Scull). The contract is for 15 years and is worth more than R5 billion (National Treasury South Africa, 2001).

AME International is responsible for implementing the complete HIS (AME International, 2011b) at IALCH, which consists of:

- Electronic Medical Record;
- Picture Archiving and Communication System;
- Radiological Information System;
- Laboratory Information System;
- Pharmacy Information System;
- Critical Care System;
- Administration and Financial Systems; and

- Human Resource Management System.

IALCH is in its tenth year of its 15-year Public Private Partnership contract, and hospital staff at IALCH are subject to continuous training of the HIS, with the result that “most clinical staff are now literate” (IALCH, 2008:21). In addition, the most recent annual report (published for financial year 2007/2008) confirms that surveys are conducted on a monthly basis with clinical staff to ensure that the quality of service levels regarding the IT systems and training is acceptable.

4.3.2 *Hospital profile: Sebokeng Hospital*

Sebokeng Hospital is a 704-bed regional hospital in Gauteng Province, with three associated clinics (Levai Mbatha, Johan Deo and Helga Kuhn). In August 2008, Sebokeng Hospital completed a proof of concept for a planned provincial implementation of an HIS (Means, 2009).

The Baoki Consortium (AME International is part of the consortium) was awarded the Gauteng provincial contract (valued at $120 million) for supplying an HIS to 37 provincial hospitals and 400 community clinics (AME International, 2011a). The scope of this implementation includes:

- Patient Management and Scheduling;
- Electronic Medical Record System;
- Clinical Documentation;
- Pharmacy Information System;
- Visit Summaries and Discharge Summaries; and
- Statistics and Reporting.

In August 2010, implementation of the system was halted due to a dispute between the Baoki Consortium and the Gauteng Provincial Department of Health regarding non-payment and non-delivery between the two parties (Hudleston, 2010). As a

result, the contract has been suspended and there has been no further training of staff on site since November 2010.

4.3.3 *Presentation and discussion of observations*

a) *Information security and patient confidentiality*

Thirty-eight per cent of respondents at IALCH expressed a lack of confidence in the ability of the electronic system to offer enhanced confidentiality of patient information compared to paper processes (Table 5). This was qualified during interviews, where doctors and nurses complained that once users had logged into the system, they had unrestricted access to all electronic data across all departments and for all patients. Sebokeng users identified electronic security measures as very important compared to other statements in the survey (Table 5), suggesting that either confidentiality measures relating to paper-based records at Sebokeng Hospital are poor or the perception of logging into a system with a username and password intimates a higher level of security practice. The recommendation for both hospitals is to enforce security policies that grant various levels of system access according to user profile and with complete audit ability of user log on and record-modification instances.

Table 5: Information security and confidentiality perceptions – IALCH and Sebokeng

	Absolutely disagree	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Absolutely agree	Total	t-value	p-value	Significance
I have confidence that information is more secure and confidential in electronic format compared to paper											
IALCH	4	8	7	3	5	15	8	50	0.1240	0.9018	
Sebokeng Hospital	1	0	2	3	1	21	11	39	4.4528	0.0001	+

b) *Lowering costs*

Both hospitals perceived the potential for cost savings as a result of the new system to be of high importance relative to other factors (Table 6). Qualitative interviews demonstrated a poor understanding of business value modelling amongst hospital

staff as productivity enhancements that result from automation are difficult to quantify in terms of cost savings. This was in keeping with findings from the literature review, where Menachemi et al. (2006) and Otieno et al. (2008) identified challenges in measuring ROI from similar type projects. A potential focus area to include in the change management effort is identification of processes that would enjoy lower costs as a result of implementing an HIS.

Table 6: Perceived cost benefits – IALCH and Sebokeng

	Absolutely disagree	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Absolutely agree	Total	t-value	p-value	Significance
I believe the hospital will save money as a result of moving to the new system											
IALCH	**1**	**1**	**3**	**6**	**7**	**13**	**12**	**43**	3.2478	0.0023	+
Sebokeng Hospital	**1**	**0**	**0**	**1**	**4**	**18**	**12**	**36**	4.6376	0.0001	+

c) *Service delivery and reputational impact perceptions*

While both hospitals demonstrated overall positive perceptions of the system with regard to service delivery and reputational impact, IALCH respondents considered the impact on patient waiting times for admission, patient waiting times for treatment and satisfaction with overall working conditions in the hospital to be of statistically higher significance relative to other factors (Table 7). This suggests that the HIS implementation at IALCH has translated into workflow optimisation benefits that have been internalised by hospital staff.

A nurse at IALCH commented that the presence of technology in the hospital "raises the patients' perceptions that they're being treated in an advanced hospital", but in order to realise the benefits, integrating technology into existing workflows is fundamental to convincing healthcare providers and administrators of positive service delivery and reputational outcomes. IALCH has implemented an end-to-end solution, meaning that the entire patient process from admission to treatment to discharge has been transitioned to an electronic-based system. In contrast, Sebokeng has implemented modules of the HIS that hospital staff acknowledges enhance certain

processes. However, service delivery and reputational perceptions are based on the complete end-to-end experience.

Table 7: Service delivery and reputation perceptions – IALCH and Sebokeng

IALCH	Absolutely disagree	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Absolutely agree	Total	t-value	p-value	Significance
Patient waiting times for admissions have decreased	2	3	1	5	7	17	9	44	2.5868	0.0132	+
Patient waiting times to be seen by a doctor or nurse are decreased	1	2	1	2	14	16	7	43	2.8648	0.0066	+
Patient overall satisfaction with care received is higher	2	2	1	0	13	20	6	44	2.2536	0.0295	+
I believe more patiens are treated per shift as a result of the system	2	2	3	6	11	11	11	46	2.2875	0.0270	+
There is increased satisfaction with the overall working conditions in the hospital	1	1	1	3	12	21	11	50	4.4010	0.0001	+
Sebokeng Hospital											
Patient waiting times for admissions have decreased	1	5	4	3	2	14	7	36	1.9812	0.0557	
Patient waiting times to be seen by a doctor or nurse are decreased	1	3	3	5	5	16	2	35	1.3926	0.1730	
Patient overall satisfaction with care received is higher	0	0	1	9	8	13	4	35	2.8182	0.0081	+
I believe more patiens are treated per shift as a result of the system	0	6	1	5	3	12	8	35	2.0665	0.0467	+
There is increased satisfaction with the overall working conditions in the hospital	0	4	7	3	6	9	9	38	1.9221	0.0625	

d) ***Management of patient records***

Respondents from both hospitals were in agreement as to the benefits of EHRs (Table 8). Sebokeng, however, did not perceive the reduction of the duplication of information and the concomitant time spent entering information as a factor of very high significance relative to other factors. The reason for this was that the EMR module was only partially implemented at Sebokeng Hospital, which limited user experience and perceptions of potential workflow optimisations associated with that specific module.

Table 8: Electronic Health Record perceptions – IALCH and Sebokeng

IALCH	Absolutely disagree	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Absolutely agree	Total	t-value	p-value	Significance
I have superior access to patient record information when compared to paper based systems	2	0	0	1	6	20	20	49	5.4834	0.0000	+
There is a reduction of duplication of information which means cleaner patient records and less time spent entering information	1	0	5	4	10	21	8	49	2.9933	0.0044	+
Patient information is more disorganised with the computer system compared to the paper system	15	20	5	2	3	3	2	50	-6.8174	0.0000	-
Fewer records are lost and record management has improved	1	2	2	3	6	20	16	50	5.2823	0.0000	+
Sebokeng Hospital											
I have superior access to patient record information when compared to paper based systems	0	2	1	1	7	15	12	38	5.5230	0.0000	+
There is a reduction of duplication of information which means cleaner patient records and less time spent entering information	4	4	2	0	8	16	6	40	0.9469	0.3497	
Patient information is more disorganised with the computer system compared to the paper system	9	19	6	3	0	1	2	40	-5.6107	0.0000	-
Fewer records are lost and record management has improved	1	4	0	1	7	14	11	38	3.4564	0.0014	+

e) ***Executive sponsorship***

Both hospitals agreed that management encouraged staff to adopt the system and identified this factor as highly significant (Table 9). As confirmed in the literature review by Littlejohns et al. (2003), the success of HIS implementations relies on management's support and buy-in as perceived by the end-user base, i.e. clinicians and administrators.

Table 9: Management support for system utilisation – IALCH and Sebokeng

	Absolutely disagree	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Absolutely agree	Total	t-value	p-value	Significance
Management encourage staff to use the computer system											
IALCH	2	1	0	3	4	26	12	48	4.2918	0.0001	+
Sebokeng Hospital	0	2	2	1	4	14	16	39	6.0133	0.0000	+

f) *Training perceptions*

Over 80% of IALCH respondents believed that training provided was sufficient, while Sebokeng staff held mixed thoughts about this (Table 10). This may be attributable to the fact that the system at IALCH was implemented some seven years prior; thus staff at this hospital had been exposed to more training sessions than those at Sebokeng. Common to both hospitals was the need to sustain continuous training programmes to ensure system adoption. Factors specific to each of the three population groups are described in Section 4.6.2.

Table 10: Training perceptions – IALCH and Sebokeng

IALCH	Absolutely disagree	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Absolutely agree	Total	t-value	p-value	Significance
Insufficient training was provided when I first had to use the system	15	24	3	0	5	3	0	50	-10.0113	0.0000	-
There is no need for continuous training on the system as its easy and intuitive to use	6	15	8	3	8	7	3	50	-3.6817	0.0006	-
Sebokeng Hospital											
Insufficient training was provided when I first had to use the system	4	11	5	1	6	7	6	40	-0.9344	0.3560	
There is no need for continuous training on the system as its easy and intuitive to use	8	19	3	0	3	2	4	39	-3.9477	0.0003	-

g) *Willingness to adopt new systems*

Survey results indicated that staff at IALCH was more eager to learn the new system compared to respondents from Sebokeng Hospital (Table 11). There also appeared

to be more resistance at Sebokeng Hospital to adopting the new system; however, willingness to move to the new system was less important compared to other factors for Sebokeng staff. Interestingly, both hospitals perceived the implementation of new systems as valuable in raising staff perceptions relating to professionalism (staff identified this as significant relative to other factors). This suggests that by positioning HIS as an enabling rather than as a support capability, hospital staff may achieve a higher degree of job satisfaction.

Table 11: Willingness to adopt new systems – IALCH and Sebokeng

IALCH	Absolutely disagree	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Absolutely agree	Total	t-value	p-value	Significance
Staff are eager to learn the new system	1	1	2	2	5	25	13	49	5.3527	0.0000	+
Initially I did not want to move to the computer system	9	22	3	4	4	3	3	48	-5.2291	0.0000	-
Initially the hospital staff did not want to move to the computer system	0	13	2	5	8	4	1	33	-3.4992	0.0014	-
As a result of the computer systems, I see improved moral in the workplace	2	3	4	7	8	18	6	48	1.4482	0.1544	
As a result of the computer systems, my overall level of professionalism is increased	3	3	2	2	12	16	12	50	2.6286	0.0115	+
Sebokeng Hospital											
Staff are eager to learn the new system	3	4	4	3	8	12	6	40	0.7866	0.4364	
Initially I did not want to move to the computer system	9	16	1	1	2	6	5	40	-3.0845	0.0038	-
Initially the hospital staff did not want to move to the computer system	0	5	4	3	2	10	6	30	1.4828	0.1493	
As a result of the computer systems, I see improved moral in the workplace	3	2	3	5	7	8	10	38	1.6116	0.1158	
As a result of the computer systems, my overall level of professionalism is increased	1	1	4	6	5	10	13	40	3.2468	0.0024	+

4.3.4 *Hospital case study conclusion*

The two hospitals that participated in the study were at different stages of their respective HIS implementation life cycles.

Respondents from both hospitals agreed that the HIS has the potential to impact positively on information security, workflow optimisation, cost reduction and patient care. Some key findings from the case studies are:

1. Confidentiality and information security controls could be improved, particularly at IALCH.
2. Respondents from IALCH had a better appreciation of workflow optimisation benefits as they were working in an environment where the system had been in operation for ten years (continuous development had been ongoing during this time to refine the system and eliminate errors) and continuous training was not as significant a factor (compared to Sebokeng Hospital respondents, who were still new to the system).
3. Users at Sebokeng demonstrated some initial resistance to the new system. This would have been interesting to monitor at IALCH when the system was first implemented; however, the introduction of an executive committee endorsed change management programme to accompany the implementation of a hospital information system is fundamental to ensuring mass adoption and usage.

4.4 Presentation and discussion of results pertaining to Research Question 1: Perceived reasons that influence the investment of automated systems within the hospital

Results are reported according to respondent perceptions in four areas: 1) manual processes, 2) HIS, 3) information security and patient confidentiality, and 4) cost containment.

4.4.1 *Perceptions of manual processes*

The research data confirms that for hospital staff conditioned to working in non-automated environments, the perceptions of inefficiency relating to paper-driven processes are not significant (Table 12).

Table 12: Reasons for investing in Hospital Information Systems – all respondents

All respondents	Absolutely disagree	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Absolutely agree	Total	t-value	p-value	Significance
I spent more than 20% of my time doing administration tasks	7	11	8	8	11	27	14	86	0.9516	0.3440	
Paper process were inefficient at this facility	11	13	8	7	7	23	11	80	-0.6922	0.4908	
I frequently (more than 80% of the time) needed to enter the same information on more than one chart for every patient I treat	12	5	5	11	11	30	9	83	-0.4516	0.6528	
Manual processes prevented me from spending time with the patients	13	11	7	14	5	20	13	83	-1.1870	0.2387	

The majority of doctors disagreed with the statement that paper processes resulted in more than 20% of their time being dedicated to administrative activities. This is likely attributable to the fact that doctors did not perceive the urgency of making detailed clinical notes as they are less under threat of being sued for medical liability than their global colleagues. This is because, while the notion of punitive damages for medical liability in South Africa exists, in general these damages are not recoverable (Funnah and Sibanda, 2008).

Thus, it could be expected that it would be nurses and staff who are delegated a high administrative workload that would hold this perception. In addition, 71% of the nursing sample group recognised the need for duplicate data entries, which is to be expected, given that nurses are tasked with recording multiple aspects of patient data on a frequent basis, e.g. patient history, medication, observations, and laboratory results.

The observations suggest that paper processes are not as inefficient as is suggested by the literature (Goldzweig et al., 2009). Rather, the physician resistance to adoption was demonstrated (with 55% of doctors believing that paper processes were efficient) through the unwillingness to adopt new workflow processes that required data to be accessed and entered onto a computer system. This is in keeping with the findings of

Poon et al. (2004), which suggested that the number one barrier to adoption resides in the change management function, which needs to be addressed in order to shift perceptions towards acceptance of HIS. It can be inferred from the results of the current study that doctors, nurses and administrators integrate manual processes into their daily workflow without questioning the impact of these processes on job function efficiencies. It is only when automation is introduced that healthcare providers realise the shortcomings of manual processes in comparison to the automated ones.

This aligns with the findings of Poissant et al. (2005), which confirm clinician perceptions regarding the value of IT investment in hospitals.

4.4.2 *Perceptions of hospital information systems*

Respondents considered administrative tasks and patient interaction workflow separately. (Table 12 indicates that 46% of respondents did not believe inefficient processes prevented them from spending time with patients.) This suggests that while respondents recognise that there are benefits to be gained from automation, the direct impact on their daily business processes is not well understood. Some staff also perceived the introduction of hospital systems as disruptive to patient care, with one nurse from Sebokeng Hospital commenting that “concerning patient care on the nursing side, more time is now taken to sit in front of a computer instead of taking care of the patient”.

Thus, obtaining buy-in and acceptance for the implementation of a computerised system from hospital staff should not rely on broad promises of potential optimisation benefits, but should rather target processes specific to the various user groups within their daily workflow that are genuinely perceived as inefficient. Table 13 describes the data relating to the impact of automation and the perceived barriers to adoption for doctors, nurses and hospital administrators, respectively.

Table 13: Perceptions of Hospital Information Systems – doctors, nurses and administrators

Doctors	Absolutely disagree	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Absolutely agree	Total	t-value	p-value	Significance
I find it easier to work with electronic system than with paper records	0	0	2	4	4	6	4	20	2.8881	0.0098	+
I have confidence that information is more secure and confidential in electronic compared to paper	1	4	6	1	0	6	1	19	-0.4984	0.6246	
I believe the computer systems will save the hospital money	1	2	2	3	3	5	1	17	0.4029	0.6927	
I believe the cost of learning new computer systems is not worth the benefits	4	7	4	0	3	1	0	19	-4.2001	0.0006	-
I prefer using a paper based system	4	7	4	2	2	1	0	20	-4.6680	0.0002	-
I would like to move to a paperless system as soon as possible	1	1	1	3	2	3	9	20	2.9370	0.0088	+
Nurses											
I find it easier to work with electronic system than with paper records	1	2	2	1	9	15	10	40	3.6251	0.0008	+
I have confidence that information is more secure and confidential in electronic compared to paper	3	1	3	3	4	18	8	40	2.0762	0.0447	+
I believe the computer systems will save the hospital money	1	1	1	3	10	11	4	31	1.5837	0.1241	
I believe the cost of learning new computer systems is not worth the benefits	9	14	4	2	3	5	0	37	-5.9191	0.0000	-
I prefer using a paper based system	13	14	4	3	2	1	3	40	-4.9693	0.0000	-
I would like to move to a paperless system as soon as possible	1	2	0	2	4	18	13	40	4.7026	0.0000	+
Administrators											
I find it easier to work with electronic system than with paper records	1	1	0	1	0	17	10	30	3.6777	0.0010	+
I have confidence that information is more secure and confidential in electronic compared to paper	1	3	0	2	2	12	10	30	3.1072	0.0043	+
I believe the computer systems will save the hospital money	0	2	1	5	3	9	7	27	2.5319	0.0180	+
I believe the cost of learning new computer systems is not worth the benefits	7	14	1	3	1	2	2	30	-4.5328	0.0001	-
I prefer using a paper based system	13	16	0	1	0	0	0	30	-16.0300	0.0000	-
I would like to move to a paperless system as soon as possible	4	0	0	0	2	12	12	30	2.0536	0.0495	+

For all three sample groups (doctors, nurses and administrators) that had experience using the HIS, there was consensus that it was easier to work with electronic systems compared to paper records. This was a statistically significant factor and is in keeping with the literature review discussion as evidenced by Poon et al. (2004); Ormond et al. (2005); Westbrook et al. (2008); and Devine et al. (2010). There is no doubt that

the perceived benefits of investing in an HIS are not as well understood by potential users, compared to those users who have had some exposure to working with the system. The data also revealed a belief across all three sample groups (doctors, nurses and administrators) that the cost of learning the new system was worth the benefits, that the HIS was preferred to the previous paper-based system, and that hospital staff would like to move to the HIS for all functions as soon as possible. A nurse from Sebokeng Hospital alluded to the excitement amongst the hospital staff attributed to moving to an automated system: “Personally I think it’s a great thing. I love technology and the fact that it can help people. I didn’t have exposure to technology before, and now I can use email and the internet.”

Thus, the perceived value of the hospital IT investment would benefit from exposing the potential user population to hands-on usage models, i.e. live system demonstrations that would allow users to internalise the impact on workflow. This exposure would be likely to have a more positive effect than trying to identify inefficiencies in the existing manual system.

4.4.3 *Information security and patient confidentiality*

Over 75% of nursing staff and hospital administrators were confident that information is more secure and confidential in electronic format compared to a paper-based system (Table 14). While this was a statistically significant factor for these sample groups, 58% of doctors surveyed disagreed. This was probably because paper-based records are accessible to all hospital staff while the electronic system requires a log on with a password. Qualitative data provided some insight, with one doctor at IALCH confirming that staff can access data of patients that are not directly in their care and that “people who don’t work in that department should not be able to access records of patients in other departments”. As described in the literature review, privacy and confidentiality of data are fundamental concerns with international HIS implementations (Simon et al., 2007). There is currently no protocol or guidance in South Africa as to the exact measures that should be implemented to protect patient confidentiality effectively. The Patient Right Charter and Medical Schemes Act merely state that all patients have the right to privacy (South Africa, 1998; South Africa

National Department of Health, 2002). It can be inferred that electronic records have the ability to offer password-restricted access to electronic patient information; however, hospital staff was discouraged by the fact that once a user logs onto the system, that person has complete access to all patient records regardless of who the treating doctor is, or which ward the patient is allocated to. Going forward, measures should be taken to ensure that security and privacy of information are included in the system security and design architecture in accordance with the hospital risk management function.

