CURRENT STATUS OF MEDICAL INFORMATICS AND IMPLEMENTING ELECTRONIC HEALTHCARE RECORDS, CHALLENGES, AND FUTURE DIRECTION IN SOUTH AFRICA

DISSERTATION
Submitted to Texila American University
in partial fulfilment of the requirement for the award of the Degree of

Doctor of Philosophy in Clinical Research

Submitted by

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Application Number: 4596

Under the Guidance of
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CERTIFICATE

This is to certify that the thesis, entitled **"CURRENT STATUS OF MEDICAL INFORMATICS AND IMPLEMENTING ELECTRONIC HEALTHCARE RECORDS, CHALLENGES, AND FUTURE DIRECTION IN SOUTH AFRICA"** submitted to the Texila American University, in partial fulfilment of the requirements for the award of the Degree of **Doctor of Philosophy in Clinical Research** is a record of original research work done by **Michael Sello Seahloli,** under my/our supervision and guidance and the thesis has not formed the basis for the award of any Degree / Diploma / Associateship / Fellowship or other similar title to any candidate of any University.

22 April 2016
[Signature of the Mentor with Seal]

DECLARATION

I, Michael Sello Seahloli declare that this thesis entitled **CURRENT STATUS OF MEDICAL INFORMATICS AND IMPLEMENTING ELECTRONIC HEALTHCARE RECORDS, CHALLENGES, AND FUTURE DIRECTION IN SOUTH AFRICA** submitted in partial fulfilment of the degree of **Doctor of Philosophy** is a record of original work carried out by me under the supervision of **Dr Kannan Sridharan and Prof Patrick Demana**, and has not formed the basis for the award of any other degree or diploma, in this or any other Institution or University. In keeping with the ethical practice in reporting scientific information, due acknowledgements have been made wherever the findings of others have been cited.

Michael Sello Seahloli

22 April 2016

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[Michael Sello Seahloli]

DEDICATIONS

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ABBREVIATIONS

AdH	-	Addington Hospital
ANH	-	Alberlito Netcare Hospital
BoH	-	Bongani Hospital
BMC	-	Brits Mediclinic
BSC	-	Balance Score Card
BWH	-	Barkley West Hospital
CEO	-	Chief Executive Officer
CDISC	-	Clinical Data Interchange Standards Consortium
CGM	-	Cape Gate Mediclinic
CMH	-	Charlotte Maxeke Hospital
CeMH	-	Cecilia Makiwane Hospital
CNH	-	Cuyler Netcare Hospital
CSF	-	Critical Success Factor
DHIS	-	District Health Information System
DICOM	-	Digital Imaging and Communications in Medicine
EBM	-	Evidence-Based Medicine
EHR	-	Electronic Health Record
ErH	-	Ermelo Hospital
EsH	-	Eshowe Hospital
EvH	-	Evander Hospital
FNH	-	Ferncrest Netcare Hospital

GH	-	Gelukspan Hospital
GP(s)	-	General Practitioner(s)
HIPAA	-	Health Insurance Portability and Accountability Act of 1996
HIT	-	Health Information Technology
HIS	-	Hospital Information System
HL7	-	Health Level 7
HMC	-	Highveld Mediclinic
HMI	-	Health and Medical Informatics
HSH	-	Dr Harry Surtie Hospital
IALCH	-	Inkosi Albert Luthuli Central Hospital
ICD	-	International Classification of Diseases
ICF	-	Informed Consent Form
ICT	-	Information and Communication Technology
IHTSDO	-	International Health Terminology Standards Development Organisation
IMIA	-	International Medical Informatics Association
IOM	-	Institute of Medicine
IT	-	Information Technology
JNH	-	Jakaranda Netcare Hospital
KH	-	Klerksdorp Hospital
KiH	-	Kimberley Hospital
KMC	-	Kimberley Mediclinic
LMC	-	Limpopo Mediclinic
LTH	-	Louise Trichardt Hospital
LOINC	-	Logical Observation Identifiers Names and Codes