Table 14: Patient data confidentiality perceptions – all respondents

	Absolutely disagree	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Absolutely agree	Total	t-value	p-value	Significance
I have confidence that information is more secure and confidential in electronic format compared to paper											
Doctors	1	4	6	1	0	6	1	19	-0.4984	0.6246	
Nurses	3	1	3	3	4	18	8	40	2.0762	0.0447	+
Administration Staff	1	3	0	2	2	12	10	30	3.1072	0.0043	+

4.4.4 *Lowering costs*

As to the perceived cost benefits of implementing the new system, the statement “I believe the hospital will save costs as a result of moving to the new system” was identified as statistically significant by nurses and administrators but not by doctors (Table 15). From the qualitative interviews, it was clear that while nurses and administrators believed that IT would reduce costs, both sample groups did not understand how this would be achieved. When asked “Do you see cost savings as a result of the system?”, one nurse at IALCH replied “Yes, it saves time; more patients are admitted because it is faster than writing.” One possible explanation is that the positive attitude towards the IT system within these two sample groups translated into a logical association of workflow efficiencies with cost reduction. One doctor felt: “It’s costing the hospital as well as provincial government a lot of money. The cost of running a computer system is expensive. You need to have someone to maintain the system on call 24 hours a day.” Another clinician was of the opinion that “The hospital will save money as they don’t have to buy as much paper. Information will be

accessed more efficiently and patients will be treated more efficiently, so there's a faster turnaround time. For example, to discharge a patient, it's all done on the system and the patient just goes to one place and all paperwork is done there."

The research suggests that there is an opportunity to include the IT value proposition specific to cost reduction in the change management process during system implementation (and education of doctors, nurses and administrators) in order to gain further support for system adoption and usage.

Table 15: Perceived cost benefit – all respondents

	Absolutely disagree	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Absolutely agree	Total	t-value	p-value	Significance
I believe the computer systems will save the hospital money											
Doctors	1	2	2	3	3	5	1	17	0.4029	0.6927	
Nurses	1	1	1	3	10	11	4	31	1.5837	0.1241	
Administration Staff	0	2	1	5	3	9	7	27	2.5319	0.0180	+

In summary, the perceived reasons that influence the investment of automated systems within a hospital are the ability to reduce administrative workload associated with data capture; the optimisation of workflow; the potential to enhance patient data security; and the potential for lower overall costs. Factors that are not well understood present an opportunity for inclusion in the change management process. Suggested actions would be:

1. Identify and target usage models for workflow optimisation specific to each user group as user experience differs from doctors to nurses to administrators.
2. Provide potential users with exposure to the HIS or demonstrations to assist with internalising automation benefits and thereby driving system adoption.
3. Enhance patient confidentially within the system.
4. Develop a value proposition specific to each user group to encourage support, adoption and usage of the new system.

4.5 Presentation and discussion of results pertaining to Research Question 2: Outcomes experienced from automating systems in hospital departments

Following the implementation of the hospital system, respondents were asked about their perceptions relating to the impact of automation in terms of cost and strategic value of the system. The results provided insight into the impact of automation on service delivery and hospital reputation perceptions; patient record management; and HIS user experience Table 16).

Table 16: Service delivery and hospital reputation perceptions – doctors, nurses and administrators

Doctors	Absolutely disagree	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Absolutely agree	Total	t-value	p-value	Significance
Patient waiting times for admissions have decreased	2	3	1	3	3	6	0	18	-0.0914	0.9283	
Patient waiting times to be seen by a doctor or nurse are decreased	1	4	2	0	6	4	0	17	-0.4756	0.6412	
Patient overall satisfaction with care received is higher	1	2	1	3	4	5	2	18	0.9382	0.3621	
I am treating more patients per shift in the outpatient/ward/where I work	2	4	2	3	4	4	1	20	-0.7749	0.4484	
There is increased satisfaction with the overall working conditions in the hospital	1	1	1	3	5	6	3	20	1.7130	0.1039	
The hospital has enjoyed improved service delivery	1	2	1	3	1	9	2	19	1.6998	0.1074	
Nurses											
Patient waiting times for admissions have decreased	0	4	3	3	4	15	8	37	2.7761	0.0088	+
Patient waiting times to be seen by a doctor or nurse are decreased	1	0	1	5	10	17	4	38	1.9725	0.0563	
Patient overall satisfaction with care received is higher	1	0	1	1	12	18	6	39	2.9657	0.0053	+
I am treating more patients per shift in the outpatient/ward/where I work	0	3	2	6	8	10	8	37	2.1513	0.0384	+
There is increased satisfaction with the overall working conditions in the hospital	0	1	7	2	9	14	7	40	2.2247	0.0321	+
The hospital has enjoyed improved service delivery	1	1	2	1	12	15	6	38	2.6109	0.0131	+
Administrators											
Patient waiting times for admissions have decreased	1	1	1	2	2	10	8	25	2.6938	0.0130	+
Patient waiting times to be seen by a doctor or nurse are decreased	0	1	1	2	3	11	5	23	3.3013	0.0034	+
Patient overall satisfaction with care received is higher	0	0	0	5	5	10	2	22	2.1914	0.0404	+
I believe more patients are treated per shift as a result of the system	0	1	0	2	2	9	10	24	4.8093	0.0001	+
There is increased satisfaction with the overall working conditions in the hospital	0	3	0	1	4	10	10	28	3.5554	0.0015	+
The hospital has enjoyed improved service delivery	0	1	0	2	2	18	6	29	5.3258	0.0000	+

4.5.1 *Impact on service delivery and hospital reputation perceptions*

As was to be expected, the overall perceptions relating to the impact on patient experience were overtly positive. Significant statistical factors were observed with nursing and administrator respondents regarding patient waiting times for admission and discharge, and overall patient satisfaction with care received. It stands to reason that as nursing staff and administrators are involved in the administrative tasks relating to patient admission and discharge, the perception of these two sample groups would hold a higher level of significance concerning where automation can replace manual processes. Doctors on the other hand did not identify these factors relating to patient workflow as significant, as they are not involved in patient administrative tasks and the system was not perceived to enhance the doctors' ability to treat patients more effectively.

Given that patients spend more time with nurses and administrators during the admission, waiting and discharge processes compared to the time spent with the doctor for consultation and treatment, it is likely that the nurses and administrators perceive the hospital to have experienced a higher level of service delivery to patients as a result of the automated system. This is consistent with Ammenwerth et al. (2009) and Furukawa et al.'s (2010) findings described in the literature review. One nurse at Sebokeng Hospital commented: "waiting time decreased ... You don't have to look for papers to file, staple or punch." Research findings were consistent with those of Poon et al.'s (2004) presented in the literature review, confirming that positive patient experience and hospital reputation perceptions are supported through IT investment.

The image of public sector tertiary hospitals in South Africa has been an emotive issue. Public opinion considers these facilities to be antiquated, under resourced and associated with poor service delivery (Seokoma and Mukendi, 2010). The results of this study suggest not only that IT has a role to play in modernising state hospitals in terms of automation but that there is a real belief that automated systems are an important component to improving health service delivery, patient experience and the overall public perception of state healthcare services.

IT systems also have a role to play in the reputational management of internal stakeholders, as evidenced by the perceived increased satisfaction in overall working conditions within the hospital, particularly for 87% of nurses and 86% of administrators surveyed.

4.5.2 *Patient record management*

The majority of hospital staff was in agreement as to the benefits of EMRs (Table 17).

Table 17: Electronic Health Record perceptions – doctors, nurses and administrators

Doctors	Absolutely disagree	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Absolutely agree	Total	t-value	p-value	Significance
I have superior access to patient record information when compared to paper based systems	0	2	1	1	2	3	11	20	3.6665	0.0018	+
There is a reduction of duplication of information which means cleaner patient records and less time spent entering information	2	1	4	0	3	8	2	20	0.7483	0.4640	
Patient information is more disorganised with the computer system compared to the paper system	4	9	2	1	1	2	1	20	-3.1743	0.0053	-
Fewer records are lost and record management has improved	0	0	0	0	6	6	8	20	5.9135	0.0000	+
Nurses											
I have superior access to patient record information when compared to paper based systems	1	0	0	0	8	16	13	38	4.6403	0.0000	+
There is a reduction of duplication of information which means cleaner patient records and less time spent entering information	2	0	1	2	12	15	7	39	2.0770	0.0448	+
Patient information is more disorganised with the computer system compared to the paper system	10	19	6	2	1	0	2	40	-5.8010	0.0000	-
Fewer records are lost and record management has improved	2	4	1	0	4	18	10	39	2.9957	0.0049	+
Administrators											
I have superior access to patient record information when compared to paper based systems	1	0	0	1	3	16	8	29	3.1605	0.0039	+
There is a reduction of duplication of information which means cleaner patient records and less time spent entering information	1	3	2	2	3	14	5	30	1.6292	0.1145	
Patient information is more disorganised with the computer system compared to the paper system	10	11	3	2	1	2	1	30	-5.8357	0.0000	-
Fewer records are lost and record management has improved	0	2	1	4	3	10	9	29	3.3449	0.0024	+

Doctors, nurses and administrators all identified the statement “I have superior access to patient record information when compared to paper based systems” as being very important relative to other factors. A doctor from IALCH confirmed “Patient

care is improved because access to results are easier and don't get lost. Results are logged and you can prove that you ordered them." The perceived advantages of EMRs were shared by the nursing respondents. As a nurse from IALCH commented: "The system is user friendly, very fast, and saves money because the doctors are able to read the scans from the rural hospitals without the patient, the decision is made on the phone, results are posted through the computer, multidisciplinary teams are able to work fast with the system and patient care is improved." The research suggests a unanimous recognition of the value of HIS and raises questions as to how this capability will enhance the clinician's ability to improve healthcare delivery. Nurses and administrators believe that the HIS results in fewer records lost, improved record management, and the reduction of duplication of information. A nurse at IALCH confirmed: "Record keeping is good as the history of the patient is written on the computer and is well kept and can be retrieved easily."

The study results suggest that paper patient records are cumbersome and costly to manage and that there are efficiencies to be gained by moving from paper to electronic format. This is in keeping with international research findings discussed in the literature review, which reports on studies such as those by Byrne et al. (2010), Chen et al. (2009) and Poissant et al. (2005) that present the benefits of transitioning electronic patient records. The results from this study suggest that the HIS offers cost savings to be achieved by optimising the manual processes required to maintain manual record management systems.

4.5.3 *Hospital information system user experience*

The HIS user experience varied between the three sample groups (Table 18). Doctors, nurses and administrators inferred that the system was easy to use, but only nurses and administrators believed the statement "I find the computerised system is faster and easier to use compared to handwritten notes" to be very important relative to other factors (78% of nurses and 80% of administrators believed that the fact that computerised systems were faster than handwritten notes was an important factor while only 55% of doctors agreed with this statement to varying degrees). Opinion as to whether the users perceived the system as slow varied, with doctors emerging as

the most sensitive to system performance. The reasons relating to system usability and performance were not well understood, and while infrastructure and system design considerations are not evaluated in this study, it can be inferred that these factors have the potential to define the user experience and hence the user attitude towards system adoption and usage..

Table 18: Hospital Information Systems – user experience

Doctors	Absolutely disagree	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Absolutely agree	Total	t-value	p-value	Significance
I found the system difficult to use	4	10	2	1	3	0	0	20	-5.4430	0.0000	-
I find the system slow	1	3	3	2	5	3	3	20	0.6043	0.5532	
Information on the computer system is not secure or confidential	0	3	1	1	7	1	5	18	1.7642	0.0968	
I find the computerised system is faster and easier to use compared to handwritten notes	1	2	3	3	1	4	6	20	1.6704	0.1121	
Nurses											
I found the system difficult to use	8	17	7	1	4	1	1	39	-6.4026	0.0000	-
I find the system slow	4	6	4	2	15	4	5	40	-0.7674	0.4476	
Information on the computer system is not secure or confidential	6	9	4	3	9	6	3	40	-2.4867	0.0174	-
I find the computerised system is faster and easier to use compared to handwritten notes	0	0	4	0	5	18	13	40	5.2386	0.0000	+
Administrators											
I found the system difficult to use	11	18	0	0	1	0	0	30	-12.5423	0.0000	-
I find the system slow	5	4	3	3	10	5	0	30	-2.9752	0.0060	-
Information on the computer system is not secure or confidential	6	13	1	1	2	4	2	29	-3.8574	0.0006	-
I find the computerised system is faster and easier to use compared to handwritten notes	2	2	0	0	2	10	14	30	3.4187	0.0019	+

4.6 Presentation and discussion of results pertaining to Research Question 3: Organisational factors that influence the sustained successful adoption of healthcare systems

Respondents were asked about their perceptions relating to organisational factors that influenced the sustained successful adoption of healthcare systems. The results provided insight into the role of executive sponsorship, training, and user willingness to adopt new systems.

4.6.1 *Executive sponsorship*

Sixty-eight per cent of doctors, 100% of nurses and 82% of administrators were in agreement that management encouraged staff to use the computer systems (Table 19).

Table 19: Management support for system utilisation – all respondents

	Absolutely disagree	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Absolutely agree	Total	t-value	p-value	Significance
Management encourage staff to use the computer system											
Doctors	1	0	2	3	1	9	3	19	2.0852	0.0524	
Nurses	0	0	0	0	3	22	15	40	12.0441	0.0000	+
Administration Staff	1	3	0	1	4	9	10	28	2.8274	0.0089	+

Nurses and administrators identified this factor as statistically very important compared to expected results. It can be inferred that these two sample groups perceive management's role in endorsing the system as an important factor in ensuring successful user adoption. This was also demonstrated by Poon et al. (2004), who identified the role of management as critical for successful business process reengineering.

Management's involvement in supporting and encouraging staff to adopt the new HIS was identified as an important factor of success. Merely implementing a new system

and then providing training to hospital staff do not guarantee adoption. The hospital management team needs to encourage adoption continuously through change management programmes that actively endorse system usage, and include the HIS as an important factor that promotes professionalism with staff at the hospital.

4.6.2 *Training perceptions*

While doctors, nurses and administrators generally agreed that the training provided was sufficient, perceptions of the need for continuous training amongst doctors differed from those of nursing and administration staff (Table 20).

Table 20: Training perceptions – doctors, nurses and administrators

Doctors	Absolutely disagree	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Absolutely agree	Total	t-value	p-value	Significance
Insufficient training was provided when I first had to use the system	8	7	2	1	1	0	1	20	-4.1356	0.0006	-
There is no need for continuous training on the system as its easy and intuitive to use	0	2	4	0	6	3	5	20	1.7266	0.1014	
Nurses											
Insufficient training was provided when I first had to use the system	8	13	6	0	5	6	2	40	-4.1474	0.0002	-
There is no need for continuous training on the system as its easy and intuitive to use	9	17	6	0	4	3	0	39	-7.8623	0.0000	-
Administrators											
Insufficient training was provided when I first had to use the system	3	15	0	0	5	4	3	30	-2.7526	0.0103	-
There is no need for continuous training on the system as its easy and intuitive to use	5	15	1	3	1	3	2	30	-4.1744	0.0003	-

Seventy per cent of doctors agreed that further training on the system was not required, while not only did nurses and administrators disagree with the statement “There is no need for continuous training on the system as it’s easy and intuitive to use”, but it can be inferred that nurses and administrators require continuous training. The reasons as to why nurses and administrators would require continuous training but not doctors have not been explored in this study.

Some respondents were not satisfied with the training provided. One doctor at Sebokeng discussed how inadequate training indirectly impacted on daily workflow: “Sometimes we have a lot of patients and we are short staffed, we have to go to the computer and some of us are slow.” The nurses echoed some of the doctor’s sentiments that training was insufficient. Said one nurse at Sebokeng, “Because they [the nurses] don’t have basic training on how to use the computer, and proper training wasn’t given to begin with, when I arrived here I wasn’t given any training on how to use the computer except for the sister who showed me what to do when you order and that was it, and that was less than an hour.”

When asked what she would change with the system, another nurse replied, “Because the system is an unknown obviously it’s going to be difficult, so I say basically let’s start with training people, showing them the basics of what they are doing, see what is it, what is it for and then after that we can improve. We don’t know really what the system is about to begin with. I’m sure we could use it more for actually seeing patient records, but I didn’t know that. I only knew that you can use it for ordering patients’ medication and things like that.”

Another nurse further related the frustrations associated with the need for continuous training: “My computer at the moment is not functioning and I become frustrated because it’s better if you use the computer everyday so you don’t forget some of the things you learned since when we started using the computer when they were introduced to the hospital. It was our first encounter with a computer so we’re still learning.”

Intuitiveness of the system was not recognised as a significant factor, which was offset by the level of training provided. Barriers to adoption did not reside in an unwillingness to learn the new system, but were rather based on the need to adapt current workflow to accommodate interacting with IT. There was consensus amongst nurses and administrators about the need for continuous training. This may be as a result of the frequent reallocation of nurses to various areas within the hospital, but this would require further investigation to confirm.

4.6.3 *Willingness to adopt new systems*

Respondents indicated that they were eager to use the new system, were comfortable using a computer, and believed that they could not get by without having to learn a computer system. However, their responses indicating their willingness to use the computer; the impact of the system on morale; and their perceptions of how computers convey professionalism in the hospital environment varied (Table 21).

Table 21: Willingness to adopt new systems – doctors, nurses and administrators

Doctors	Absolutely disagree	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Absolutely agree	Total	t-value	p-value	Significance
Staff are eager to learn the new system	1	2	3	2	1	7	3	19	1.3622	0.1909	
Initially I did not want to move to the computer system	6	6	2	4	2	0	0	20	-4.8408	0.0001	-
Initially the hospital staff did not want to move to the computer system	0	2	1	3	5	2	0	13	-0.1996	0.8454	
As a result of the computer systems, I see improved moral in the workplace	2	2	0	6	4	1	2	17	-0.3466	0.7337	
As a result of the computer systems, my overall level of professionalism is increased	2	2	1	5	5	3	2	20	-0.0862	0.9322	
I have a fear of having to use a computer instead of paper	9	8	0	3	0	0	0	20	-7.0867	0.0000	-
I can get by without having to learn the computer system	5	7	1	0	2	1	0	16	-4.3597	0.0007	-
Nurses											
Staff are eager to learn the new system	3	0	3	1	10	14	9	40	1.9387	0.0600	
Initially I did not want to move to the computer system	7	15	2	0	4	6	6	40	-2.3553	0.0238	-
Initially the hospital staff did not want to move to the computer system	0	6	4	3	4	9	4	30	0.2093	0.8357	
As a result of the computer systems, I see improved moral in the workplace	2	1	6	5	7	14	4	39	0.5032	0.6178	
As a result of the computer systems, my overall level of professionalism is increased	0	2	5	1	8	13	11	40	3.4205	0.0015	+
I have a fear of having to use a computer instead of paper	14	20	1	1	3	1	0	40	-11.2977	0.0000	-
I can get by without having to learn the computer system	15	16	4	0	1	3	1	40	-7.2398	0.0000	-
Administrators											
Staff are eager to learn the new system	0	3	0	2	2	16	7	30	3.6346	0.0011	+
Initially I did not want to move to the computer system	5	17	0	1	0	3	2	28	-4.2944	0.0002	-
Initially the hospital staff did not want to move to the computer system	0	10	1	2	1	3	3	20	-1.6708	0.1121	
As a result of the computer systems, I see improved moral in the workplace	1	2	1	1	4	11	10	30	3.0791	0.0046	+
As a result of the computer systems, my overall level of professionalism is increased	2	0	0	2	4	10	12	30	2.8525	0.0081	+
I have a fear of having to use a computer instead of paper	10	19	0	1	0	0	0	30	-16.8528	0.0000	-
I can get by without having to learn the computer system	13	12	1	0	1	1	0	28	-9.2708	0.0000	-

Respondents were asked about their perceptions regarding the impact of the new computer system on morale in the workplace. While doctors did not see a correlation between hospital morale and the new computer system, 64% of nurses agreed that there was a positive relationship, and administrators perceived the relationship as

statistically significant. The results are likely a reflection of the degree to which the three sample groups depend on computer systems for their job functions. There were, however, varying opinions, with one of the doctors at IALCH expressing the opinion that the system “lifts morale because you are living in a very modern environment; access to patient information is quick, less work and saves time; there is improved communication between departments”.

As to the ability of systems to increase individual levels of professionalism, nurses and administrators identified this factor as being very important relative to other factors, while doctors did not find this statement of statistical importance. A nurse at Sebokeng Hospital commented: “I think the presence of the electronics in our work has improved confidence and morale, and it puts the hospital at a certain level; once you come in and see your information has been computerised you will quickly develop that confidence in the future.”

4.7 Summary of the results

Significant differences were observed among the three sample groups of doctors, nurses and administrators. There were also significant differences observed between the two hospitals, Sebokeng in Gauteng Province, and IALCH in KwaZulu-Natal Province.

Regarding reasons for investing in system automation, the efficiencies associated with computer systems were recognised as significant factors along with patient record confidentiality and security. Healthcare workers (including hospital administrators) believed the change management costs associated with the new system were justified.

The impact of automation in terms of cost and strategic value in public sector hospitals was felt to have yielded positive outcomes with regard to patient experience, hospital staff workflow enhancements, and overall morale in the workplace.

In consideration of sustained successful adoption of healthcare systems, management support, training and ease-of-use of the system were identified as common themes that were significant factors. The perception of need for continuous training differed from doctors to nurses and administrators, although the reasons for this were not investigated. The research also identified the role of technology in the reputation management of health services, a factor not identified in the literature review, whereby IT encouraged the perception of modernisation of facilities and increased levels of professionalism of nurses and administrators.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter is considered in three sections: conclusions from the study as relating to the research questions; recommendations; and suggestions for further research.

5.2 Conclusions of the study

The role of technology in public sector tertiary health facilities in South Africa is widely recognised as an important consideration in reducing costs and enabling improved access to health services. While Gauteng and KwaZulu-Natal have embarked on a path of implementing HIS, these two provinces are at different stages of their implementation life cycles, with various components in design and/or operational phase. The challenges of implementing system automation are as a much a function of technology as they are of understanding the impact on business processes within the hospital ecosystem. While HIMSS recommends a staged-progression approach to implementation that takes into account infrastructure, connectivity, people and culture (HIMSS Analytics, 2010), results from the research suggest that the benefits of the system are only fully understood and appreciated once all components are implemented and holistic change management support has been applied. Doctors, nurses and administrators were surveyed to understand differences in perceptions about what benefits the HIS offers, and how the system is used. The results provide some insight into the reasons for investing in automated systems; the outcomes experienced as a result of automation; and the organisational factors that are critical to the successful adoption of IT systems.

Given the challenges facing the public healthcare sector relating to resource allocation and utilisation, access to healthcare services, and efficient management of patient encounters at tertiary public health facilities, the research has demonstrated the impact of IT in these regards. Automation of systems and processes complements the evolution of patient treatment protocols, medical record

management, and back office administrative functions while enabling time and cost savings within the healthcare system. The South African health system has the opportunity to alleviate some of its resource constraints and reduce transactional costs by investing in technology to help better co-ordinate care and move all functions of public health management into the service economy.

5.2.1 *Conclusions relating to Research Question 1: Perceived reasons that influence the investment of automated systems within the hospital*

Hospital staff conditioned to working in non-automated environments was accustomed to the inefficiencies of manual paper-driven processes. There was general consensus amongst doctors, nurses and administrators that system automation is a required investment, but the direct impact on workflow and job function efficiencies was only understood once staff had migrated to the automated system. All respondents believed that the hospital would ultimately save costs as a result of automated processes, but the mechanisms for saving costs within the hospital were poorly understood. All respondents, however, supported the investment in IT systems, and indicated an overall willingness to learn the new systems and a desire to move off manual processes. Information security and confidentiality was one area that was identified as a function that could be more effectively enforced through IT systems. South Africa is ready to invest in IT in healthcare, but the business case for investment is not clear. In addition, concerns around patient data security are not being adequately addressed.

5.2.2 *Conclusions relating to Research Question 2: Outcomes experienced from automating systems in hospital departments*

Results from this section of the research provided some interesting insights into the perception differences between doctors, nurses and administrators. The ability of the system to impact metrics such as patient waiting times, patient satisfaction and ease of use (compared to paper processes) directly was more positively perceived by nurses and administrators, who are more involved in administrative tasks as part of

patient care/handling. There is little doubt from both the literature review and the research conducted that the management of patient records is made more efficient via automated systems as compared to paper processes. Interestingly, the role of the HIS has evolved from being a support function to providing a capability that has the potential to enhance the reputation of the facility to both patients and staff alike. The South African public health sector is faced with resource challenges that can be assisted by investment in HIS, along with the accompanying perception of modernisation that IT projects bring.

5.2.3 *Conclusions relating to Research Question 3: Organisational factors that influence the sustained successful adoption of healthcare systems*

The role of management to champion the use of IT systems is critical to the long-term adoption by end users. The need for continuous training was identified by nurses and administrators, suggesting that there is the potential for further productivity improvements to be gained (through additional training programmes). Finally, respondents were generally keen to adapt to the new system and perceived the HIS as a component of their overall professionalism. The success of IT projects depends not only on the IT department, but also on the broader management team as a whole. In South Africa, hospital staff comprises a diverse user base, with varying workflow perceptions, and the change management function must be fully considered to ensure successful system implementation and user adoption.

5.3 Recommendations

The justification by provincial and/or national health authorities for investment in IT systems should be an inclusive process that incorporates the views of the various end-user groups. This would be strengthened by conducting pre-emptive workshops with hospital staff, explaining how new systems will translate into cost savings, improved efficiencies and enhanced security for patient information. Another consideration for HIS investment is the reputational consequences for the hospital.

Staff perceives a higher level of morale in the workplace, while patients perceive IT as a key component of the modernisation of hospital facilities.

Hospital management should look to implement regular review sessions as to the success of HIS implementation projects. Otieno et al.'s (2008) model for comparative analysis of EMR implementations provides a framework for assessing such projects that will enable healthcare authorities to better negotiate service level agreements and evaluate HIS initiatives. In line with Menachemi et al.'s (2006) research, incentives should be installed to ensure users not only adopt, but champion the use of new systems to the entire end-user base.

End-user adoption or system usage should be included as part of management's project success metrics. A member of the management team should be appointed to promote system usage and this metric should be monitored on a weekly basis to ensure timeous response to potential issues that may result in users reverting to paper-based processes.

As per Poon et al.'s (2004) investigation into overcoming barriers to adoption, four strategies are recommended to encourage end-user take-up:

1. Ensure strong leadership support within management.
2. Identify champions for each user group (i.e. doctors, nurses and administrators).
3. Establish a workflow review committee to address business process concerns which may arise from users being forced to adapt workflow in accordance with the technology.
4. Leverage hospital staff to provide feedback on a regular basis to improve design concerns.

Regular refresher training should be provided to the various end-user groups and hospital departments, particularly those departments that experience a high turnover of staff throughout the year. From an IT perspective, the HIS vendor should be required to ensure that the software design is intuitive and easy to use to reduce training time.

5.4 Suggestions for further research

Further research is suggested to support the business case for IT investment and to prioritise HIS implementation projects as a national priority for the South African Department of Health. Similar to Chen et al.'s (2009) research at Kaiser Permanente, further research to evaluate the impact of EHRs on patient contact with the public healthcare system would highlight the potential for technology to reduce the costs associated with patient visits in outpatient and other clinic settings. In addition, research could be carried out to:

- Quantify the benefits in terms of patient safety via the reduction of medical errors;
- Demonstrate ROI in terms of reduced medication expenditure, improved charge capture and reduced billing errors;
- Determine the impact (cost and benefit) of a defined change management programme that accompanies HIS implementation;
- Evaluate the role of technology in determining job satisfaction within hospital staff populations;
- Evaluate the role of technology in contributing towards hospital or health services reputation management;
- Determine the impact of system usability and performance on end-user adoption;
- Determine the role of IT in human factor engineering projects within the healthcare domain; and
- Explore the value of providing continuous training to hospital end-user groups for HIS implementation.

6 REFERENCES

Amarasingham, R., Plantinga, L., Diener-West, M., Gaskin, D. J. and Powe, N. R. (2009) Clinical information technologies and inpatient outcomes, *Archives of Internal Medicine,* 169(2), pp. 108-114.

AME International (2011a) *AME Projects in South Africa: Gauteng,* (last accessed 28 April, 2011), from http://www.ame-international.com/index.php?tabid=93.

AME International (2011b) *AME Projects in South Africa: IALCH,* (last accessed 28 April, 2011), from http://www.ame-international.com/index.php?tabid=92.

Ammenwerth, E. and Spotl, H. P. (2009) The time needed for clinical documentation versus direct patient care - A work-sampling analysis of physicians' activities, *Methods of Information in Medicine,* 48(1), pp. 84-91.

Anderson, G. F., Frogner, B. K., Johns, R. A. and Reinhardt, U. E. (2006) Health care spending and use of information technology in OECD countries, *Health Affairs,* 25(3), p. 819.

Barlow, S., Johnson, J. and Steck, J. (2004) The economic effect of implementing an EMR in an outpatient clinical setting, *Journal of Healthcare Information Management,* 18(1), pp. 46-51.

Benanti, J. F. (1988) The physician as a customer, *Health Progress,* 69(3), pp. 62-65.

Borzekowski, R. (2009) Measuring the cost impact of hospital information systems: 1987-1994, *Journal of Health Economics,* 28(5), pp. 938-949.

Boutsioli, Z. (2009) Measuring unexpected hospital demand: The application of a univariate model to public hospitals in Greece, *Hospital Topics,* 87(4), pp. 14-21.

Broonberg, J. (1990) The impact of the fee-for-service reimbursement system on the utilization of health services, *SAMJ: South African Medical Journal,* 78, pp. 130-132.

Buntin, M. B., Jain, S. H. and Blumenthal, D. (2010) Patient Protection and Affordable Care Act, *Health Affairs,* 29(6), pp. 1214-1219.

Byrne, C. M., Mercincavage, L. M., Pan, E. C., Vincent, A. G., Johnston, D. S. and Middleton, B. (2010) The value from investments in health information technology at the US Department of Veterans Affairs, *Health Affairs,* 29(4), pp. 629-638.

Calder, B. J., Phillips, L. W. and Tybout, A. M. (1982) The concept of external validity, *Journal of Consumer Research,* 9(3), pp. 240-244.

Capgemini (2004) *Enterprise workflow benefits guide: Key findings,* (last accessed 21 August, 2010), from www.localegovnp.org.uk/benefits.

Carmichael, B. D. (1994) Business process reengineering: A remedy for health care, *Healthcare Management Forum,* 7(4), pp. 44-50.

Chen, C., Garrido, T., Chock, D., Okawa, G. and Liang, L. (2009) The Kaiser Permanente electronic health record: Transforming and streamlining modalities of care, *Health Affairs,* 28(2), pp. 323-333.

Collen, M. F. (1991) A brief historical overview of hospital information system (HIS) evolution in the United States, *International Journal of Bio-Medical Computing,* 29(3-4), pp. 169-189.

Creswell, J. W. (2003) *Research design: Quantitative, qualitative, and mixed methods approaches,* 2nd ed., Sage Publications, Thousand Oaks, California.

Devine, E. B., Hollingworth, W., Hansen, R. N., Lawless, N. M., Wilson-Norton, J. L., Martin, D. P., Blough, D. K. and Sullivan, S. D. (2010) Electronic prescribing at the point of care: A time-motion study in the primary care setting, *Health Services Research,* 45(1), pp. 152-171.

Doherty, J. and McLeod, H. (2003) *Medical Schemes*, Durban.

eHealth Initiative (2010) *National Progress Report on eHealth 2010*, eHealth Initiative.

Fenn, J., Raskino, M. and Gammage, B. (2009) *Gartner's Hype Cycle Special Report for 2009*, Stamford, Connecticut.

Funnah, A. K. and Sibanda, O. (2008) Towards a selective awarding of punitive damages awards in South Africa? A comment on Fose v The Minister of Safety and Security, *Codicillus,* 48(2), pp. 36-49.

Furukawa, M. F., Raghu, T. S. and Shao, B. B. M. (2010) Electronic medical records, nurse staffing, and nurse-sensitive patient outcomes: Evidence from California hospitals, 1998-2007, *Health Services Research,* 45(4), pp. 941-962.

Garrib, A., Stoops, N., McKenzie, A., Dlamini, L., Govender, T., Rohde, J. and Herbst, K. (2008) An evaluation of the District Health Information System in rural South Africa, *South African Medical Journal,* 98(7), pp. 549-552.

Goldzweig, C. L., Towfigh, A., Maglione, M. and Shekelle, P. G. (2009) Costs and benefits of health information technology: New trends from the literature, *Health Affairs,* 28(2), pp. 282-293.

Halamka, J., Aranow, M., Ascenzo, C., Bates, D., Berry, K., Debor, G., Fefferman, J., Glaser, J., Heinold, J. and Stanley, J. (2006) E-prescribing collaboration in Massachusetts: Early experiences from regional prescribing projects, *Journal of the American Medical Informatics Association,* 13(3), pp. 239-244.

Harrison, D. (2010) *An overview of health and health care in South Africa 1994–2010: Priorities, progress and prospects for new gains*, Muldersdrift.

Health Systems Trust (2011) *Health Statistics,* (last accessed 3 May, 2011), from http://www.hst.org.za/healthstats/256/data/geo.

Hendy, J., Reeves, B. C., Fulop, N., Hutchings, A. and Masseria, C. (2005) Challenges to implementing the national programme for information technology (NPfIT): A qualitative study, *BMJ: British Medical Journal,* 331(7512), p. 331.

Hillestad, R., Bigelow, J., Bower, A., Girosi, F., Meili, R., Scoville, R. and Taylor, R. (2005) Can electronic medical record systems transform health care? Potential health benefits, savings, and costs, *Health Affairs,* 24(5), pp. 1103-1117.

HIMSS Analytics (2010) *EMR Adoption Model,* (last accessed September 29, 2010), from http://www.himssanalytics.org/hc_providers/emr_adoption.asp.

Houweling, T., Tripathy, P., Nair, N., Costello, A. and Prost, A. (2010) Cause-of-death data to support MDG 4 progress, *The Lancet,* 376(9743), pp. 770-771.

Hudleston, S. (2010) *Health MEC asks for probe into ID contract,* (last accessed 28 April 2011), from http://www.businessday.co.za/articles/Content.aspx?id=117088.

Hung, S.-Y., Hung, W.-H., Tsai, C.-A. and Jiang, S.-C. (2009) Critical factors of hospital adoption on CRM system: Organizational and information system perspectives, *Decision Support Systems,* 48(4), pp. 592-603.

IALCH (2008) *Annual Report*, Department of Health KwaZulu-Natal, Durban.

Jaspers, M. W. M., Peute, L. W. P., Lauteslager, A. and Bakker, P. (2008) Pre-post evaluation of physicians' satisfaction with a redesigned electronic medical record system, *Studies in Health Technology and Informatics,* 136, pp. 303-308.

Kasiri, N. and Sharda, R. (2009) Electronic health record systems investment valuation: A system dynamics approach, *AMCIS 2009 Proceedings*, pp. 1-10.

Kirk, J. and Miller, M. L. (1986) *Reliability and validity in qualitative research*, Sage Publications Ltd, London.

Kohli, R., Piontek, F., Ellington, T., VanOsdol, T., Shepard, M. and Brazel, G. (2001) Managing customer relationships through E-business decision support applications: A case of hospital-physician collaboration, *Decision Support Systems,* 32(2), pp. 171-187.

Krosnick, J. A. (1999) Survey research, *Annual Review of Psychology,* 50(1), pp. 537-567.

Leape, L. L., Brennan, T. A., Laird, N., Lawthers, A. G., Localio, A. R., Barnes, B. A., Hebert, L., Newhouse, J. P., Weiler, P. C. and Hiatt, H. (1991) The nature of adverse events in hospitalized patients, *New England Journal of Medicine,* 324(6), pp. 377-384.

Leedy, P. D. and Ormrod, J. E. (2009) *Practical research: Planning and design,* Ninth ed., Merrill, Upper Saddle River, New Jersey.

Littlejohns, P., Wyatt, J. C. and Garvican, L. (2003) Evaluating computerised health information systems: Hard lessons still to be learnt, *BMJ: British Medical Journal,* 326(7394), pp. 860-863.

Longhurst, C. A., Parast, L., Sandborg, C. I., Widen, E., Sullivan, J., Hahn, J. S., Dawes, C. G. and Sharek, P. J. (2010) Decrease in hospital-wide mortality rate after implementation of a commercially sold computerized physician order entry system, *Pediatrics,* 126(1), pp. 14-21.

Matisonn, S. (2000) *Medical savings accounts in South Africa,* (last accessed 8 May, 2011), from http://www.ncpa.org/pub/st234.

Matshidze, P. and Hanmer, L. (2007) Health information systems in the private health sector, *South African Health Review*, pp. 89-102.

McCullough, J. S., Casey, M., Moscovice, I. and Prasad, S. (2010) The effect of health information technology on quality in US hospitals, *Health Affairs,* 29(4), pp. 647-654.

Means, C. (2009) *South African hospitals, clinics to get hospital information systems,* (last accessed 28 April, 2011), from http://www.healthcareitnews.com/news/south-african-hospitals-clinics-get-hospital-information-systems.

Menachemi, N. and Brooks, R. (2006) Reviewing the benefits and costs of Electronic Health Records and associated patient safety technologies, *Journal of Medical Systems,* 30(3), pp. 159-168.

Mildon, J. and Cohen, T. (2001) Drivers in the electronic medical records market: Seventeen reasons why physician practices should make the leap to EMRs, *Health Management Technology,* 22(5), pp. 14-18.

Morse, J. M., Barrett, M., Mayan, M., Olson, K. and Spiers, J. (2002) Verification strategies for establishing reliability and validity in qualitative research, *International Journal of Qualitative Methods,* 1(2), pp. 1-19.

National Treasury South Africa (2001) *Inkosi Albert Luthuli Hospital PPP reaches financial closure,* (last accessed 28 April 2011), from http://www.ppp.gov.za/Documents/QuarterlyPubs/dec_2001.pdf.

Ormond, C. and Portland, M. (2005) Discussion Paper-Computer Physician Order Entry (CPOE), *Institute for Health Policy, Muskie School of Public Service, Portland, Maine*.

Otieno, G. O., Hinako, T., Motohiro, A., Daisuke, K. and Keiko, N. (2008) Measuring effectiveness of electronic medical records systems: Towards building a composite index for benchmarking hospitals, *International Journal of Medical Informatics,* 77(10), pp. 657-669.

Payne, A. and Frow, P. (2005) A strategic framework for customer relationship management, *Journal of Marketing,* 69(4), pp. 167-176.

Pinsonneault, A. and Kraemer, K. L. (1993) Survey research methodology in management information systems: An assessment, *Journal of Management Information Systems,* 10(2), pp. 75-105.

Poissant, L., Pereira, J., Tamblyn, R. and Kawasumi, Y. (2005) The impact of electronic health records on time efficiency of physicians and nurses: A systematic review, *Journal of the American Medical Informatics Association,* 12(5), pp. 505-516.

Poon, E. G., Blumenthal, D., Jaggi, T., Honour, M. M., Bates, D. W. and Kaushal, R. (2004) Overcoming barriers to adopting and implementing computerized physician order entry systems in U.S. hospitals, *Health Affairs,* 23(4), pp. 184-190.

Preston, S. H. (2007) The changing relation between mortality and level of economic development, *International Journal of Epidemiology,* 36(3), pp. 484-490.

Ruane, J. M. (2004) *Essentials of research methods: A guide to social research*, Wiley-Blackwell, Oxford.

Runyon, B. (2009) *The Hype Cycle for Healthcare Provider Technologies and Standards, 2009*, Gartner, Stamford, Connecticut.

Ruxwana, N. L., Herselman, M. E. and Conradie, D. P. (2010) ICT applications as e-health solutions in rural healthcare in the Eastern Cape Province of South Africa, *Health Information Management Journal,* 39(1), pp. 17-29.

Ruxwana, N. L., Herselman, M. E., Pottas, D. and Ouma, S. (2010) Advocating a quality assurance model for the implementation of e-health solutions in rural South Africa, *Health Information Management Journal,* 39(1), pp. 36-40.

SA Nursing Council (2011) *Age Statistics 2010,* (last accessed 3 May 2011), from http://www.sanc.co.za/stats/stat2010/Age%20stats%202010_files/frame.htm.

Seokoma, B. and Mukendi, A. (2010) *SA Healthcare System Failing,* (Last updated on 11 October 2010), accessed 6 June 2011, from http://www.ngopulse.org/article/sa-healthcare-system-failing.

Shona, K. (2008) *Healthcare Research Brief,* (last accessed September 2008), from http://us-cdn.creamermedia.co.za/assets/articles/attachments/17471_2008healthcarebrief.pdf.

Simon, S. R., Kaushal, R., Cleary, P. D., Jenter, C. A., Volk, L. A., Poon, E. G., Orav, E. J., Lo, H. G., Williams, D. H. and Bates, D. W. (2007) Correlates of electronic health record adoption in office practices: A statewide survey, *Journal of the American Medical Informatics Association,* 14(1), pp. 110-117.