MedDRA	-	Medical Dictionary for Regulatory Activities
MeSH	-	Medical Subject Heading
MiNH	-	Milpark Netcare Hospital
MKH	-	Moses Kotane Hospital
MNH	-	Mulbarton Netcare Hospital
MMC	-	Morningside Mediclinic
MiMC	-	Milnerton Mediclinic
N1CNH	-	N1 City Netcare Hospital
NeH	-	Newcastle Hospital
NHIF	-	National Health Insurance Fund
NHLS	-	National Health Laboratory Services
NMH	-	Nelson Mandela Hospital
NSH	-	Natalspriut Hospital
PeH	-	Pelonomi Hospital
PoH	-	Polokwane Hospital
PNH	-	Pelonomi Netcare Hospital
PNC	-	Presidential National Commission
POMR	-	problem-oriented medical record
PPH	-	Port Elizabeth Provincial Hospital
PRH	-	Piet Retief Hospital
P value	-	Probability value
RPH	-	Rustenburg Provincial Hospital
SMC	-	Sandton Mediclinic
SNOMED	-	Systematized Nomenclature of Medicine

TB	-	Tuberculosis
TdH	-	Tshilidzini Hospital
TeH	-	Tembisa Hospital
ToH	-	Tokollo Hospital
TMC	-	Tzaneen Mediclinic
UCTNH	-	University of Cape Town Netcare Hospital
UH	-	Universitas Hospital
UK	-	United Kingdom
USA	-	United State of America (USA)
UmH	-	Umzimkhulu Hospital
VistA	-	Vererans Health Information System and Technology Architecture
VH	-	Vryburg Hospital
WHO	-	World Health Organisation
WiH	-	Witbank Hospital
WIREC	-	Washington and Idaho Reginal Extension Centre
ZJH	-	Zola-Jabulani Hospital

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CHAPTER 1

1. INTRODUCTION

1.1 Medical Informatics

Medical Informatics is also called Healthcare or Health Informatics; it has been defined as application of computer systems and information technology to fields of medicine. Medical informatics is applied in medical care, medical education and medical and clinical research and these applications help to improve patient care, education and administration. Medical informatics emphasises the sharing of information for the benefit of better patient care, safety, medical education, disease management, evidence based medicine, proper handling of medical record, electronic scripting, x-ray digital picture and electronic lab results. Medical informatics is a multidisciplinary field that uses health information technology (HIT) to improve health care. [1,2]. The term medical informatics was first documented by Dr Anderson at Kings College of Medicine in London [1]. According to Morris et al the use of computer systems in medicine started in the 1950s and early 1970s. It was agreed to term the domain medical or medicine [1].

South African department of health refer to it as eHealth and define it together with World Health Organisation (WHO) as the use of information and communication technologies (ICTs) for health, to record and store information when treating patients, pursuing research, educating students, tracking diseases and monitoring public health [3]. The eHealth in South Africa will include number of domains like:

- Electronic health records (EHRs) which enable sharing of patient data between points of care.
- Routine health management information like web-based surveillance systems, electronic disease registry and district health information system.
- Vital registry where deaths and births are registered.
- Telemedicine used to provide care at distant areas
- Consumer health informatics whereby patients and individuals will access health information.

- m-Health where mobile devices used to share information and collect aggregate or patient data.
- Health knowledge management where the best practice guidelines are managed and accessed electronically.
- Health research where large volume of data are handled by high performance computing.
- Virtual healthcare used by professionals working together via ICTs.

Medical informatics aspects are interconnected and will be able to gather information that will capture health statistics in a country or an area. Several health portals can be set via a central website to give and capture health information, and health providers can analyse and give recommendations. There are multiple sources driving the adoption of medical informatics however, the adoption is very slow [3].

1.2 Electronic Health Records

Electronic Health Records (EHRs) are an electronic record of health related information a patient encounters with a heath provider during episodes of patient care. They are sometimes called electronic medical records or computer-based patient records [4]. The EHRs are also defined as a repository of patient data in an electronic format or digital form, securely shared and stored and where it is accessed by multiple authorised medical staff or personnel. It is used to support continuing efficient and quality integrated health care [5].

There are different types and structures of EHRs - mostly they combined all the three elements namely; Time-oriented, Problem oriented, and Source-oriented EHRs. In the time-oriented electronic medical record, the data are presented in chronological order as they are recorded in the system. In the problem-oriented medical record (POMR), notes are taken for each problem assigned to the patient, and each problem is described according to the subjective information, objective information, assessments and plan (SOAP). In the source-oriented record, the content of the record is arranged according to the method by which the information was obtained, e.g. notes of visits, X-ray reports and blood tests. Within each section, the data is reported in a chronological order [5].