Smith, M. J., Solanki, G. C., Lalloo, R., Myburgh, N. G. and Cornell, J. E. (2008) Support for Social Health Insurance in South Africa, *Journal of Health Management,* 10(1), pp. 1-8.

Song, X., Hwong, B., Matos, G., Rudorfer, A., Nelson, C., Han, M. and Girenkov, A. (2006) Understanding requirements for computer-aided healthcare workflows: Experiences and challenges, *28th International Conference on Software Engineering*, pp. 930-933, Shanghai, China.

South Africa (1998) Medical Schemes Act No. 131 of 1998, *Government Gazette No. 6652*, Government Printer, Pretoria.

South Africa National Department of Health (2002) National Patients' Rights Charter, Vol. 13, pp. 1-9, Pretoria.

South Africa National Department of Health (2008) *A policy on quality in health care for South Africa,* (last accessed 4 April 2007), from http://www.doh.gov.za/docs/.

Stacey, A. (2005) The reliability and validity of the item means and standard deviations of ordinal level response data, *Management Dynamics,* 14(3), pp. 2-24.

Steinbrook, R. (2009) Health care and the American Recovery and Reinvestment Act, *New England Journal of Medicine,* 360(11), pp. 1057-1060.

Sutherland, J. and van den Heuvel, W. J. (2006) Towards an intelligent hospital environment: Adaptive workflow in the or of the future, *Proceedings of the 39th International Conference on System Sciences*, pp. 1-10, Hawaii.

Tarwa, C. and De Villiers, F. P. R. (2007) The use of the road to health card in monitoring child health, *South African Family Practice,* 49(1), pp. 15-15d.

Truffer, C. J., Keehan, S., Smith, S., Cylus, J., Sisko, A., Poisal, J. A., Lizonitz, J. and Clemens, M. K. (2010) Health spending projections through 2019: The recession's impact continues, *Health Affairs,* 29(3), p. 522.

United Kingdom Department of Health (2002) Delivering 21st century IT support for the NHS: National strategic programme, p. 31, Department of Health, London.

Van Lerberghe, W. (2008) *World Health Report 2008: Primary Health Care: Now more than ever*, World Health Organization, Geneva.

Wang, S. J., Middleton, B., Prosser, L. A., Bardon, C. G., Spurr, C. D., Carchidi, P. J., Kittler, A. F., Goldszer, R. C., Fairchild, D. G. and Sussman, A. J. (2003) A cost-benefit analysis of electronic medical records in primary care, *The American Journal of Medicine,* 114(5), pp. 397-403.

Wears, R. L. and Berg, M. (2005) Computer technology and clinical work: Still waiting for Godot, *JAMA: Journal of the American Medical Association,* 293, pp. 1261-1263.

Webster, P. C. (2011) Experts call for health infoway "watchdog", *Canadian Medical Association Journal,* 183(3), p. 298.

Weiner, J. P., Famadas, J. C., Waters, H. R. and Gikic, D. (2008) Managed care and private health insurance in a global context, *Journal of Health Politics, Policy and Law,* 33(6), pp. 1107-1131.

Westbrook, J. I., Ampt, A., Kearney, L. and Rob, M. I. (2008) All in a day's work: An observational study to quantify how and with whom doctors on hospital wards spend their time, *Medical Journal of Australia,* 188(9), pp. 506-509.

Williams, F. and Boren, S. A. (2008) The role of the electronic medical record (EMR) in care delivery development in developing countries: A systematic review, *Informatics in Primary Care,* 16(2), pp. 139-145.

Wilson, J. F. (2009) Making electronic health records meaningful, *Annals of Internal Medicine,* 151(4), pp. 293-296.

Winter, A., Haux, R., Ammenwerth, E., Brigl, B., Hellrung, N. and Jahn, F. (2011) Health Information Systems, *Health Information Systems*, pp. 33-42.

Worldbank (2011) *World Development Indicators (WDI) and Global Development Finance (GDF),* (Last updated on 14 April 2011), accessed 30 May 2011, from http://databank.worldbank.org/ddp/home.do.

Zheng, K., Haftel, H. M., Hirschl, R. B., O'Reilly, M. and Hanauer, D. A. (2010) Quantifying the impact of health IT implementations on clinical workflow: A new methodological perspective, *Journal of the American Medical Informatics Association,* 17, pp. 454-461.

7 APPENDIX A – RESEARCH INSTRUMENT





Letter to Respondents

Dear Participant,

I am a Master of Business Administration student at the University of the Witwatersrand, Wits Business School, currently conducting research on the value of information systems to national healthcare by identifying the reasons for investing in system automation, the impact of automation and the organisational influence on successful systems implementation in South African public sector health facilities.

Permission has been obtained from hospital management to interview doctors, nurses and hospital administration staff for the purpose of this research. Your participation is greatly appreciated and requires 25 minutes of your time to answer the questions included in the research survey.

Only hospital staff who have experience working with computer systems, be it for administration duties or managing patients, are elibigle to participate. All information provided during this study will be considered confidential and will be destroyed once the research is complete.

Should you have any queries, please feel free to contact either myself or my supervisor, Professor John Luiz.

Thank you in advance for your participation.

Sincerely,

Dr Gregory Cline

Gregory Cline contact number: + 27 11 805 4530

John Luiz contact number: +27 11 717 3578

Section 1

The purpose of this section is to capture respondent profile details.

Health Systems Research Project Questionnaire

Respondent details

Date: _____

Age: _____

Occupation: _____

Gender: M / F

Hospital: _____

Hospital department where most frequently working: _____

Number of years working at this hospital: _____ years

Interviewed by: _____

Section 2

Please answer the following questions by indicating which answer most accurately represents the extent to which you agree or disagree with the statement on the left. There can only be one answer per statement.

		Absolutely disagree	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	Absolutely Agree		I do not know
	Necessitate investment: Before the computer system was installed...									
1	I spent more than 20% of my time doing administration tasks									
2	Paper process were inefficient at this facility									
3	I frequently (more than 80% of the time) needed to enter the same information on more than one chart for every patient I treat									
4	Manual processes prevented me from spending time with the patients									
	Impact of automation: As a result of the computer system…									
5	Patient waiting times for admissions have decreased									
6	Patient waiting times to be seen by a doctor or nurse are decreased									
7	Patient overall satisfaction with care received is higher									
8	I have superior access to patient record information when compared to paper based									
9	I am treating more patients per shift in the outpatient/ward/where I work									
10	There is increased satisfaction with the overall working conditions in the hospital									
11	The hospital has enjoyed improved service delivery									
12	There is a reduction of duplication of information which means cleaner patient records and less time spent entering information									
13	Patient information is more disorganised with the computer system compared to the paper system									
14	Fewer records are lost and record management has improved									
15	I find it easier to work with electronic system than with paper records									
16	Quality of care for patients has improved									
17	There is improved communication between healthcare professionals									
18	The referral process between hospital departments is improved									
19	I believe patient discharge times from hospital is quicker									
20	I have confidence that information is more secure and confidential in electronic compared to paper									
21	I believe the computer systems will save the hospital money									
22	I believe the cost of learning new computer systems is not worth the benefits									
23	I believe that the investment in computer systems should have been allocated									
	Organisational Influence									
24	Management encourage staff to use the computer system									
25	Staff are eager to learn the new system									
26	Initially I did not want to move to the computer system									
27	Initially the hospital staff did not want to move to the computer system									
28	As a result of the computer systems, I see improved morale in the workplace									
29	As a result of the computer systems, my overall level of professionalism is increased									
	Barriers									
30	Insufficient training was provided when I first had to use the system									
31	There is no need for continuous training on the system as its easy and intuitive to use									
32	I have a fear of having to use a computer instead of paper									
33	I found the system difficult to use									
34	I find the system slow									
35	Information on the computer system is not secure or confidential									
36	I prefer using a paper based system									
37	I can get by without having to learn the computer system									
38	The time taken to learn how to use the system must be costing the hospital a lot of money									
	Overall									
39	I would like to move to a paperless system as soon as possible									
40	I find the computerised system is faster and easier to use compared to handwritten notes									
41	I believe the hospital will save money as a result of moving to the new system									

Section 3

Please provide an answer to each of the interview questions below.

1. Tell me more about your experiences with the system (both positive and negative).
2. Has the system alleviated or worsened time spent on administration tasks? Please explain.
3. Has the system improved patient care and how?
4. Do you see cost savings in the system as a result? Please explain. For example, can you process more patients per day now?
5. Would you recommend other hospitals to do likewise (i.e. implement automated systems)?
6. Given your experience, what would you change about the system?
7. Do you have any other comments?

8 APPENDIX B – DISTRIBUTION-FITTING ANALYSIS

8.1 All respondents (IALCH and Sebokeng Hospital)

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Observed																				
Absolutely disagree	7	11	12	13	3	2	2	2	2	1	2	5	24	2	2	1	3	5	1	5
Strongly disagree	11	13	5	11	8	5	2	2	8	5	4	4	39	6	3	4	4	4	2	8
Somewhat disagree	8	8	5	7	5	4	2	1	4	8	3	7	11	2	4	6	5	4	7	9
Neither agree nor disagree	8	7	11	14	8	7	9	2	11	6	6	4	5	4	6	10	6	10	12	6
Somewhat agree	11	7	11	5	9	19	21	13	14	18	15	18	3	13	13	17	16	13	11	6
Strongly agree	27	23	30	20	31	32	33	35	23	30	42	37	4	34	38	35	35	33	38	36
Absolutely agree	14	11	9	13	16	9	10	32	19	20	14	14	4	27	24	15	18	20	13	19
Total	**86**	**80**	**83**	**83**	**80**	**78**	**79**	**87**	**81**	**88**	**86**	**89**	**90**	**88**	**90**	**88**	**87**	**89**	**84**	**89**
Solver parameters																				
μ	0.1558964	-0.00769	0.0227715	-0.0594206	0.3487044	0.2679605	0.2903202	0.7062233	0.3563332	0.417938	0.4093916	0.2768923	-0.6822131	0.5918155	0.5436204	0.3715593	0.4007735	0.3694106	0.3511597	0.3396597
σ	0.8673991	0.9636737	0.8900596	0.9694859	0.7803022	0.6240089	0.6095675	0.7866679	0.7721633	0.6866843	0.6524047	0.7539902	0.7937745	0.7866524	0.7273314	0.6206248	0.7383375	0.828518	0.6055241	0.8439988
Expected																				
Absolutely disagree	6.0044277	9.8449452	8.1781054	11.269252	2.3550695	0.9967266	0.7982286	0.865487	2.2273555	1.0827992	0.8019035	2.799701	25.948894	1.2778735	0.9788089	0.6981131	1.6849119	3.1686266	0.6195342	3.67547
Strongly disagree	13.840483	15.034283	15.47701	16.216483	9.1082076	7.9308752	7.2863582	4.8182792	8.996894	7.2597022	6.5701572	11.157672	27.976092	6.2861606	6.1389076	6.7211693	8.3813299	10.344039	6.454172	11.000807
Somewhat disagree	6.4694545	6.0900632	6.6503123	6.4081726	5.2315662	5.7483751	5.5826934	3.3671147	5.2538884	5.1479748	5.0025985	6.3723107	8.3550159	4.1178968	4.3619133	5.3738327	5.3158617	5.6328661	5.2792759	5.7877307
Neither agree nor disagree	7.7336004	6.8674322	7.6363238	7.140281	6.8588764	8.128233	8.1007906	4.9506812	6.9368961	7.3916024	7.3883755	8.2638999	7.7924033	5.8301468	6.3634268	8.0514977	7.2827547	7.2566249	7.9567078	7.3413095
Somewhat agree	12.680044	10.60762	11.932752	10.868022	12.433438	15.316929	15.666011	10.455826	12.662891	14.63345	14.954485	14.656032	9.1247052	11.713596	13.061796	16.341386	13.811871	13.01237	16.136056	12.943882
Strongly agree	24.484457	19.278547	21.350491	19.265966	27.181177	29.897887	31.294656	30.752816	27.847409	34.195601	34.754028	30.032636	9.155649	31.297011	34.282991	36.320983	31.591008	28.962732	34.894013	28.214935
Absolutely agree	14.78753	12.27711	11.775006	11.831825	16.831666	9.9809738	10.271262	31.789796	17.074666	18.28887	16.528453	15.717748	1.8472412	27.477315	24.812157	14.493018	18.932263	20.622742	12.660241	20.035866
χ2 contributions																				
Absolutely disagree	0.1650722	0.1355164	1.7860956	0.2658109	0.1766127	1.0098631	1.8093241	1.4871621	0.0232071	0.0063315	1.7900345	1.7292259	0.1463718	0.4080737	1.0654084	0.1305458	1.0264374	1.0584802	0.2336501	0.4773212
Strongly disagree	0.5829523	0.2752581	7.0923087	1.6780268	0.1348371	1.0831124	3.8353292	1.6484511	0.1104601	0.7033696	1.0054109	4.591663	4.3439434	0.0130267	1.6049665	1.1017074	2.2903348	3.8908232	3.0739261	0.8185622
Somewhat disagree	0.3620969	0.5989853	0.4095342	0.0546583	0.0102499	0.5317704	2.2991934	1.6641048	0.2992519	1.580048	0.8016635	0.061829	0.8373342	1.0892664	0.0300284	0.072962	0.0187681	0.4733384	0.5608518	1.7828532
Neither agree nor disagree	0.0091764	0.0025591	1.4816446	6.5901811	0.1898508	0.1566035	0.0998146	1.7586508	2.3798559	0.2619942	0.2608945	2.2000318	1.0006561	0.5745031	0.020756	0.4715472	0.2259392	1.037136	2.0546452	0.2450668
Somewhat agree	0.2225976	1.2269408	0.0729107	3.1683485	0.9481284	0.8856219	1.8161253	0.6190637	0.1411889	0.7745033	0.0001385	0.7629706	4.1110384	0.1412748	0.0002924	0.0265444	0.3466517	1.176E-05	1.6347906	3.7251184
Strongly agree	0.2584479	0.7183744	3.5040883	0.0279668	0.5365261	0.1477991	0.0929296	0.5865665	0.8437902	0.5147758	1.5107345	1.6163803	2.903204	0.2334455	0.4030032	0.0480437	0.367865	0.562776	0.2764702	2.148055
Absolutely agree	0.041941	0.1328496	0.6539835	0.1153358	0.0410933	0.0964144	0.007164	0.0013899	0.2171001	0.1600955	0.386792	0.1877278	3.3604514	0.0082916	0.0265837	0.0177348	0.0459065	0.0188048	0.009118	0.0535548
326.906701	1.6422844	3.0904837	15.000566	11.900328	2.0372983	3.9111847	9.9598802	7.7653889	4.0148541	4.0011179	5.7556684	11.149828	16.702999	2.4678818	3.1510385	1.8690853	4.3219028	7.0413704	7.843452	9.2505315
Solver thresholds	Standardised thresholds																			
τ_1	-1.1253744	τ_1	-1.2921343																	
τ_2	-0.4828246	τ_2	-0.5957626																	
τ_3	-0.2841134	τ_3	-0.3804067																	
τ_4	-0.0730595	τ_4	-0.1516743																	
τ_5	0.2503341	τ_5	0.1988077																	
τ_6	0.9768856	τ_6	0.9862174																	
Standardised parameters																				
μ	0.0965	-0.0808	-0.0478	-0.1369	0.3054	0.2179	0.2421	0.6929	0.3137	0.3805	0.3712	0.2276	-0.8119	0.5689	0.5167	0.3302	0.3618	0.3279	0.3081	0.2956
σ	0.9401	1.0444	0.9646	1.0507	0.8457	0.6763	0.6606	0.8526	0.8368	0.7442	0.7071	0.8171	0.8603	0.8525	0.7883	0.6726	0.8002	0.8979	0.6562	0.9147
t-value	0.9516	-0.6922	-0.4516	-1.1870	3.2303	2.8458	3.2578	7.5804	3.3736	4.7957	4.8685	2.6275	-8.9530	6.2597	6.2181	4.6051	4.2179	3.4447	4.3026	3.0489
p-value	0.3440	0.4908	0.6528	0.2387	0.0018	0.0057	0.0017	0.0000	0.0012	0.0000	0.0000	0.0102	0.0000	0.0000	0.0000	0.0000	0.0001	0.0009	0.0000	0.0030
Significance					+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+
Chi-test p-value	0.0002																			
Significance level	5%																			

Question	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Observed																					
Absolutely disagree	2	20	23	2	4	18	0	5	4	19	14	33	23	10	12	30	33	9	6	3	2
Strongly disagree	5	35	39	3	5	38	18	5	4	35	34	47	45	13	25	37	35	15	3	4	1
Somewhat disagree	4	9	7	2	6	4	6	7	6	8	11	1	9	10	6	8	6	5	1	7	3
Neither agree nor disagree	11	5	7	4	5	5	8	12	8	1	3	5	2	7	5	6	0	10	5	3	7
Somewhat agree	16	7	6	8	13	6	10	15	17	11	11	3	8	30	18	4	4	14	8	8	11
Strongly agree	25	8	3	40	37	9	14	26	26	10	9	1	1	12	11	2	5	11	33	32	31
Absolutely agree	12	2	2	28	19	8	7	16	25	6	7	0	1	8	10	3	1	10	34	33	24
Total	**75**	**86**	**87**	**87**	**89**	**88**	**63**	**86**	**90**	**90**	**89**	**90**	**89**	**90**	**87**	**90**	**84**	**74**	**90**	**90**	**79**
Solver parameters																					
μ	0.2762543	-0.6458373	-0.7275746	0.6608155	0.4020597	-0.5052796	-0.0413846	0.2371364	0.4383688	-0.5060759	-0.3980014	-0.954394	-0.7565493	-0.0822247	-0.2081712	-0.8157242	-0.9276835	-0.0947159	0.6730187	0.6701828	0.5772468
σ	0.6724765	0.7241978	0.70893698	0.7606108	0.7880632	0.9141469	0.7342277	0.7921307	0.8450351	0.8546575	0.8238868	0.4948255	0.62118	0.6916699	0.878568	0.8172906	0.7536383	0.8791842	1.0317125	0.9085345	0.7672439
Expected																					
Absolutely disagree	1.3925544	21.838267	25.000091	0.820243	2.3405791	21.892702	4.405127	3.6731419	2.8908247	21.090944	16.790486	32.83609	24.594258	5.9180992	12.897615	31.715162	33.30929	8.9199902	3.6591115	2.1653209	1.045851
Strongly disagree	8.3195738	28.819775	30.2484962	4.9517388	9.2960442	22.969574	12.846999	11.953373	9.5138011	24.88574	24.060455	41.837391	35.059579	19.393015	19.926325	27.515084	27.380635	15.459056	8.1569611	7.0331625	5.5536366
Somewhat disagree	5.4634251	8.7920522	8.62579726	3.5420293	5.447529	7.5492602	6.0879174	6.325657	5.26085	8.2443567	8.5415389	7.426705	9.457855	9.3557129	7.6796855	7.5768287	6.7985248	6.3101107	4.0939901	4.0112034	3.7328639
Neither agree nor disagree	7.4538699	8.1031456	7.64462023	5.2419672	7.2386015	7.5892011	7.0760302	7.9481425	6.8611393	8.2210964	8.7563416	4.5295028	7.8200169	10.808931	8.3130238	6.8348307	5.7261383	7.0379608	5.2215105	5.3896577	5.3360257
Somewhat agree	13.717588	9.1624802	8.18295612	11.08389	13.38331	10.026306	10.813136	13.671281	12.549397	10.631896	11.657128	2.6995374	7.394248	16.144782	12.006996	7.7134249	5.8282642	10.568468	9.5598518	10.380555	10.798374
Strongly agree	27.497745	8.2073722	6.59308761	31.878396	30.568184	13.355619	16.558019	27.362511	29.346325	13.203849	14.959398	0.6664981	4.4398923	22.722467	18.460106	7.3719924	4.4742022	17.457196	24.732578	27.914501	28.736341
Absolutely agree	11.155244	1.0769073	0.70495157	29.481736	20.725752	4.6173385	5.2127712	15.065894	23.577662	3.7221172	4.2346515	0.0042762	0.2341514	5.6569924	7.7162483	1.2726764	0.4829459	8.2472176	34.575997	33.1056	23.796908
χ2 contributions																					
Absolutely disagree	0.2649736	0.1547388	0.16001398	1.6968462	1.1764942	0.6921542	4.4051269	0.4793042	0.4255774	0.2072951	0.4637634	0.0008182	0.1033435	2.8154165	0.0624698	0.0927563	0.0028719	0.0007177	1.4975655	0.3217487	0.8704875
Strongly disagree	1.3245354	1.3253115	2.53198763	0.7692821	1.9853602	9.8353465	2.0668965	4.0448329	3.1955684	4.1107179	4.1060963	0.6370506	2.8184017	2.1074928	1.2918679	3.269611	2.1202842	0.0136317	3.2603131	1.3080993	3.7336987
Somewhat disagree	0.3919909	0.0049183	0.30643158	0.6713254	0.0560298	1.6686731	0.0012696	0.0718879	0.1038507	0.0072426	0.7076044	5.5613542	0.0221648	0.0443692	0.3673775	0.0236344	0.0937912	0.2720063	2.3382505	2.2269888	0.1438813
Neither agree nor disagree	1.6870483	1.1883672	0.05435656	0.2942564	0.6923073	0.8833555	0.1206496	2.0655831	0.1890362	6.3427346	3.7841681	0.0488724	4.3315247	1.3422191	1.3203531	0.1019692	5.7261382	1.2466219	0.0093971	1.0595225	0.51889
Somewhat agree	0.3797611	0.5103771	0.58234424	0.8580361	0.0109783	1.6168608	0.061147	0.129139	1.5783916	0.0127447	0.0370432	0.033442	0.0496245	11.890346	2.9912636	1.7877304	0.573507	1.1142023	0.2545162	0.5459285	0.0037647
Strongly agree	0.2268816	0.0052396	1.95815362	2.0691269	1.3533108	1.4204819	0.3951837	0.0678459	0.3815774	0.7773983	2.3740546	0.1668775	2.6651229	5.0598072	3.0147815	3.9145865	0.0617905	2.3884353	2.7635724	0.5979439	0.1783161
Absolutely agree	0.0639711	0.7912474	2.37909988	0.0744712	0.1436966	2.4781373	0.6127618	0.0579158	0.0858035	1.3940318	1.8058515	0.0042761	2.5048908	0.9704245	0.6759142	2.3443876	0.553571	0.3725191	0.0095955	0.0003368	0.0017333
326.906701	4.339162	3.9802	7.97238749	6.4333444	5.4181772	18.595009	7.6630351	6.9165088	5.9598051	12.852165	13.278582	6.4526909	12.495073	24.230076	9.7240276	11.534676	9.131954	5.4081342	10.13321	6.0605684	5.4507716
Solver thresholds																					
τ_1																					
τ_2																					
τ_3																					
τ_4																					
τ_5																					
τ_6																					
Standardised parameters																					
μ	0.2269	-0.7724	-0.8610	0.6437	0.3632	-0.6201	-0.1173	0.1845	0.4026	-0.6210	-0.5038	-1.1068	-0.8924	-0.1616	-0.2981	-0.9565	-1.0779	-0.1751	0.6569	0.6538	0.5531
σ	0.7288	0.7849	0.7683	0.8243	0.8541	0.9907	0.7957	0.8585	0.9158	0.9262	0.8929	0.5363	0.6732	0.7496	0.9522	0.8857	0.8168	0.9528	1.1181	0.9846	0.8315
t-value	2.6962	-9.1268	-10.4527	7.2833	4.0123	-5.8715	-1.1705	1.9931	4.1704	-6.3600	-5.3233	-19.5802	-12.5058	-2.0453	-2.9202	-10.2451	-12.0952	-1.5812	5.5735	6.2995	5.9122
p-value	0.0087	0.0000	0.0000	0.0000	0.0001	0.0000	0.2463	0.0495	0.0001	0.0000	0.0000	0.0000	0.0000	0.0438	0.0045	0.0000	0.0000	0.1182	0.0000	0.0000	0.0000
Significance	+	-	-	+	+	-		+	+	-	-	-	-	-	-	-	-		+	+	+
Chi-test p-value																					
Significance level																					

8.2 Inkosi Albert Luthuli Central Hospital respondents

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Observed																				
Absolutely disagree	4	6	5	7	2	1	2	2	2	1	1	1	15	1	1	1	0	2	1	4
Strongly disagree	5	6	4	4	3	2	2	0	2	1	1	0	20	2	0	2	1	1	2	8
Somewhat disagree	5	3	4	3	1	1	1	0	3	1	1	5	5	2	1	2	2	0	4	7
Neither agree nor disagree	7	5	9	11	5	2	0	1	6	3	2	4	2	3	2	3	3	5	8	3
Somewhat agree	5	6	8	4	7	14	13	6	11	12	9	10	3	6	7	9	8	10	6	5
Strongly agree	13	11	11	11	17	16	20	20	11	21	27	21	3	20	25	24	23	23	19	15
Absolutely agree	7	3	3	5	9	7	6	20	11	11	7	8	2	16	14	8	11	8	9	8
Total	46	40	44	45	44	43	44	49	46	50	48	49	50	50	50	49	48	49	49	50
Solver parameters																				
μ	0.0913271	-0.14537	-0.111905	-0.125995	0.4033514	0.36773	0.3191602	0.8403188	0.3635874	0.5186265	0.4792731	0.370878	-0.787517	0.7049095	0.6751427	0.4627755	0.6143303	0.3909317	0.3590371	0.0865442
σ	0.916283	0.9315696	0.7918507	0.9101556	0.8550027	0.6816605	0.7336103	0.9834792	0.8707134	0.7209374	0.6674355	0.7037933	0.8893439	0.8500079	0.7568575	0.6970469	0.6263913	0.7589345	0.746645	0.9475046
Expected																				
Absolutely disagree	3.6946753	5.1793447	3.7532237	5.3847558	1.3474539	0.4667601	0.8528685	0.9386459	1.681095	0.4332167	0.2885662	0.6345716	16.130973	0.6313893	0.3344743	0.4229022	0.0919811	0.8921682	0.9104615	4.3885152
Strongly disagree	7.2279115	7.8710847	8.7283068	8.7835899	4.3171673	3.2160669	4.1678357	2.8117683	4.9039362	2.8888519	2.5371627	3.8656057	13.812182	2.7494016	2.1994811	3.0174909	1.3426157	4.2016209	4.3805368	7.9064243
Somewhat disagree	3.3282029	3.229805	4.0120457	3.6800646	2.4563092	2.3957154	2.7093123	1.6529111	2.6846176	2.1922691	2.121731	2.7533658	4.1982569	1.8276782	1.7046962	2.3239885	1.4004153	2.7347741	2.8553255	3.5558464
Neither agree nor disagree	4.6045976	4.1909284	5.374415	4.8120364	3.8058232	4.1606026	4.4000683	2.6797152	4.0774341	3.918457	3.9556832	4.6879939	4.5720095	3.1181949	3.1301066	4.1543961	2.9836105	4.4851554	4.6672924	4.8791798
Somewhat agree	7.8048967	6.5037043	8.3934775	7.5132019	7.4625486	8.9522553	8.8310047	5.781721	7.8040528	8.9713063	9.3459294	9.9233194	5.4895256	7.0135515	7.5731675	9.3975587	8.3125065	9.2299773	9.5094375	8.2262218
Strongly agree	12.911684	9.2894211	10.860187	10.696604	15.245568	17.507667	16.507776	15.438157	15.470978	20.782074	21.001417	19.524466	4.9144965	18.278927	20.341685	20.558129	22.998057	18.616065	18.560723	13.737387
Absolutely agree	6.4280316	3.7357117	2.8783438	4.1297472	9.3651302	6.3009329	6.5311347	19.697082	9.3778865	10.813825	8.7495104	7.610678	0.8825567	16.380857	14.716389	9.1255342	10.870814	8.8402391	8.1162228	7.3064254
χ2 contributions																				
Absolutely disagree	0.0252318	0.130031	0.4141643	0.4845185	0.3160156	0.6091882	1.5429229	1.2001035	0.0604965	0.7415302	1.7539749	0.2104379	0.0792946	0.2151982	1.3242402	0.7875149	0.091981	1.3756275	0.0088056	0.0343952
Strongly disagree	0.6867253	0.4447872	2.5614229	2.6051685	0.4018676	0.4598221	1.1275664	2.8117682	1.7196075	1.2350102	0.9313037	3.8656056	2.7721245	0.2042636	2.199481	0.3430956	0.0874305	2.4396242	1.2936669	0.0011075
Somewhat disagree	0.8397642	0.0163509	3.617E-05	0.1256738	0.863424	0.8131272	1.0784097	1.652911	0.0370504	0.6484175	0.5930442	1.8331619	0.1531093	0.0162473	0.291311	0.0451674	0.2567108	2.734774	0.4588898	3.335969
Neither agree nor disagree	1.2461354	0.1561937	2.4458227	7.9573158	0.3747042	1.1220018	4.4000682	1.0528891	0.906516	0.2152795	0.9668865	0.1009676	1.4468983	0.0044802	0.4080183	0.320776	9.003E-05	0.0590983	2.3797394	0.7237521
Somewhat agree	1.008014	0.0390113	0.0184458	1.6427866	0.02867	2.8461796	1.9681251	0.0082408	1.3088172	1.0224804	0.0128042	0.0005925	1.1290115	0.1464717	0.0433796	0.0168185	0.0117486	0.0642401	1.2951504	1.265284
Strongly agree	0.0006041	0.3149906	0.0017999	0.0086054	0.2018969	0.1298322	0.738781	1.3479855	1.2920736	0.0022852	1.7133604	0.1115115	0.7458133	0.1620495	1.0667697	0.5762428	1.642E-07	1.0323818	0.0103964	0.1160477
Absolutely agree	0.0508939	0.1448912	0.0051419	0.1833865	0.0142358	0.0775591	0.0431937	0.0046585	0.2805805	0.0032053	0.3498238	0.0199157	1.4148434	0.008855	0.0348736	0.1388222	0.0015352	0.0798623	0.0962347	0.0658387
259.6513862	3.8573687	1.2462559	5.4468337	13.007455	2.2008141	6.0577102	10.899067	8.0785566	5.6051416	3.8682082	6.3211977	6.1421927	7.7410947	0.7575654	5.3680734	2.2284374	0.4494962	7.7856082	5.5428831	5.5423943
Solver thresholds	Standardised thresholds																			
T_1	-1.196959	T_1	-1.301932																	
T_2	-0.56482	T_2	-0.652304																	
T_3	-0.364525	T_3	-0.446468																	
T_4	-0.11786	T_4	-0.192979																	
T_5	0.2757157	T_5	0.2114885																	
T_6	1.0844401	T_6	1.0425859																	
Standardised parameters																				
μ	0.0220	-0.2212	-0.1869	-0.2013	0.3427	0.3060	0.2561	0.7917	0.3018	0.4611	0.4207	0.3093	-0.8812	0.6526	0.6220	0.4037	0.5595	0.3299	0.2971	0.0171
σ	0.9437	0.9573	0.8138	0.9353	0.8787	0.7005	0.7539	1.0107	0.8948	0.7409	0.6859	0.7233	0.9139	0.8735	0.7778	0.7163	0.6437	0.7799	0.7673	0.9737
t-value	0.1581	-1.4617	-1.5232	-1.4440	2.5868	2.8648	2.2536	5.4834	2.2875	4.4010	4.2492	2.9933	-6.8174	5.2823	5.6544	3.9452	6.0214	2.9608	2.7105	0.1240
p-value	0.8751	0.1521	0.1352	0.1560	0.0132	0.0066	0.0295	0.0000	0.0270	0.0001	0.0001	0.0044	0.0000	0.0000	0.0000	0.0003	0.0000	0.0048	0.0093	0.9018
Significance					+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	
Chi-test p-value	0.1830																			
Significance level	5%																			

Question	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Observed																					
Absolutely disagree	1	8	11	2	1	9	0	2	3	15	6	17	12	7	4	18	16	4	4	1	1
Strongly disagree	3	20	20	1	1	22	13	3	3	24	15	27	28	8	7	22	23	2	1	4	1
Somewhat disagree	1	6	3	0	2	3	2	4	2	3	8	0	3	7	4	3	4	4	1	3	3
Neither agree nor disagree	5	4	6	3	2	4	5	7	2	0	3	3	0	3	4	2	0	10	2	0	6
Somewhat agree	10	3	5	4	5	4	8	8	12	5	8	2	5	17	13	2	2	10	3	5	7
Strongly agree	13	5	1	26	25	3	4	18	16	3	7	1	1	4	7	2	2	9	18	20	13
Absolutely agree	5	1	2	12	13	3	1	6	12	0	3	0	0	4	9	1	0	5	21	17	12
Total	**38**	**47**	**48**	**48**	**49**	**48**	**33**	**48**	**50**	**50**	**50**	**50**	**49**	**50**	**48**	**50**	**47**	**44**	**50**	**50**	**43**
Solver parameters																					
μ	0.2671978	-0.606329	-0.657182	0.585764	0.652846	-0.587416	-0.313957	0.2274532	0.4132416	-0.856948	-0.348151	-0.978876	-0.842943	-0.199961	0.1157378	-0.945397	-0.949211	-0.00882	0.8373208	0.6912147	0.4941155
σ	0.6994542	0.7196541	0.8231197	0.832707	0.7623171	0.8709272	0.6302107	0.7536417	0.9235557	0.654654	0.8029462	0.5313504	0.5215249	0.797862	0.9384641	0.8118291	0.6099602	0.7904201	1.2398867	0.9193685	0.8564632
Expected																					
Absolutely disagree	0.6901521	9.6775356	12.287351	0.7748165	0.3734517	11.616091	2.659434	1.4100674	2.0312482	15.087478	7.2614568	17.037254	12.182849	5.2862619	3.8851589	18.916495	16.088523	2.9214741	2.521504	0.9999439	1.0390211
Strongly disagree	3.7602799	14.90337	13.856883	3.2344237	2.3262975	12.880676	8.7352042	5.6252721	5.2085448	18.526774	12.420565	22.066967	22.268208	10.900186	7.3549973	15.103	18.490082	7.6779438	3.9313233	3.2970148	3.6115984
Somewhat disagree	2.5118916	5.1026432	4.5234425	2.0815948	1.759612	4.3510048	4.0501277	3.3366474	2.7528943	5.0872891	4.9112262	4.7058683	5.7543707	4.7283124	3.3715971	4.123159	4.4836084	3.7598898	1.8568229	1.9738352	2.1451377
Neither agree nor disagree	4.0950671	5.6300661	5.0364505	3.4640342	3.1849819	4.9973405	5.0865344	5.1515369	4.1385424	4.8257356	6.0502398	3.5614086	4.7659398	6.1341877	4.6704734	4.156405	3.8747451	5.2268067	2.7172449	3.2002343	3.4144685
Somewhat agree	8.1272193	6.5086331	6.1264471	7.476524	7.5652752	6.4350138	6.7029345	9.7019366	7.9094037	4.3827298	8.4271226	2.173029	3.2457416	9.1748248	7.9663581	4.3873722	3.0144434	8.5989251	5.2377469	6.8117853	6.9622878
Strongly agree	14.205126	4.7358885	5.3449063	17.786241	19.793913	6.4021564	5.3286622	16.642903	16.274963	2.0144502	9.069479	0.4528953	0.7775169	11.090207	13.504168	3.0033706	1.0284856	12.149265	12.684813	16.995677	15.278285
Absolutely agree	4.6102636	0.4418635	0.8245203	13.182365	13.996469	1.317717	0.437103	6.1316368	11.684404	0.0755436	1.8599101	0.0025777	0.0053731	2.6860204	7.2472468	0.3101979	0.0201123	3.6656958	21.050545	16.721509	10.549202
χ2 contributions																					
Absolutely disagree	0.139108	0.2907895	0.1348763	1.9373291	1.0511738	0.589177	2.6594339	0.2468112	0.4620213	0.0005072	0.2191397	8.146E-05	0.0027443	0.5555718	0.0033946	0.0444038	0.0004871	0.3981613	0.8669232	3.147E-09	0.0014655
Strongly disagree	0.1537188	1.7429372	2.7234041	1.5435978	0.7561651	6.4563433	2.0822047	1.2251947	0.9364746	1.616914	0.5356828	1.102771	1.4753515	0.7716453	0.0171343	3.1496131	1.1000148	4.1989166	2.1856906	0.1498896	1.8884841
Somewhat disagree	0.9099979	0.1578102	0.5130776	2.0815947	0.0328404	0.4194925	1.0377509	0.1318799	0.2059105	0.8564042	1.942595	4.7058682	1.3183992	1.0914178	0.1171226	0.3059514	0.0521627	0.0153337	0.3953772	0.5334864	0.3406725
Neither agree nor disagree	0.1999732	0.471951	0.1843417	0.062161	0.440876	0.1990435	0.0014722	0.6632614	1.1050662	4.8257355	1.5377842	0.0884986	4.7659397	1.6013746	0.0962503	1.1187751	3.874745	4.3589471	0.1893242	3.2002342	1.957837
Somewhat agree	0.4315507	1.8914119	0.2071157	1.6165559	0.8698476	0.9214109	0.2509914	0.2985577	2.1155802	0.0869373	0.0216484	0.0137776	0.9481415	6.6740639	3.1805689	1.2990796	0.3413882	0.2282856	0.956043	0.4818951	0.0002043
Strongly agree	0.1022398	0.014729	3.5320002	3.793147	1.3692766	1.8079327	0.331292	0.1106606	0.0046454	0.4821705	0.4722149	0.6609112	0.0636626	4.5329213	3.1326776	0.3352075	0.9176989	0.8163349	2.2271685	0.5310736	0.3397359
Absolutely agree	0.032947	0.7050055	1.6758258	0.1060498	0.0709429	2.1477116	0.7248931	0.002826	0.0085243	0.0755435	0.6988536	0.0025776	0.005373	0.6427882	0.4239049	1.5339456	0.0201122	0.4856834	0.0001214	0.0046382	0.1995237
259.6513862	1.9695355	5.2746344	8.9706412	11.140435	4.5911225	12.541112	7.0880381	2.6791915	4.8382225	7.9442121	5.4279186	6.5744855	8.5796118	15.869783	6.9710532	7.786976	6.3066089	10.501663	6.820648	4.9012171	4.7279229
Solver thresholds																					
τ_1																					
τ_2																					
τ_3																					
τ_4																					
τ_5																					
τ_6																					
Standardised parameters																					
μ	0.2027	-0.6950	-0.7472	0.5301	0.5991	-0.6755	-0.3945	0.1619	0.3528	-0.9525	-0.4296	-1.0778	-0.9381	-0.2774	0.0471	-1.0434	-1.0473	-0.0809	0.7886	0.6385	0.4359
σ	0.7188	0.7396	0.8459	0.8557	0.7834	0.8950	0.6476	0.7745	0.9491	0.6728	0.8252	0.5461	0.5360	0.8199	0.9644	0.8343	0.6268	0.8123	1.2742	0.9448	0.8802
t-value	1.7386	-6.4422	-6.1200	4.2918	5.3527	-5.2291	-3.4992	1.4482	2.6286	-10.0113	-3.6817	-13.9571	-12.2526	-2.3918	0.3382	-8.8435	-11.4546	-0.6608	4.3765	4.7785	3.2478
p-value	0.0906	0.0000	0.0000	0.0001	0.0000	0.0000	0.0014	0.1544	0.0115	0.0000	0.0006	0.0000	0.0000	0.0207	0.7367	0.0000	0.0000	0.5123	0.0001	0.0000	0.0023
Significance		-	-	+	+	-	-		+	-	-	-	-	-		-	-		+	+	+
Chi-test p-value																					
Significance level																					