1.3 Introduction to the challenges

The healthcare system, particularly the United States of America (USA), continues to face multiple challenges related to unsustainable increases in cost, uneven quality of care and persistent barriers of entry to universal access. Additional pressures are mounting as a result of demographic and other trends: especially the ageing of the USA population. This lead to a more complex and costly disease burden in the coming years as well as; the potentially transformative impact of personalized medicine based on individual genomic information and the movement towards greater involvement in decision making about health issues by patients and their families [6].

Efforts to determine "what works" are hardly new in the study of medicine, but the systematic utilization of "evidence-based medicine" (EBM) which began in the 1990s, is the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients [7]. Improved efficiency and effectiveness of care relies on the best information being made available and readily accessible by health professionals and patients to use in making decisions. An underlying series of complex processes is required for this to happen via basic, translational, and clinical research such as collecting patient data and making it available to researchers and clinicians, organizing the information that is needed for clinical decision making, creating methods to effectively disseminate the information; and capturing the results of decisions so that this information is available for new analyses and future cycles of improvement [3].

In South Africa the population has grown from 46,5 million people in 2004 to 49.9 million in 2010 and this increase in population also increases the disease burden that the country has to confront. South Africa is faced with a quadruple burden of diseases consisting of HIV and AIDS and Tuberculosis (TB); high maternal and child mortality; non communicable diseases and violence and injuries [3].

The South African public healthcare sector, like most developing countries, 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 [9]. 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.

The experience of Hospital Information System (HIS) in two South African hospitals and the perceptions of stakeholders as to its effectiveness in introducing efficiencies into everyday processes has identified that there is a 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. HIS was also found to determine the systemic and workflow-related strategic and cost benefits that result from automating healthcare systems in South Africa [10].

1.4 Perceived Benefits of Medical Informatics

Information Technology (IT) has the substantial 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. 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 [10, 11]. In general, Hospital Information Systems (HIS) automate the patient administrative functions (such as patient profile information, scheduling of appointments, billing) and the clinical care functions (e.g. clinical notes, computerised prescriptions, online laboratory results, digital radiological imaging) and ultimately has the capability of eliminating paper processes within the clinical setting. This aims to create a more cost effective, resource efficient, informed healthcare service that can be accessed by all [10].

Ruxwana et al, stated that Information and Communication Technologies (ICTs) in South Africa have the potential to improve the lives of people in rural communities. According to the 2006 United Nations Development Program, (cited in Ruxwana 2009), increased use of ICTs enhances service delivery by:

- delivering economies of scale to improve access to basic services.
- optimising service delivery providing incentives for development and transfer of new technologies and products.
- increasing efficiency through enhanced connectivity and exchange of knowledge.
- enabling regions to focus on delivering services where they have a comparative advantage.
- providing access to digital development for continuous improvement.

The need to develop and organise new ways to provide efficient healthcare services has thus been accompanied by major technological advances, resulting in a dramatic increase in the use of ICT applications in healthcare and e-health.

The Presidential National Commission (PNC) on Information Society and Development (2006) states that ICT applications such as e-health are suitable for addressing the digital divide between rural and urban populations, including rich and poor, young and old, males and females, and unequal distribution of health professionals, particularly in specialist healthcare. Computerised health information systems can improve treatment of patients, management of health institutions, and provide up-to-date information for policy and decision making. The PNC defines e-health as the combined utilisation of electronic communication and information technology to generate, transmit, store and retrieve digital data for clinical, educational and administrative purposes [12].

1.5 Research topic and central research question

This research has identified the need to investigate the use of medical informatics and implementation in South Africa. The world is moving toward using information technology to

advance their services. In healthcare cost and access to information or care is always a problem. Medical informatics is introduced as a required intervention in order to lower transactional costs, co-ordinate care, improve human resource management, measure improvements and streamline operational effectiveness. Implementation of e-health is important and it will help to solve some of the health care problems in South Africa. The major challenges in South Africa are to improve systems performance. Critical health information tools can be deployed to measure the performance of systems, in terms of costs, quality, at all levels, from individual clinicians to national network [13]. USA has invested in EHR and they have moved a number of steps ahead. However, there are problems implementing EHRs. Furthermore, the questions, we need to ask are as follows: how is the use of e-health and its implementation in South Africa, how far South Africa has invested in the e-health, and what challenges have they encountered when implementing the e-health including data sharing and data privacy. The purpose of this research is to answer the questions raise above which can be fulfilled and through PhD programme.