8.3 Sebokeng Hospital respondents

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Observed																				
Absolutely disagree	3	5	7	6	1	1	0	0	0	0	1	4	9	1	1	0	3	3	0	1
Strongly disagree	6	7	1	7	5	3	0	2	6	4	3	4	19	4	3	2	3	3	0	0
Somewhat disagree	3	5	1	4	4	3	1	1	1	7	2	2	6	0	3	4	3	4	3	2
Neither agree nor disagree	1	2	2	3	3	5	9	1	5	3	4	0	3	1	4	7	3	5	4	3
Somewhat agree	6	1	3	1	2	5	8	7	3	6	6	8	0	7	6	8	8	3	5	1
Strongly agree	14	12	19	9	14	16	13	15	12	9	15	16	1	14	13	11	12	10	19	21
Absolutely agree	7	8	6	8	7	2	4	12	8	9	7	6	2	11	10	7	7	12	4	11
Total	40	40	39	38	36	35	35	38	35	38	38	40	40	38	40	39	39	40	35	39
Solver parameters																				
μ	0.1987724	0.0941688	0.1362398	0.0353206	0.2881479	0.1875227	0.2602717	0.5715399	0.3042736	0.2713106	0.3374798	0.174944	-0.557111	0.4579854	0.3988367	0.2891014	0.2143435	0.3506437	0.3710241	0.5211423
σ	0.7815896	0.9293051	0.9117185	1.037768	0.6900212	0.5404714	0.4197995	0.5706169	0.6984515	0.6767341	0.6274105	0.7657581	0.6959671	0.7092751	0.6856022	0.5311834	0.7285688	0.900679	0.4132763	0.6463342
Expected																				
Absolutely disagree	2.2834766	4.4793333	3.8720248	5.7371858	0.9900218	0.4129332	0.0353088	0.0920901	0.9626829	1.0146243	0.5433643	2.2764192	9.8295199	0.6885039	0.7275506	0.2459951	1.6800117	2.473867	0.0116065	0.311883
Strongly disagree	6.5020663	7.3333517	6.8962491	7.008851	4.6731367	4.3533974	1.9358335	1.5567135	4.4514514	5.0102436	3.9443366	6.6891655	13.614505	3.5746995	4.0843223	3.4756128	6.0172204	5.5468698	1.0415257	2.6436097
Somewhat disagree	3.5356656	3.3309917	3.2304425	2.9431439	3.0754512	3.6550036	2.9305502	1.7751226	2.9219701	3.3326867	3.0684172	3.6490327	4.5358005	2.5701968	2.9457973	3.375151	3.5337529	2.8992622	1.9605415	2.291843
Neither agree nor disagree	3.5827867	3.1719308	3.1156723	2.7350167	3.3555772	4.2297842	4.353093	2.5243003	3.1935564	3.638899	3.5805596	3.6878762	3.483082	2.9663816	3.3767306	4.2318911	3.6729512	2.9535603	3.3569951	2.8727547
Somewhat agree	5.1817262	4.3814014	4.35556	3.7180249	5.1534914	6.5103389	7.9696394	4.9856906	4.9260148	5.5707066	5.8039526	5.3002847	3.6368543	4.8783808	5.4735393	7.0850953	5.3995694	4.3819709	7.1624255	5.0831951
Strongly agree	11.09379	9.2170452	9.3118324	7.8459081	11.556673	12.212099	15.204391	15.629258	11.218313	12.270138	13.521287	11.104883	4.0917172	12.662162	13.538213	15.227473	11.505708	10.448377	17.475969	14.286966
Absolutely agree	7.8205888	8.0859459	8.2182189	8.0118696	7.1956486	3.6264433	2.5711844	11.436825	7.326011	7.1627021	7.5380821	7.2923386	0.8085212	10.679676	9.8538471	5.3587819	7.1907859	11.296092	3.9909367	11.509749
χ2 contributions																				
Absolutely disagree	0.2248351	0.060521	2.5269023	0.0120392	0.0001006	0.8346322	0.0353087	0.09209	0.9626828	1.0146242	0.38375	1.3050016	0.0700038	0.1643814	0.1020254	0.245995	1.0371171	0.111896	0.0116064	1.5182126
Strongly disagree	0.0387678	0.0151531	5.0412554	1.118E-05	0.0228625	0.4207483	1.9358334	0.1262294	0.5387013	0.2037011	0.2260891	1.0810932	2.1303424	0.0506002	0.2878702	0.6264889	1.5129276	1.1694065	1.0415256	2.6436096
Somewhat disagree	0.0811272	0.836264	1.5399976	0.3795073	0.2779399	0.1173815	1.271783	0.338464	1.2642049	4.0355388	0.3720209	0.7452136	0.4726575	2.5701967	0.0009973	0.1156797	0.0806203	0.4179075	0.5511099	0.0371633
Neither agree nor disagree	1.861899	0.4329923	0.3995043	0.025673	0.0376791	0.1402512	4.960552	0.9204496	1.0218196	0.1121746	0.0491348	3.6878761	0.0670005	1.3034926	0.1150417	1.8106389	0.1232968	1.4179211	0.1231623	0.0056362
Somewhat agree	0.1292179	2.6096388	0.4218844	1.9869849	1.9296642	0.3503847	0.0001157	0.8138175	0.7530495	0.0330825	0.0066221	1.3751078	3.6368542	0.9226971	0.0506365	0.1181425	1.2523663	0.4358412	0.6528632	3.2799217
Strongly agree	0.761332	0.8402733	10.079712	0.1697609	0.5165713	1.1749159	0.319601	0.0253349	0.0544675	0.8715306	0.1617147	2.1578047	2.3361133	0.1413512	0.0213967	1.173637	0.021235	0.0192415	0.1329065	3.1542817
Absolutely agree	0.0861017	0.0009135	0.5987301	1.758E-05	0.0053197	0.7294524	0.7939975	0.027732	0.0620066	0.4712835	0.0384093	0.2290265	1.755825	0.0096077	0.0021677	0.5026509	0.0050619	0.0438635	2.058E-05	0.022576
230.6919572	3.1832807	4.7957562	20.607986	2.5739941	2.7901372	3.7677662	9.3171914	2.3441174	4.6569322	6.7419352	1.237741	10.581123	10.468797	5.162327	0.5801356	4.5932329	4.0326252	3.6160773	2.5131945	10.661381
Solver thresholds	Standardised thresholds																			
τ_1	-1.035911	τ_1	-1.275566																	
τ_2	-0.40572	τ_2	-0.542266																	
τ_3	-0.193155	τ_3	-0.294921																	
τ_4	-0.004106	τ_4	-0.07494																	
τ_5	0.251986	τ_5	0.2230519																	
τ_6	0.8691824	τ_6	0.9412318																	
Standardised parameters																				
μ	0.1611	0.0394	0.0884	-0.0291	0.2651	0.1480	0.2327	0.5949	0.2839	0.2455	0.3225	0.1334	-0.7184	0.4628	0.3939	0.2662	0.1793	0.3379	0.3616	0.5362
σ	0.9095	1.0814	1.0609	1.2076	0.8029	0.6289	0.4885	0.6640	0.8127	0.7875	0.7301	0.8910	0.8098	0.8253	0.7978	0.6181	0.8478	1.0480	0.4809	0.7521
t-value	1.1205	0.2305	0.5202	-0.1484	1.9812	1.3926	2.8182	5.5230	2.0665	1.9221	2.7234	0.9469	-5.6107	3.4564	3.1230	2.6900	1.3204	2.0388	4.4481	4.4528
p-value	0.2695	0.8189	0.6060	0.8829	0.0557	0.1730	0.0081	0.0000	0.0467	0.0625	0.0099	0.3497	0.0000	0.0014	0.0034	0.0107	0.1948	0.0485	0.0001	0.0001
Significance							+	+	+		+		-	+	+	+		+	+	+
Chi-test p-value	0.6554																			
Significance level	5%																			

Question	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Observed																					
Absolutely disagree	1	12	12	0	3	9	0	3	1	4	8	16	11	3	8	12	17	5	2	2	1
Strongly disagree	2	15	19	2	4	16	5	2	1	11	19	20	17	5	18	15	12	13	2	0	0
Somewhat disagree	3	3	4	2	4	1	4	3	4	5	3	1	6	3	2	5	2	1	0	4	0
Neither agree nor disagree	6	1	1	1	3	1	3	5	6	1	0	2	2	4	1	4	0	0	3	3	1
Somewhat agree	6	4	1	4	8	2	2	7	5	6	3	1	3	13	5	2	2	4	5	3	4
Strongly agree	12	3	2	14	12	6	10	8	10	7	2	0	0	8	4	0	3	2	15	12	18
Absolutely agree	7	1	0	16	6	5	6	10	13	6	4	0	1	4	1	2	1	5	13	16	12
Total	**37**	**39**	**39**	**39**	**40**	**40**	**30**	**38**	**40**	**40**	**39**	**40**	**40**	**40**	**39**	**40**	**37**	**30**	**40**	**40**	**36**
Solver parameters																					
μ	0.2842742	-0.669439	-0.766265	0.7115576	0.150252	-0.399171	0.2436731	0.2768398	0.4381157	-0.064605	-0.459349	-0.912017	-0.649728	0.0303323	-0.520074	-0.623754	-0.931687	-0.266888	0.5137784	0.5935785	0.5868103
σ	0.6203928	0.7380321	0.5517539	0.6763532	0.7232973	0.9421103	0.6773709	0.8282975	0.7359659	0.8453653	0.8220451	0.4611822	0.660157	0.6190037	0.656512	0.767269	0.8904004	0.9081834	0.8058525	0.9083533	0.6811881
Expected																					
Absolutely disagree	0.6167631	12.080331	12.188458	0.190627	2.0203611	9.9825175	0.8832877	2.1468871	0.9038763	5.0113013	9.4198476	15.764084	11.171135	1.6995259	8.4245833	11.822954	16.776133	5.9568494	1.0894927	1.4566029	0.3097783
Strongly disagree	4.3052833	12.863141	16.798968	1.7311349	6.8214993	9.9065426	4.1823834	5.6414044	4.1273158	8.7201195	11.094456	18.79029	14.595557	7.9236169	13.771861	12.651423	9.9616147	7.2206869	3.9876887	3.9689824	2.3020278
Somewhat disagree	3.2468418	3.9417827	4.1832131	1.6080527	3.8570238	3.5728747	2.7193337	3.0498273	2.7894841	3.8513008	3.9372415	3.0644621	4.4496992	4.7382034	4.742627	4.0325427	2.7354054	2.7930763	2.5298499	2.3030199	1.9279084
Neither agree nor disagree	3.7090406	2.9519146	2.5694517	2.1251951	3.9212876	3.0387193	2.9327692	3.1168303	3.1378289	3.5583258	3.2439145	1.401325	3.2219525	4.7513164	3.6386465	3.1066942	2.0226482	2.4446811	2.8019471	2.4823325	2.4025258
Somewhat agree	5.8541909	3.031712	1.9930368	4.0331904	5.6169473	3.7101471	4.4290995	4.5902344	5.0483208	4.6983282	3.7607461	0.7477539	3.1222998	6.4816892	3.7502066	3.312091	2.1052757	3.0680862	4.4967019	3.9265534	4.2726904
Strongly agree	12.870919	3.4078452	1.2076737	13.405224	11.358059	6.2250137	9.516433	10.438801	12.83184	8.7739298	5.4755014	0.2298384	3.0113339	10.898328	4.0025471	4.040671	2.6011888	5.3522001	11.910473	10.630967	12.572307
Absolutely agree	6.3969611	0.7232734	0.0591984	15.906576	6.4048222	3.5641852	5.3366934	9.0160153	11.161334	5.3866946	2.0682926	0.002247	0.4280229	3.5073201	0.6695289	1.0336237	0.797734	3.1644199	13.183846	15.231542	12.212763
χ2 contributions																					
Absolutely disagree	0.2381311	0.0005342	0.002914	0.1906269	0.4750103	0.0967031	0.8832876	0.3390032	0.0102224	0.2040848	0.2140127	0.0035306	0.0026217	0.9951202	0.0213982	0.0026512	0.0029874	0.1536988	0.7609261	0.2027185	1.537893
Strongly disagree	1.2343743	0.3549807	0.2883833	0.0417578	1.1670247	3.7480505	0.1598363	2.3504477	2.369604	0.5960761	5.6332298	0.0778805	0.3961032	1.0787417	1.2980935	0.4359837	0.4171025	4.6256622	0.990776	3.9689823	2.3020277
Somewhat disagree	0.0187662	0.2250136	0.0080242	0.0955334	0.0053	1.8527613	0.603128	0.0008141	0.5253117	0.3426141	0.2231059	1.3907836	0.5401337	0.6376575	1.5860414	0.2321051	0.1977115	1.1511044	2.5298498	1.2504196	1.9279083
Neither agree nor disagree	1.4150546	1.2906778	0.9586397	0.5957401	0.2164521	1.3678052	0.0015412	1.1377996	2.6107297	1.8393568	3.2439144	0.2557663	0.4634357	0.1188042	1.9134739	0.2568632	2.0226481	2.444681	0.0139992	0.1079548	0.8187544
Somewhat agree	0.0036316	0.3092582	0.4947836	0.0002731	1.0110367	0.7882714	1.3322176	1.2650704	0.0004625	0.3606282	0.1538883	0.0850923	0.0047905	6.5551392	0.416506	0.5197873	0.0052644	0.2830635	0.0563322	0.2186399	0.0174036
Strongly agree	0.0589313	0.0488102	0.5198266	0.0263896	0.0362816	0.0081335	0.0245719	0.5697734	0.6249546	0.3586565	2.206028	0.2298383	3.0113338	0.7707884	1.621E-06	4.0406709	0.0611453	2.0995563	0.8014103	0.1763012	2.3432337
Absolutely agree	0.0568482	0.1058765	0.0591983	0.0005487	0.0255871	0.578411	0.0824435	0.1073896	0.3028932	0.0698283	1.8041419	0.0022469	0.7643465	0.0692077	0.1631164	0.9035038	0.0512847	1.064762	0.0025637	0.03877	0.0037066
230.6919572	3.0257374	2.3351511	2.3317698	0.9508696	2.9366925	8.4401361	3.0870261	5.7702979	6.444178	3.7712446	13.478321	2.0451385	5.1827651	10.225459	5.3986309	6.3915652	2.7581438	11.822528	5.1558572	5.9637863	8.9509273
Solver thresholds																					
τ_1																					
τ_2																					
τ_3																					
τ_4																					
τ_5																					
τ_6																					
Standardised parameters																					
μ	0.2606	-0.8491	-0.9618	0.7578	0.1047	-0.5346	0.2134	0.2520	0.4396	-0.1453	-0.6047	-1.1314	-0.8262	-0.0349	-0.6753	-0.7960	-1.1543	-0.3807	0.5277	0.6205	0.6127
σ	0.7219	0.8588	0.6420	0.7870	0.8416	1.0963	0.7882	0.9638	0.8564	0.9837	0.9565	0.5366	0.7682	0.7203	0.7639	0.8928	1.0361	1.0568	0.9377	1.0570	0.7926
t-value	2.1960	-6.1748	-9.3554	6.0133	0.7866	-3.0845	1.4828	1.6116	3.2468	-0.9344	-3.9477	-13.3341	-6.8023	-0.3062	-5.5207	-5.6386	-6.7767	-1.9732	3.5590	3.7131	4.6376
p-value	0.0348	0.0000	0.0000	0.0000	0.4364	0.0038	0.1493	0.1158	0.0024	0.3560	0.0003	0.0000	0.0000	0.7612	0.0000	0.0000	0.0000	0.0584	0.0010	0.0007	0.0001
Significance	+	-	-	+		-			+		-	-	-		-	-	-		+	+	+
Chi-test p-value																					
Significance level																					

8.4 All doctor respondents (from both hospitals)

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Observed																				
Absolutely disagree	3	2	3	1	2	1	1	0	2	1	1	2	4	0	0	1	0	1	1	1
Strongly disagree	3	4	3	2	3	4	2	2	4	1	2	1	9	0	0	2	1	2	1	4
Somewhat disagree	5	5	2	2	1	2	1	1	2	1	1	4	2	0	2	0	4	1	5	6
Neither agree nor disagree	0	0	0	3	3	0	3	1	3	3	3	0	1	0	4	5	2	2	6	1
Somewhat agree	5	1	4	2	3	6	4	2	4	5	1	3	1	6	4	4	4	4	1	0
Strongly agree	3	5	7	8	6	4	5	3	4	6	9	8	2	6	6	6	7	7	3	6
Absolutely agree	1	3	0	2	0	0	2	11	1	3	2	2	1	8	4	2	2	3	2	1
Total	20	20	19	20	18	17	18	20	20	20	19	20	20	20	20	20	20	20	19	19
Solver parameters																				
μ	-0.155594	0.0194399	0.0340354	0.2579977	0.0361599	-0.012386	0.1943587	1.0015334	-0.063442	0.2999028	0.3045362	0.1704726	-0.455069	0.7254255	0.4093354	0.1785111	0.2584542	0.3189819	0.038576	-0.017079
σ	0.6556103	0.7828377	0.7640545	0.6468232	0.6842105	0.5487318	0.6487283	1.1595183	0.6599096	0.6500644	0.6503938	0.7145764	0.7128589	0.5101133	0.5550136	0.5991812	0.5288548	0.6863318	0.5750243	0.5945634
Expected																				
Absolutely disagree	2.3411349	2.2244745	1.9417091	0.6497752	1.3995537	0.7859187	0.7337408	0.9478361	1.8626104	0.5734463	0.5371472	1.2163359	5.0020234	0.0112873	0.1537801	0.6295821	0.2395058	0.6754398	0.8570715	1.1623733
Strongly disagree	4.2466283	3.3045116	3.0988468	2.1204953	2.9367076	2.8720435	2.1846416	1.173839	3.7675347	1.944235	1.8290268	2.6734573	5.1094036	0.2062362	1.0830192	2.3501263	1.5944884	1.9803429	2.9453641	3.3176217
Somewhat disagree	3.1159435	2.4605967	2.3640458	2.21336	2.4328121	2.8028364	2.1571863	0.9606425	2.9685134	2.0865222	1.9689528	2.3488177	2.8931922	0.541715	1.6467332	2.5170632	2.2372745	2.0167977	2.8848972	2.9693539
Neither agree nor disagree	2.8939984	2.4416797	2.3705167	2.6324785	2.4996846	2.9529892	2.46696	1.0943577	2.9062589	2.5370853	2.3999803	2.552337	2.3110331	1.1733819	2.4281588	2.9584991	3.0284088	2.405823	3.1183708	3.0529825
Somewhat agree	3.4027975	3.2658947	3.1880173	4.0762839	3.342948	3.706231	3.6566091	1.8398824	3.6344493	4.0368411	3.8301158	3.6886229	2.3604269	3.2545962	4.5000768	4.3815071	4.9558291	3.817863	4.1218437	3.8716294
Strongly agree	3.0920387	3.9741003	3.8623716	5.4840185	3.7675974	3.2134456	4.6227678	3.6520174	3.6270099	5.673924	5.4091847	4.7878486	1.8420817	8.2627505	6.9183206	5.2037072	6.0559432	5.5504107	4.011849	3.650946
Absolutely agree	0.9074586	2.3287424	2.1744927	2.8235887	1.6206966	0.6665355	2.1780943	10.331425	1.2336233	3.1479461	3.0255925	2.7325807	0.4818411	6.5500328	3.2699114	1.959515	1.8885502	3.5533229	1.0606036	0.9750932
χ2 contributions																				
Absolutely disagree	0.1854242	0.022652	0.5768008	0.188769	0.2576077	0.0583149	0.0966199	0.947836	0.0101341	0.3172886	0.3988343	0.5049011	0.200729	0.0112872	0.15378	0.2179373	0.2395057	0.1559567	0.0238353	0.022682
Strongly disagree	0.3659567	0.1463769	0.003153	0.006847	0.0013641	0.4429897	0.0156055	0.5814613	0.0143436	0.4585761	0.0159822	1.0475047	2.9625259	0.2062361	1.0830191	0.0521625	0.2216488	0.0001951	1.2848807	0.1403536
Somewhat disagree	1.1391955	2.6207337	0.0560604	0.0205671	0.843859	0.2299621	0.6207531	0.0016125	0.3159892	0.5657886	0.476837	1.1607554	0.2757481	0.5417149	0.0757848	2.5170631	1.3888331	0.5126332	1.5507172	3.0932033
Neither agree nor disagree	2.8939983	2.4416796	2.3705166	0.0513098	0.1001388	2.9529891	0.1151748	0.0081357	0.0030236	0.0844631	0.1500111	2.5523369	0.7437383	1.1733818	1.0175137	1.4087297	0.3492344	0.0684557	2.6628605	1.380531
Somewhat agree	0.7496836	1.5720895	0.2068107	1.0575698	0.0351825	1.4196028	0.0322477	0.0139344	0.0367669	0.2298022	2.0912045	0.1285579	0.7840791	2.3158761	0.0555717	0.0332186	0.1843504	0.0086891	2.3644535	3.8716293
Strongly agree	0.0027397	0.2648323	2.5488773	1.1542927	1.3227585	0.1925247	0.0307833	0.1164087	0.0383571	0.0187393	2.383715	2.1550215	0.013538	0.6196532	0.1218956	0.121852	0.1471684	0.3785862	0.2552036	1.5114041
Absolutely agree	0.0094372	0.1934893	2.1744926	0.2402256	1.6206965	0.6665354	0.0145621	0.0432653	0.0442435	0.0069531	0.3476476	0.1963984	0.557214	0.3209762	0.1630104	0.0008364	0.006577	0.0861634	0.8320408	0.0006362
180.5632742	5.3464453	7.2618532	7.9367114	2.7195812	4.181607	5.9629188	0.9257465	1.712654	0.4628581	1.6816111	5.8642315	7.7454759	5.5375724	5.1891256	2.6705752	4.3517997	2.5373178	1.2106795	8.9739916	10.02044
Solver thresholds	Standardised thresholds																			
τ_1	-0.935658	τ_1	-1.25917																	
τ_2	-0.445113	τ_2	-0.63308																	
τ_3	-0.179945	τ_3	-0.294642																	
τ_4	0.0617735	τ_4	0.0138681																	
τ_5	0.3962406	τ_5	0.440754																	
τ_6	0.9533556	τ_6	1.151809																	
Standardised parameters																				
μ	-0.2636	-0.0402	-0.0215	0.2643	-0.0188	-0.0808	0.1831	1.2133	-0.1459	0.3178	0.3237	0.1526	-0.6458	0.8609	0.4575	0.1629	0.2649	0.3421	-0.0157	-0.0868
σ	0.8368	0.9991	0.9752	0.8256	0.8733	0.7004	0.8280	1.4799	0.8423	0.8297	0.8301	0.9120	0.9098	0.6511	0.7084	0.7647	0.6750	0.8760	0.7339	0.7589
t-value	-1.4086	-0.1798	-0.0963	1.4318	-0.0914	-0.4756	0.9382	3.6665	-0.7749	1.7130	1.6998	0.7483	-3.1743	5.9135	2.8881	0.9524	1.7551	1.7468	-0.0935	-0.4984
p-value	0.1760	0.8593	0.9244	0.1693	0.9283	0.6412	0.3621	0.0018	0.4484	0.1039	0.1074	0.4640	0.0053	0.0000	0.0098	0.3535	0.0963	0.0977	0.9266	0.6246
Significance								+					-	+	+					
Chi-test p-value	0.9984																			
Significance level	5%																			

Question	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Observed																					
Absolutely disagree	1	4	4	1	1	6	0	2	2	8	0	9	4	1	0	4	5	1	1	1	1
Strongly disagree	2	7	7	0	2	6	2	2	2	7	2	8	10	3	3	7	7	2	1	2	0
Somewhat disagree	2	4	3	2	3	2	1	0	1	2	4	0	2	3	1	4	1	1	1	3	3
Neither agree nor disagree	3	0	1	3	2	4	3	6	5	1	0	3	1	2	1	2	0	3	3	3	1
Somewhat agree	3	3	3	1	1	2	5	4	5	1	6	0	3	5	7	2	2	6	2	1	4
Strongly agree	5	1	0	9	7	0	2	1	3	0	3	0	0	3	1	1	1	3	3	4	3
Absolutely agree	1	0	1	3	3	0	0	2	2	1	5	0	0	3	5	0	0	2	9	6	4
Total	**17**	**19**	**19**	**19**	**19**	**20**	**13**	**17**	**20**	**20**	**20**	**20**	**20**	**20**	**18**	**20**	**16**	**18**	**20**	**20**	**16**
Solver parameters																					
μ	0.1106966	-0.475463	-0.414021	0.3664748	0.2730831	-0.568357	0.0293849	-0.003472	0.038227	-0.72977	0.3165334	-0.788798	-0.537222	0.1451599	0.3417067	-0.498925	-0.620988	0.1504562	0.7182943	0.3787068	0.3113598
σ	0.6118907	0.5462761	0.7066109	0.6596723	0.7109345	0.5721027	0.3887186	0.6469215	0.6577242	0.8441975	0.6880205	0.5299053	0.483224	0.6974848	0.6993468	0.5267676	0.6164633	0.6099507	1.0162232	0.8776	0.7687326
Expected																					
Absolutely disagree	0.7417043	3.7957363	4.3735966	0.4597252	0.8463604	5.2086053	0.0847716	1.2715727	1.386894	8.0731886	0.6876028	7.8166927	4.096346	1.2123911	0.6099593	4.0705789	4.8779232	0.6747133	1.0362069	1.3421614	0.8381289
Strongly disagree	2.3496956	6.1251597	4.792982	1.616866	2.1213675	6.4970126	1.3595921	2.9342954	3.2373053	4.5670882	1.9952852	7.0171899	7.4153649	2.761528	1.7350417	6.7430716	4.9187391	2.2849828	1.486569	2.1365865	1.7625886
Somewhat disagree	2.3043501	3.4880647	2.7992054	1.7945541	2.0100378	3.3224929	2.392082	2.4667597	2.7768987	2.2111848	2.0224878	2.6604902	3.8914083	2.4374427	1.7564766	3.7381507	2.4086416	2.3326196	1.2447263	1.7653142	1.5812902
Neither agree nor disagree	2.5625778	2.4998797	2.2773178	2.2483224	2.3020126	2.264789	3.0951796	2.5102168	2.8844835	1.6641832	2.4063659	1.4209938	2.4455791	2.6370109	2.0990869	2.5767799	1.6502329	2.6672881	1.4150324	1.9359125	1.7814239
Somewhat agree	3.5953473	2.0409206	2.3675462	3.7224384	3.5267753	1.7892516	3.8239629	3.25553	3.8522189	1.6617384	3.8105445	0.8313261	1.6173848	3.7630084	3.358828	1.9788958	1.3530901	3.8575838	2.3305667	2.9794265	2.7399366
Strongly agree	4.0143382	0.965612	1.8860841	5.6084082	4.9764378	0.8396754	2.1309496	3.3790404	4.2210253	1.3608316	5.531102	0.2432052	0.5135379	4.7229509	5.0044843	0.8341825	0.7061373	4.4902576	4.3161486	4.714606	4.0674999
Absolutely agree	1.4319867	0.084627	0.5032678	3.5496858	3.2170087	0.0781734	0.1134623	1.1825851	1.6411744	0.4617852	3.5466119	0.010102	0.0203791	2.4656679	3.4361232	0.0583405	0.0852358	1.6925548	8.1707501	5.1259929	3.2291318
χ2 contributions																					
Absolutely disagree	0.0899505	0.0109922	0.031913	0.6349377	0.0278902	0.1202444	0.0847715	0.4172834	0.2710365	0.0006635	0.6876027	0.1791315	0.0022661	0.0372074	0.6099592	0.0012238	0.0030551	0.1568243	0.0012651	0.0872282	0.0312628
Strongly disagree	0.0520438	0.1249511	1.0162626	1.6168659	0.0069437	0.0380208	0.301651	0.2974846	0.4729008	1.2960248	1.114E-05	0.1376499	0.9008779	0.0205933	0.9222369	0.0097896	0.8806418	0.035543	0.1592589	0.0087316	1.7625885
Somewhat disagree	0.0401975	0.0751356	0.0144035	0.0235201	0.4875655	0.5264082	0.8101279	2.4667596	1.1370126	0.0201697	1.9335368	2.6604901	0.9193138	0.1298372	0.3257982	0.018342	0.8238133	0.7613221	0.0481158	0.8635567	1.2728451
Neither agree nor disagree	0.0746663	2.4998796	0.7164309	0.251307	0.0396226	1.3294648	0.0029269	4.8516074	1.5515465	0.2650786	2.4063658	1.7545891	0.8544802	0.1538799	0.5754845	0.129105	1.6502328	0.0415018	1.7753105	0.5848829	0.3427726
Somewhat agree	0.0985825	0.4506953	0.1689504	1.9910795	1.8103204	0.0248232	0.3616832	0.1702443	0.3419851	0.2635179	1.2580132	0.831326	1.1819233	0.4066289	3.9472498	0.0002251	0.3092864	1.1898502	0.0468875	1.3150615	0.5794878
Strongly agree	0.2420148	0.0012246	1.886084	2.0510088	0.8228383	0.8396753	0.008047	1.6749823	0.3532087	1.3608315	1.1582641	0.2432051	0.5135378	0.6285392	3.204305	0.0329609	0.1222925	0.4945969	0.401341	0.1083148	0.2801613
Absolutely agree	0.1303172	0.0846269	0.4902813	0.0851215	0.0146387	0.0781733	0.1134622	0.5650055	0.0784535	0.6272942	0.595593	0.0101019	0.020379	0.1157945	0.7117645	0.0583404	0.0852357	0.0558461	0.0841606	0.1490225	0.184024
180.5632742	0.7277725	3.2475054	4.3243256	6.6538404	3.2098193	2.9568099	1.6826696	10.443367	4.2061436	3.8335802	8.0393867	5.8164938	4.3927781	1.4924804	10.296798	0.2499867	3.8745576	2.7354844	2.5163393	3.1167984	4.453142
Solver thresholds																					
τ_1																					
τ_2																					
τ_3																					
τ_4																					
τ_5																					
τ_6																					
Standardised parameters																					
μ	0.0763	-0.6718	-0.5934	0.4028	0.2836	-0.7904	-0.0275	-0.0694	-0.0162	-0.9964	0.3390	-1.0717	-0.7506	0.1203	0.3712	-0.7018	-0.8576	0.1271	0.8518	0.4184	0.3324
σ	0.7810	0.6972	0.9019	0.8420	0.9074	0.7302	0.4961	0.8257	0.8395	1.0775	0.8781	0.6763	0.6167	0.8902	0.8926	0.6723	0.7868	0.7785	1.2970	1.1201	0.9811
t-value	0.4029	-4.2001	-2.8680	2.0852	1.3622	-4.8408	-0.1996	-0.3466	-0.0862	-4.1356	1.7266	-7.0867	-5.4430	0.6043	1.7642	-4.6680	-4.3597	0.6924	2.9370	1.6704	1.3552
p-value	0.6927	0.0006	0.0107	0.0524	0.1909	0.0001	0.8454	0.7337	0.9322	0.0006	0.1014	0.0000	0.0000	0.5532	0.0968	0.0002	0.0007	0.4986	0.0088	0.1121	0.1968
Significance		-	-			-				-		-	-			-	-		+		
Chi-test p-value																					
Significance level																					

8.5 All nurse respondents (from both hospitals)

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Observed																				
Absolutely disagree	4	5	4	9	0	1	1	1	0	0	1	2	10	2	1	0	3	3	0	3
Strongly disagree	2	7	2	7	4	0	0	0	3	1	1	0	19	4	2	2	1	2	1	1
Somewhat disagree	3	2	3	4	3	1	1	0	2	7	2	1	6	1	2	4	1	3	2	3
Neither agree nor disagree	3	3	2	2	3	5	1	0	6	2	1	2	2	0	1	2	1	3	3	3
Somewhat agree	6	6	6	2	4	10	12	8	8	9	12	12	1	4	9	9	10	5	8	4
Strongly agree	16	7	16	9	15	17	18	16	10	14	15	15	0	18	15	18	16	17	17	18
Absolutely agree	6	6	5	5	8	4	6	13	8	7	6	7	2	10	10	5	7	7	7	8
Total	40	36	38	38	37	38	39	38	37	40	38	39	40	39	40	40	39	40	38	40
Solver parameters																				
μ	0.241675	-0.067357	0.2170619	-0.3345159	0.491325	0.3087059	0.4423705	0.7939164	0.3782237	0.3564366	0.4093481	0.3729359	-0.8256413	0.5882867	0.602223	0.4237005	0.3527373	0.3575869	0.5672246	0.4216126
σ	1.0889946	1.2681947	1.0782342	1.4411224	0.9203049	0.741911	0.7813437	0.9599361	0.8677803	0.8105651	0.7981156	0.906884	0.9779142	1.077051	0.9262646	0.6981168	1.0227253	1.0493293	0.7034996	1.0670707
Expected																				
Absolutely disagree	2.5724224	5.1950759	2.4806299	8.629621	0.7124731	0.3856573	0.3424433	0.4084333	0.7213332	0.5805481	0.4256587	0.9535956	10.960179	1.2342895	0.591443	0.1702144	1.6426044	1.830279	0.0926797	1.7107943
Strongly disagree	5.5599276	6.3092061	5.4023155	6.9544504	3.1747098	3.2381119	2.7291237	2.0489723	3.5451421	3.5981436	2.9842279	3.9948984	11.697098	3.5622796	2.8542241	2.227563	4.618584	4.7937882	1.4382605	4.4861893
Somewhat disagree	3.533678	3.2580888	3.427186	3.1929501	2.7241539	3.4155879	2.9159693	1.9328972	3.090689	3.4138396	3.0077037	3.274776	4.725867	2.6342	2.5752509	2.8867967	3.2644132	3.3089616	2.0704294	3.1295692
Neither agree nor disagree	2.4252893	2.0625799	2.3462646	1.9369572	2.1126392	2.7969373	2.4416715	1.5887974	2.3852977	2.7085333	2.454586	2.4720521	2.5493441	1.9479865	2.053133	2.5975168	2.3386264	2.3527639	1.9819711	2.2433781
Somewhat agree	6.9083031	5.3855813	6.6478113	4.8459704	6.885441	9.1888487	8.4462289	5.6894702	7.5971748	8.7839824	8.2444188	7.7247101	5.1564969	6.1469556	6.9727676	9.5289308	6.984831	6.9898104	7.9934778	6.7630321
Strongly agree	11.726598	8.2817347	11.101118	7.1698684	13.590349	14.911092	16.023062	14.000982	13.63264	15.30139	15.120232	13.869332	4.2016268	12.729671	15.006528	17.637095	12.535236	12.618834	17.858659	12.702727
Absolutely agree	7.2737815	5.5077333	6.5946944	5.2701826	7.8002342	4.0637653	6.1015014	12.330447	6.0277231	5.6135628	5.7631733	6.7106356	0.7093873	10.744618	9.9466532	4.9518835	7.6157046	8.1055631	6.5645227	8.9643099
χ2 contributions																				
Absolutely disagree	0.7922407	0.0073251	0.9306045	0.0158965	0.712473	0.9786327	1.2626347	0.8568135	0.7213331	0.580548	0.7749586	1.1482456	0.0841176	0.4750202	0.282223	0.1702143	1.1217081	0.7475621	0.0926796	0.9715084
Strongly disagree	2.2793614	0.0756349	2.1427387	0.0002983	0.2145405	3.2381118	2.7291236	2.0489722	0.0838273	1.8760646	1.3193229	3.9948983	4.559453	0.0537855	0.2556557	0.0232473	2.8351005	1.6282014	0.1335448	2.7090955
Somewhat disagree	0.0805994	0.4858024	0.0532425	0.2039899	0.027932	1.7083632	1.2589084	1.9328971	0.3848988	3.7671794	0.3376219	1.5801404	0.3435168	1.0138219	0.1284976	0.4292722	1.5707469	0.0288481	0.0023958	0.0053644
Neither agree nor disagree	0.1361868	0.4260472	0.0511022	0.0020519	0.3727135	1.7352856	0.851227	1.5887973	5.4777534	0.1853473	0.8619867	0.090141	0.1183751	1.9479864	0.5401935	0.1374491	0.7662278	0.1780521	0.5229051	0.2551851
Somewhat agree	0.1194236	0.0700965	0.0631275	1.6713985	1.2091847	0.0716049	1.4952577	0.9383207	0.021359	0.0053124	1.7107803	2.3661863	3.350427	0.7498701	0.5893888	0.0293598	1.3015697	0.5664453	5.322E-06	1.1288349
Strongly agree	1.5573113	0.1983695	2.1618581	0.4671469	0.1462152	0.2926371	0.2439162	0.2854136	0.9679764	0.1106838	0.000956	0.0921753	4.2016267	2.1820175	2.84E-06	0.0074672	0.9576674	1.5211087	0.041285	2.2090611
Absolutely agree	0.2230641	0.0439975	0.3856206	0.0138513	0.005116	0.0010006	0.0016885	0.0363572	0.6453309	0.3424221	0.0097319	0.0124775	2.3480554	0.0516031	0.0002861	0.0004675	0.0497777	0.1507939	0.0288887	0.1037329
224.2102142	5.1881872	1.3072731	5.7882941	2.3746332	2.6881751	8.0256359	7.8427561	7.6875717	8.3024789	6.8675577	5.0153585	9.2842642	15.005572	6.4741047	1.7962477	0.7974775	8.6027981	4.8210116	0.8217043	7.3827823
Solver thresholds	Standardised thresholds																			
τ_1	-1.4131197	τ_1	-1.3101572																	
τ_2	-0.6620389	τ_2	-0.6472552																	
τ_3	-0.3557135	τ_3	-0.3768931																	
τ_4	-0.1712329	τ_4	-0.214071																	
τ_5	0.3099364	τ_5	0.2106078																	
τ_6	1.230872	τ_6	1.0234233																	
Standardised parameters																				
μ	0.1504	-0.1224	0.1286	-0.3582	0.3707	0.2095	0.3275	0.6378	0.2709	0.2516	0.2983	0.2662	-0.7917	0.4563	0.4686	0.3110	0.2484	0.2527	0.4377	0.3092
σ	0.9611	1.1193	0.9516	1.2719	0.8123	0.6548	0.6896	0.8472	0.7659	0.7154	0.7044	0.8004	0.8631	0.9512	0.8175	0.6162	0.9027	0.9261	0.6209	0.9418
t-value	0.9894	-0.6561	0.8333	-1.7359	2.7761	1.9725	2.9657	4.6403	2.1513	2.2247	2.6109	2.0770	-5.8010	2.9957	3.6251	3.1924	1.7184	1.7254	4.3454	2.0762
p-value	0.3287	0.5162	0.4102	0.0911	0.0088	0.0563	0.0053	0.0000	0.0384	0.0321	0.0131	0.0448	0.0000	0.0049	0.0008	0.0028	0.0941	0.0926	0.0001	0.0447
Significance					+		+	+	+	+	+	+	-	+	+	+			+	+
Chi-test p-value	0.7601																			
Significance level	5%																			