1.6 Societal and scientific relevance

This research will evaluate the status of e-health in South African sites which is thought will help to give South Africa, the Government and the research world current information on the status of e-health in South Africa. Such research will have an impact on better health - giving better healthcare and access to new medication to South Africans. Most pharmaceutical companies have advanced in using information technology when doing their studies. If this information is available, more studies will be implemented in South Africa which will improve and give access to better healthcare. Department of Health will be able to know where the IT infrastructure is lacking and it will be able to plan to improve the IT infrastructure. At the later stage patients and healthcare personnel will benefit and acquire skills through training and development. Cost of health care will reduce and access to medical records will be easy regardless of the geographical area and this will lead to a better healthcare.

Integration and assimilation of e-health into the everyday life of healthcare workers is becoming a reality in developing as well as developed countries. ICTs enable online communication about medical issues and diagnosis of complicated diseases by linking medical practitioners who are

separated geographically. They have the potential to change the delivery of healthcare services and patient care, as well as the management of healthcare systems. According to Eysenbach (2001), e-health is an emerging field in the intersection of medical informatics, public health and business, with referral and information delivery enhanced through the Internet and related technologies. In a broader sense, the term characterises not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking to improve healthcare locally, regionally and worldwide by using information and communication technologies. Thus, ICTs are widely perceived to have the capability, if used effectively, to bridge social and economic gaps that divide rural and urban communities, improving access and providing a wider range of health services to enhance the wellbeing of underprivileged people, such as those in the Eastern Cape Province of South Africa and other provinces.

1.7 Expected Output

The expected output on this research is that South African sites have not yet implemented e-health as much as it was expected since there is perception that South Africa has the infrastructure and funds to implement e-health as compared to other developing countries. UKZN Inkhosi Albert Luthuli Hospital should have advanced in implementation and other academic healthcare Centres. IALCH has started this project in the early 2000, long before other hospitals start implementing automation. The researcher expects this hospital to be at advanced stage compared to others. This study will give more information on implementation and find issues that halt or delay implementation of e-health. The research will further give insight on the data sharing status and data sharing policies in South Africa and give perception of health personnel and patients towards e-health and data privacy.

1.8 Study sample

The research is conducted in South African public hospitals and private hospitals. A total of 45 public hospitals and 22 private hospitals were planned however, the researcher managed to access 31 public hospitals and 18 Private hospitals. All hospitals regardless of the implementation of electronic system in the hospitals were randomised to select the 45 public and the 22 private hospitals. From each public hospital planned to survey in a province; the researcher surveyed at least 6 sites. For example, 3-6 public / academic hospitals (at least one in the rural area), 2 private hospitals, Radiology facilities and Pharmacies within the facilities. Provinces like Gauteng and Kwazulu-Natal had at least 2 more sites since they have high number of potential sites and the population is higher. Western Cape public hospitals were not accessed since the CEOs of the hospital decline invitation to participate. The survey questionnaire was targeted at Medical Doctors, Nurses, Pharmacists, Radiologists, Radiographers, IT personnel, site administrators and patients. The researcher planned to collect at least 600 questionnaires. At the hospitals the researcher and hospital management randomly selected the participants and the number of randomly selected participants depended on the size of the hospital. In total there will be 6 to 25 participants to be selected from each hospital. Details of sampling are discussed in section 4.1 Characteristics of the study sample.

1.9 Objectives of the study

The aim of this study was twofold.

1.9.1 Primary Objective

The primary objective of this research is to investigate the current status in South Africa on the medical informatics, implementation and the use of electronic health records in the healthcare environment.

1.9.2 Secondary Objectives

- To assess which sector of health has advanced in the implementation of medical informatics.
- To investigate the challenges encountered during the process and establish recommendation of medical informatics.

- To investigate the issue of use data sharing and data privacy laws in South Africa.
- To compare medical informatics between rural and urban setting.
- To assess the current position of the South African government regarding medical informatics or e-Health.
- To investigate a flow of data to a central database.

CHAPTER 2

2. REVIEW OF LITERATURE

2.1 Introduction

South Africa is currently having a divided health care system where there are private and public health-care systems. There is a clear difference in health-care service between the public and private hospital in South Africa which clearly reflect the in-equality amount the South African life [14]. South Africa is a developing country and has a number of rural areas which require attention in providing facilities. SA also has a burden health care challenges that include implementation of EHR. The South African Health Care System consists of public and private health sectors. Out of the two, the public healthcare caters for 82% of the population, and the private 18%. The public enjoys only 40% of health expenditure while the private enjoys 60% of the health expenditure. South Africa is inundated with inequitable health service delivery between its rich and poor, as well as rural and urban populations. There is a hope that technology will help to improve the quality of health care and services. This also helps with reducing the inequality between the poor and the rich, rural and urban health care service delivery. South African hospitals have advanced information communication technology in many of the urban healthcare institutions and do not even have the computer technology in the rural settings [15, 16].

Literature on electronic health record (EHR) implementation had documented the difficulty of the process such as the high costs, lowered productivity, disruption to patient care and dissatisfaction among staff. Yet most of the research on EHR implementation challenges comes from large organizations and/or academic institutions. Washington & Idaho Regional Extension Centre (WIREC) delivers health IT consulting services, and through these experiences, WIREC has gained valuable insight into the factors determining the success or failure of EHR adoption in small practices. EHR implementation is a complex orchestration of information technology and business process “system builds.” Successful implementation requires that end-users understand each workflow, that all technology components work properly with the corresponding workflow

and that each end-user knows how to use relevant software components. However, the implementation timeline and focus are invariably technology-driven with go-live as the culminating event in which all EHR components are turned on, used simultaneously and expected to work properly [13].

Other countries are also experienced problems in implementing e-health. These include cost and security concerns, access to and custodianship of information, defining 'expertise' and medical authority, determining and including 'relevant' health information into the patient-accessible EHR, patients' comprehension of clinical data, liability issues, tensions between flexible access to data and flexible access to physicians, data mining, accuracy of data and missing data. Increased coordination and collaboration are required to meet growing demands for improvements in health care and to enable research that answers questions like the one about the efficacy of novel cell therapeutic medicinal products or treatments. Researchers need more informatics support, especially because research in biomedical and clinical fields is going to generate large amounts of data to be analysed. Correlation of genotype with phenotype data requires access to longitudinal clinical information and large numbers of patients. To create a basic infrastructure several components are needed. IT governance provides basic rules to enforce policies on data sharing, information exchange, data security and interoperability. Each infrastructure needs resources in the form of funding, data, staff, locations and other components. An appropriate IT infrastructure should use resources to enable open collaboration in clinical research that will provide an environment which assists in the development of a study plan and a trial protocol and supports the researcher in identifying collaborators and enrolling patients [18].

In developed countries like the USA the technology in the hospitals has been proved and the hospital started implementing EHR system. The government is pushing for implementation and the use of EHR [9]. From 2008 to 2011 implementation was slow and from 2011 to 2014, the use of EHR has increased significantly. The USA government made the adoption and increase use of health IT a keynote objective. Now 97% of hospitals in the use have implemented EHR [19]. USA government has implemented an incentive to speed up the implementation of EHR and adoption of comprehensive EHR has increased more than eleven-fold in the last five years [19].

In UK, Australia, Netherlands and New Zealand, the use of Electronic Health Records in the healthcare industry is also increasing rapidly in order to enhance the efficiency of healthcare. The universal use of EHRs by general practitioners (GPs) increased above 90 percent in these four countries and in Germany the use by GPs was increased by 40-80%. [20]. EHR have been used by countries like USA, UK, Australia and Canada. These countries adopted different approaches and methods to implement EHRs. USA government incentivized that users, UK government made huge financial investments and Germany did not invest much, but they get benefited from computer systems and software that already existed in their hospitals. Canada focused on both of scope and investment, focusing on narrowing defined goals. Overall the factors for the successful implementation of EHR are directly linked to the financial support, incentives, quality of care and use of ICTs for basic administrative task [20].

The use of EHR is supported in many countries including North America and Europe. The offers of EHR are well known to the world [15, 21]. In most of the countries, the EHR are not fully utilised and more than 50% failed or are not utilised on full including South Africa [15]. In the developed countries the implementation is also slow and the degree of adoption vary from one country to another [15]. There are a number of publications that presented lessons learned from the past experience that caution us about the barriers and challenges facing EHR implementation projects in healthcare institutions.[15]. However none of these gave easy and ready readymade solution to the problem. The implementation of EHR is a highly dependent number of things i.e. the background and setup of the organization including budget, IT facilities, human resource and organisational issues. The degree of adoption of EHR is not easy to predict since it is the context of each organisation been deferent from each other [22]. These differences make it complex find an easy solution to finding a solution in the implementation of EHR [15].