Question	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Observed																					
Absolutely disagree	1	9	13	0	3	7	0	2	0	8	9	14	8	4	6	13	15	2	1	0	1
Strongly disagree	1	14	16	0	0	15	6	1	2	13	17	20	17	6	9	14	16	7	2	0	0
Somewhat disagree	1	4	4	0	3	2	4	6	5	6	6	1	7	4	4	4	4	4	0	4	0
Neither agree nor disagree	3	2	2	0	1	0	3	5	1	0	0	1	1	2	3	3	0	2	2	0	2
Somewhat agree	10	3	2	3	10	4	4	7	8	5	4	3	4	15	9	2	1	5	4	5	4
Strongly agree	11	5	2	22	14	6	9	14	13	6	3	1	1	4	6	1	3	5	18	18	18
Absolutely agree	4	0	0	15	9	6	4	4	11	2	0	0	1	5	3	3	1	5	13	13	11
Total	**31**	**37**	**39**	**40**	**40**	**40**	**30**	**39**	**40**	**40**	**39**	**40**	**39**	**40**	**40**	**40**	**40**	**30**	**40**	**40**	**36**
Solver parameters																					
μ	0.2954694	-0.8069701	-1.0902512	1.0598483	0.3998202	-0.4105969	0.1066789	0.1393758	0.5780794	-0.5997586	-0.8724092	-1.1501619	-0.7950412	-0.0437031	-0.3320146	-0.8871585	-1.1002908	-0.022435	0.8051988	0.7820475	0.7702768
σ	0.7880787	0.9025725	0.7814804	0.5190946	1.0717019	1.2940376	0.92553	0.844629	0.9370181	1.0233531	0.7495944	0.6837946	0.8450284	0.9479597	1.025799	1.219863	1.0234985	1.1125387	0.9870016	0.8580644	0.9415395
Expected																					
Absolutely disagree	0.467408	9.2842472	13.250189	3.796E-05	1.8142708	8.7700483	1.5085871	1.2879881	0.6716687	8.5345965	9.1786877	14.011318	9.058082	2.9714413	5.8384365	13.326981	15.197475	3.169438	0.4921199	0.210384	0.3671454
Strongly disagree	3.0103212	11.575843	14.367152	0.0181536	4.62124	8.1486449	4.5846585	5.3947378	3.0418924	10.494833	14.631157	16.482215	12.880696	7.3129614	9.1147983	9.6013006	11.432271	5.3108972	2.250498	1.6372802	1.9404084
Somewhat disagree	2.85617	4.7235942	4.611228	0.1096413	3.1808812	3.7579109	3.1671333	4.1937272	2.6660205	4.740332	5.6227876	4.6003213	5.3000818	4.5566124	4.678131	3.8100444	4.0316472	2.9872917	2.0476734	1.8493801	1.8636626
Neither agree nor disagree	2.2486821	2.5139731	2.0993053	0.2263987	2.2663982	2.2584166	2.1991535	3.0282736	2.0983714	2.7222135	2.7505915	1.8610518	2.7835947	3.0186423	2.8596089	2.1161251	2.0581653	1.936422	1.6601256	1.6346154	1.5406482
Somewhat agree	7.1444346	4.9079595	3.2451326	2.6168716	6.7804024	5.511837	6.1478668	8.715914	7.017061	6.0272712	4.5796708	2.3903437	5.2530133	7.9581667	6.8801793	4.6170027	3.9154485	5.1189936	5.8659607	6.3119188	5.5362651
Strongly agree	11.626593	3.5511753	1.3689532	22.192816	12.575338	7.4606555	9.0250944	12.552277	14.784802	6.0079917	2.139259	0.6447998	3.4025937	10.606736	8.0765716	4.8782792	2.9100344	7.5778315	14.358314	16.337858	13.507188
Absolutely agree	3.6463909	0.4432076	0.0580404	14.83608	8.7614699	4.0924867	3.3675064	3.8270819	9.7201843	1.4727625	0.097846	0.0099504	0.3219381	3.5754403	2.5522745	1.6502672	0.4549587	3.8991259	13.325309	12.018564	11.244682
χ2 contributions																					
Absolutely disagree	0.6068663	0.0087025	0.004724	3.786E-05	0.7749415	0.3572467	1.508587	0.3936068	0.6716686	0.0334865	0.0034786	9.143E-06	0.1235954	0.3560336	0.0044708	0.0080226	0.002566	0.4314914	0.5241448	0.2103839	1.0908615
Strongly disagree	1.3425116	0.5076552	0.1855757	0.0181535	4.6212399	5.7605978	0.4369336	3.5801036	0.3568633	0.5979956	0.383525	0.7507979	1.3173715	0.2357277	0.0014459	2.0152016	1.825022	0.5372102	0.0278824	1.6372801	1.9404083
Somewhat disagree	1.2062891	0.1108454	0.0810196	0.1096412	0.0102858	0.8223321	0.2190204	0.7779766	2.0432926	0.3347368	0.0253058	2.8176974	0.5452221	0.0679929	0.0983003	0.0094705	0.0002484	0.3433137	2.0476733	2.5009275	1.8636625
Neither agree nor disagree	0.2510264	0.10508	0.0046975	0.2263986	0.7076269	2.2584165	0.2916372	1.2838024	0.5749314	2.7222134	2.7505914	0.3983823	1.1428424	0.3437413	0.0068924	0.3691818	2.0581652	0.0020874	0.0695818	1.6346153	0.136958
Somewhat agree	1.1413434	0.7417155	0.4777478	0.0560927	1.5287896	0.4146804	0.7503955	0.3378144	0.1376886	0.1750852	0.0733717	0.1554926	0.2988841	6.2310098	0.6531283	1.4833656	2.170847	0.0027661	0.5935616	0.2726795	0.4263001
Strongly agree	0.0337691	0.5910981	0.2908938	0.0016752	0.1614003	0.2859688	6.978E-05	0.1669737	0.2154589	1.063E-05	0.3463232	0.1956687	1.6964871	4.115211	0.5339084	3.0832694	0.0027813	0.8769283	0.9236376	0.1690991	1.4944163
Absolutely agree	0.0342913	0.4432075	0.0580403	0.0018111	0.006494	0.8890943	0.1187966	0.0078129	0.1685079	0.1887469	0.0978459	0.0099503	1.4281249	0.5675861	0.078541	1.1039295	0.6529605	0.3108193	0.0079417	0.0801441	0.0053243
224.2102142	4.6160972	2.5083042	1.1026987	0.4138102	7.8107781	10.788337	3.3254401	6.5480903	4.1684113	4.052275	3.6804417	4.3279983	6.5525276	11.917303	1.3766871	8.072441	6.7125903	2.5046164	4.1944233	6.5051295	6.957931
Solver thresholds																					
τ_1																					
τ_2																					
τ_3																					
τ_4																					
τ_5																					
τ_6																					
Standardised parameters																					
μ	0.1978	-0.7752	-1.0252	0.8725	0.2899	-0.4253	0.0312	0.0601	0.4473	-0.5923	-0.8329	-1.0781	-0.7646	-0.1015	-0.3560	-0.8459	-1.0341	-0.0827	0.6477	0.6273	0.6169
σ	0.6956	0.7966	0.6897	0.4582	0.9459	1.1421	0.8169	0.7455	0.8270	0.9032	0.6616	0.6035	0.7458	0.8367	0.9054	1.0766	0.9033	0.9819	0.8711	0.7573	0.8310
t-value	1.5837	-5.9191	-9.2823	12.0441	1.9387	-2.3553	0.2093	0.5032	3.4205	-4.1474	-7.8623	-11.2977	-6.4026	-0.7674	-2.4867	-4.9693	-7.2398	-0.4615	4.7026	5.2386	4.4542
p-value	0.1241	0.0000	0.0000	0.0000	0.0600	0.0238	0.8357	0.6178	0.0015	0.0002	0.0000	0.0000	0.0000	0.4476	0.0174	0.0000	0.0000	0.6480	0.0000	0.0000	0.0001
Significance		-	-	+		-			+	-	-	-	-		-	-	-		+	+	+
Chi-test p-value																					
Significance level																					

8.6 All administrator respondents (from both hospitals)

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Observed																				
Absolutely disagree	0	4	5	3	1	0	0	1	0	0	0	1	10	0	1	0	0	1	0	1
Strongly disagree	6	2	0	2	1	1	0	0	1	3	1	3	11	2	1	0	2	0	0	3
Somewhat disagree	0	1	0	1	1	1	0	0	0	0	0	2	3	1	0	2	0	0	0	0
Neither agree nor disagree	5	4	9	9	2	2	5	1	2	1	2	2	2	4	1	3	3	5	3	2
Somewhat agree	0	0	1	1	2	3	5	3	2	4	2	3	1	3	0	4	2	4	2	2
Strongly agree	8	11	7	3	10	11	10	16	9	10	18	14	2	10	17	11	12	9	18	12
Absolutely agree	7	2	4	6	8	5	2	8	10	10	6	5	1	9	10	8	9	10	4	10
Total	**26**	**24**	**26**	**25**	**25**	**23**	**22**	**29**	**24**	**28**	**29**	**30**	**30**	**29**	**30**	**28**	**28**	**29**	**27**	**30**
Solver parameters																				
μ	0.246263	-0.029832	-0.1358309	0.0223592	0.5102056	0.4408892	0.2583547	0.4844321	0.7203583	0.5622413	0.5192008	0.2697397	-0.7686696	0.4956821	0.5631533	0.4403764	0.56704	0.4703205	0.4705419	0.5393223
σ	0.8205798	0.8586228	0.8504832	0.8446208	0.8193168	0.5405558	0.4057343	0.7082141	0.6637098	0.734402	0.4554272	0.675557	0.7860199	0.6872853	0.7362501	0.6242951	0.6483831	0.790715	0.3833581	0.8294336
Expected																				
Absolutely disagree	1.1924307	2.3642243	3.1053657	2.1208494	0.5539167	0.0402535	0.0063894	0.3191236	0.0614649	0.288962	0.0039878	0.5585886	9.5830242	0.2535446	0.3133788	0.1608254	0.1199044	0.6091482	0.0003688	0.6481276
Strongly disagree	4.2479945	5.4541609	6.5198371	5.4094807	2.6642377	1.2505466	1.046365	2.6210686	0.9756333	2.2608618	0.5714533	4.075396	10.589755	2.4129766	2.4289614	2.2098913	1.6840647	3.1819807	0.2765907	3.0810673
Somewhat disagree	0.8336674	0.9028333	1.0288019	0.9280314	0.5969815	0.4792066	0.5656563	0.688205	0.3257559	0.5927452	0.3275838	0.987667	1.1773165	0.663963	0.6350705	0.6713378	0.5281161	0.7263881	0.219974	0.6909305
Neither agree nor disagree	3.2087228	3.1927916	3.5420476	3.3348815	2.482197	2.5553275	3.505654	3.0576059	1.6790066	2.6548449	2.3091816	4.1165105	3.3655998	3.0182208	2.841063	3.173288	2.583387	3.0324675	2.001291	2.8810661
Somewhat agree	2.7154026	2.4327365	2.6006047	2.589612	2.3203928	2.9541758	4.2503122	3.0311109	1.9735922	2.6776251	3.4589527	3.7253126	1.8927226	3.0603826	2.8625357	3.3028855	2.8322578	2.8336489	3.6153383	2.7081115
Strongly agree	8.0124321	6.1339066	6.1384444	6.6904726	8.1533556	10.838057	11.194693	10.819482	9.1608559	10.107949	15.98017	10.953083	2.839619	11.130685	10.804153	11.638817	11.32706	9.7572218	16.91273	9.6726152
Absolutely agree	5.7893498	3.5193468	3.0648985	3.9266724	8.2289188	4.8824333	1.4309299	8.4634041	9.8236911	9.4170124	6.3486708	5.583442	0.551963	8.4602279	10.114838	6.8429546	8.9252106	8.8591447	3.9737071	10.318082
χ2 contributions																				
Absolutely disagree	1.1924306	1.1317716	1.1558473	0.3644321	0.3592421	0.0402534	0.0063893	1.4527051	0.0614648	0.2889619	0.0039877	0.3488149	0.0181434	0.2535445	1.5044047	0.1608253	0.1199043	0.2507847	0.0003687	0.1910337
Strongly disagree	0.7225817	2.1875459	6.519837	2.1489232	1.0395795	0.0501969	1.0463649	2.6210685	0.0006086	0.2416447	0.3213775	0.2837703	0.0158928	0.0706802	0.84066	2.2098912	0.0592704	3.1819806	0.2765906	0.002133
Somewhat disagree	0.8336673	0.0104575	1.0288018	0.0055811	0.2720752	0.5659889	0.5656562	0.6882049	0.3257558	0.5927451	0.3275837	1.037615	2.8218199	0.1700709	0.6350704	2.6295901	0.528116	0.726388	0.2199739	0.6909304
Neither agree nor disagree	0.9999847	0.2040802	8.4101758	9.6236005	0.0936726	0.1206846	0.6369909	1.3846591	0.0613677	1.0315147	0.041397	1.0882072	0.5540952	0.3193571	1.1930439	0.009463	0.0671856	1.2765788	0.4983881	0.269441
Somewhat agree	2.7154025	2.4327364	0.9851306	0.9757702	0.0442389	0.0007108	0.1322331	0.0003193	0.0003534	0.6530695	0.6153721	0.1412172	0.421062	0.0011914	2.8625356	0.1471346	0.2445686	0.4800789	0.7217354	0.1851555
Strongly agree	1.929E-05	3.8603237	0.1209228	2.035669	0.4182444	0.0024198	0.1274972	2.480504	0.0028245	0.0011528	0.2552985	0.8475878	0.2482587	0.1148579	3.5531268	0.0350626	0.0399794	0.0587652	0.0698974	0.5600057
Absolutely agree	0.2531673	0.6559213	0.2852997	1.0947405	0.0063682	0.002831	0.2263149	0.0253732	0.0031643	0.0360915	0.0191491	0.0609668	0.3636785	0.0344381	0.0013038	0.1956398	0.0006267	0.1469161	0.000174	0.0098057
227.8474386	6.7172533	10.482837	18.506115	16.248717	2.2334211	0.7830853	2.7414465	8.6528342	0.455539	2.8451803	1.5841655	3.8081793	4.4429506	0.9641402	10.590145	5.3876065	1.0596409	6.1214923	1.7871281	1.908505
Solver thresholds	Standardised thresholds																			
T_1	-1.1375344	-1.3004987																		
T_2	-0.4176159	-0.5243797																		
T_3	-0.3298586	-0.4297716																		
T_4	-0.0375434	-0.1146368																		
T_5	0.1827698	0.1228752																		
T_6	0.8725426	0.8664951																		
Standardised parameters																				
μ	0.1913	-0.1063	-0.2206	-0.0501	0.4759	0.4011	0.2044	0.4481	0.7024	0.5320	0.4856	0.2166	-0.9028	0.4602	0.5330	0.4006	0.5371	0.4329	0.4331	0.5073
σ	0.8846	0.9257	0.9169	0.9106	0.8833	0.5828	0.4374	0.7635	0.7155	0.7917	0.4910	0.7283	0.8474	0.7409	0.7937	0.6730	0.6990	0.8524	0.4133	0.8942
t-value	1.1028	-0.5627	-1.2268	-0.2749	2.6938	3.3013	2.1914	3.1605	4.8093	3.5554	5.3258	1.6292	-5.8357	3.3449	3.6777	3.1495	4.0662	2.7346	5.4454	3.1072
p-value	0.2811	0.5793	0.2318	0.7859	0.0130	0.0034	0.0404	0.0039	0.0001	0.0015	0.0000	0.1145	0.0000	0.0024	0.0010	0.0041	0.0004	0.0109	0.0000	0.0043
Significance					+	+	+	+	+	+	+		-	+	+	+	+	+	+	+
Chi-test p-value	0.7032																			
Significance level	5%																			

Question	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Observed																					
Absolutely disagree	0	7	6	1	0	5	0	1	2	3	5	10	11	5	6	13	13	6	4	2	0
Strongly disagree	2	14	16	3	3	17	10	2	0	15	15	19	18	4	13	16	12	6	0	2	1
Somewhat disagree	1	1	0	0	0	0	1	1	0	0	1	0	0	3	1	0	1	0	0	0	0
Neither agree nor disagree	5	3	4	1	2	1	2	1	2	0	3	1	0	3	1	1	0	5	0	0	4
Somewhat agree	3	1	1	4	2	0	1	4	4	5	1	0	1	10	2	0	1	3	2	2	3
Strongly agree	9	2	1	9	16	3	3	11	10	4	3	0	0	5	4	0	1	3	12	10	10
Absolutely agree	7	2	1	10	7	2	3	10	12	3	2	0	0	0	2	0	0	3	12	14	9
Total	**27**	**30**	**29**	**28**	**30**	**28**	**20**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**29**	**30**	**28**	**26**	**30**	**30**	**27**
Solver parameters																					
μ	0.3880831	-0.6133341	-0.6456471	0.5298676	0.4623205	-0.549903	-0.2328131	0.5209007	0.5737004	-0.3134046	-0.5169514	-0.9864489	-0.9660827	-0.2723915	-0.5266333	-1.0673798	-1.0594163	-0.3612813	0.5062277	0.7516491	0.5532755
σ	0.655262	0.8242414	0.6774146	0.862903	0.5930309	0.7623457	0.8072783	0.8042232	0.9694938	0.7605218	0.7685557	0.342957	0.4519318	0.6280994	0.8312417	0.3882152	0.6439501	0.9540904	1.1667229	1.0940256	0.6321427
Expected																					
Absolutely disagree	0.2686302	7.8718503	6.7825564	0.7464854	0.1047116	6.1713894	2.624132	0.5878909	1.1632529	4.1778843	6.2909658	9.8932164	10.56614	2.5258382	6.7045765	12.848922	12.648229	5.4063237	2.3830995	1.2630042	0.1009663
Strongly disagree	2.6858896	9.9435634	11.539593	3.0642634	1.9632369	9.757283	5.5651729	3.0603544	3.4348467	9.1872692	10.251631	18.648877	16.060383	9.7314087	9.3084035	15.738297	10.88677	6.9815844	4.043817	3.0145754	1.5807196
Somewhat disagree	0.7340769	1.2210223	1.3819616	0.6565865	0.6562011	1.2513444	0.853838	0.7035123	0.672022	1.375932	1.3423676	0.6245571	0.985569	1.649259	1.2003903	0.5508403	0.863658	0.9536457	0.6772971	0.5656124	0.5106996
Neither agree nor disagree	3.2771589	3.6912564	3.9402489	2.6841513	3.2651413	3.7985514	2.868176	2.9598129	2.6556141	4.5067741	4.1234324	0.7484445	1.7891441	5.4663446	3.720656	0.7421814	2.0257932	3.1116119	2.5132989	2.2170766	2.5323377
Somewhat agree	3.2136484	2.2606134	2.1458649	2.4735724	3.5711088	2.3102426	2.0217193	2.8008459	2.3759319	3.0401209	2.552718	0.075133	0.4334776	3.5972814	2.3613379	0.1005479	0.8233358	2.1560535	2.106468	1.9858193	2.8055903
Strongly agree	10.614614	3.940212	2.8470403	8.6970225	13.103073	3.842375	4.3577113	9.958569	8.329901	5.9284449	4.3796211	0.0097712	0.1645763	6.0049876	4.3658595	0.0192031	0.7144383	4.8435087	6.9728512	7.2737597	11.187167
Absolutely agree	6.2059819	1.0714823	0.3627345	9.6779184	7.3365272	0.8688141	1.7092504	9.9290147	11.368431	1.7835746	1.0592637	8.916E-07	0.0007102	1.0248804	1.3387764	8.733E-06	0.0377762	2.5472721	11.303168	13.680152	8.2825195
χ2 contributions																					
Absolutely disagree	0.2686301	0.0965622	0.0902896	0.0860963	0.1047115	0.2223411	2.6241319	0.2888868	0.601886	0.3320847	0.2649184	0.0011526	0.0178149	2.4235425	0.0740432	0.0017764	0.0097834	0.0651925	1.0970449	0.4300562	0.1009662
Strongly disagree	0.1751541	1.654807	1.7240839	0.0013477	0.5475028	5.3761841	3.5340664	0.3673925	3.4348466	3.6776803	2.1993576	0.006611	0.2342481	3.3755694	1.464041	0.0043517	0.1138337	0.1380071	4.0438169	0.3414621	0.2133429
Somewhat disagree	0.096332	0.0400081	1.3819615	0.6565864	0.656201	1.2513443	0.0250203	0.1249516	0.6720219	1.3759319	0.08732	0.624557	0.9855689	1.106255	0.0334527	0.5508402	0.0215237	0.9536456	0.677297	0.5656123	0.5106995
Neither agree nor disagree	0.9057179	0.1294506	0.0009061	1.0567085	0.4902031	2.0618096	0.2627905	1.297672	0.161857	4.506774	0.30608	0.0845489	1.789144	1.112783	1.9894257	0.0895609	2.0257931	1.1460329	2.5132988	2.2170765	0.8506103
Somewhat agree	0.0142037	0.7029711	0.6118774	0.9419498	0.6912091	2.3102425	0.5163478	0.5134058	1.1101316	1.263478	0.9444572	0.0751329	0.7404016	11.396051	0.0552928	0.1005478	0.0379071	0.3303469	0.0053813	0.0001013	0.0134714
Strongly agree	0.2456028	0.9553858	1.1982822	0.0105548	0.6404746	0.1846763	0.4230156	0.1089091	0.3348456	0.6272977	0.4345934	0.0097711	0.1645762	0.1681935	0.0306591	0.019203	0.1141392	0.7016658	3.6243745	1.0218081	0.1259805
Absolutely agree	0.1015899	0.8046282	1.1195713	0.0107189	0.0154365	1.4727907	0.9747164	0.0005075	0.0350865	0.8296209	0.8354715	8.017E-07	0.0007101	1.0248803	0.3265793	8.634E-06	0.0377761	0.0804636	0.0429591	0.0074782	0.0621524
227.8474386	1.8072304	4.3838131	6.126972	2.7639624	3.1457388	12.879389	8.360089	2.7017253	6.3506753	12.612867	5.0721981	0.8017743	3.9324637	20.607275	3.9734938	0.7662886	2.3607563	3.4153543	12.004173	4.5835946	1.8772232
Solver thresholds																					
τ_1																					
τ_2																					
τ_3																					
τ_4																					
τ_5																					
τ_6																					
Standardised parameters																					
μ	0.3442	-0.7354	-0.7702	0.4971	0.4242	-0.6670	-0.3252	0.4874	0.5443	-0.4120	-0.6315	-1.1376	-1.1157	-0.3678	-0.6419	-1.2249	-1.2163	-0.4636	0.4716	0.7362	0.5223
σ	0.7064	0.8886	0.7303	0.9303	0.6393	0.8219	0.8703	0.8670	1.0452	0.8199	0.8286	0.3697	0.4872	0.6771	0.8961	0.4185	0.6942	1.0286	1.2578	1.1794	0.6815
t-value	2.5319	-4.5328	-5.6795	2.8274	3.6346	-4.2944	-1.6708	3.0791	2.8525	-2.7526	-4.1744	-16.8528	-12.5423	-2.9752	-3.8574	-16.0300	-9.2708	-2.2985	2.0536	3.4187	3.9824
p-value	0.0180	0.0001	0.0000	0.0089	0.0011	0.0002	0.1121	0.0046	0.0081	0.0103	0.0003	0.0000	0.0000	0.0060	0.0006	0.0000	0.0000	0.0305	0.0495	0.0019	0.0005
Significance	+	-	-	+	+	-		+	+	-	-	-	-	-	-	-	-	-	+	+	+
Chi-test p-value																					
Significance level																					