2.2 Progression of Medical Informatics

In 2000, The International Medical Informatics Association (IMIA) convened and agreed on international recommendations on health informatics / medical informatics education. These

should help to establish courses, course tracks or even complete programs in this field, to further develop existing educational activities in the various nations and to support international initiatives concerning education in health and medical informatics (HMI), particularly international activities in educating HMI specialists and the sharing of courseware. The IMIA recommendations focused on educational needs for health care professionals to acquire knowledge and skills in information processing and information and communication technology [23]. In 2006, IMIA agreed on revising the 2000 recommendations in health /medical informatics education. These should help to establish courses to further develop existing educational activities in the various nations, and to support international initiatives concerning educational activities in the various nations and to support international initiatives concerning education in Biomedical and Health informatics (BMHI) [24]. The American Medical Informatics Association (AMIA) convened a 2008 Health Policy Conference to focus discussions and advance understanding about the potential for informatics-enabled evidence-based care, clinical research, and knowledge management. Conference participants explored the applicability of informatics tools and technologies to improve the evidence base from which providers and patients can draw to diagnose and treat health problems [6].

In 2007, the Institute of Medicine (IOM) called for a new "rapid learning healthcare system" to accelerate the generation of new evidence. This holistic paradigm is characterized by continuous learning and improvement, and the evolution of new approaches to rapidly generate, apply, and evaluate evidence. A key feature of this paradigm is a "culture of shared responsibility" in which stakeholders (researchers, providers, patients) embrace the concept of a healthcare system that "learns"; share an understanding of the nature of evidence and the evolution of new methods to generate it, and work together toward the goal of shared decision making that is informed by the best possible evidence [25].

There is increasing evidence that health information technology (HIT) improves health, healthcare, public health, and biomedical research. A number of recent systematic reviews have documented the evidence in favour of clinical decision support [26, 27], information and communication technology (IT) interventions [28], and telemedicine [29]. This has led to

widespread adoption of HIT around the world. In addition to a growing range of research and application fields in BMHI, there is also growth in related areas of BMHI, such as clinical research informatics [30]. The growth of HIT has also led to the recognition of the need for educational programs to train professionals to develop, implement, and evaluate these systems. In the last decade HIT investment made by government agencies and healthcare organisations in different continents has increased dramatically [31]. An example of the countries invested includes Canada to accelerate the development and adoption of Electronic Health Records (EHRs) [32], England for IT in National health Service [33], Australia for e-Health [34] and the US for the Health information technology for economic and clinical Health Act [35, 36. 37]. There was no information found on how much South Africa has invested in the implementation and development of HIT. These investment programmes are made so that a nationally coordinated effort along with major financial incentives in HIT can lead to significant benefits, with improved healthcare service access, provide cost-effective, and patients' health outcomes [31].

However, in 2012, South Africa came with eHealth Strategy South Africa (eHSSA). The objective of the eHSSA was to guide the government from the current status to an integrated and well-functioning national information system, based on agreed scientific standards for interoperability, which will improve the efficiency of clinical care and produce the indicators required by management and facilitate patent mobility. The Minister also emphasised that the system should able interphase with other transferable systems used in the health sector and able to support and help implementation of National Health Insurance (NHI). The ten strategic priorities and key activities for eHSSA identified were: 1. Strategic and leadership, 2. Stakeholder Engagement, 3. Standards and interoperability, 4. Governance and Regulation, 5. Investment, Affordability, and Sustainability, 6. Benefits Realisation, 7. Capacity and Workforce, 8. eHealth Foundations, 9. Applications and Tools to support healthcare delivery and 10. Monitoring and evaluation of the eHealth Strategy. [3]

2.3 Implementation of Medical Informatics

Despite the evidence about the implementation, HIT was very slow in developed countries including the USA. The government had to assist in speeding up the implementation. There has been a slow but steady rise in adoption of new information and communications technologies (e.g: e-prescribing, electronic health records, and personal health records) by the healthcare community. Experts have reported that HIT will be instrumental in helping to answer many of the pressing questions facing the healthcare system and will facilitate efforts to evaluate the effectiveness of healthcare interventions [38, 39]. Biomedical informatics is a vital discipline for realizing the promise of HIT while avoiding its negative consequences. The causes of e-iatrogenesis span the boundaries of traditional disciplines. Thus, a combined understanding of computation, workflow, and clinical health care is required. Academic centres are a focal point for growing biomedical informatics. However, this growth requires distinct academic units that are able to recruit and promote faculty recognizing both the biomedical and computer science roots of the field [40].

The widespread use of electronic health records in the United States (US) is inevitable. EHRs will improve caregivers' decisions and patient outcomes. Once patients experience the benefits of this technology, they will demand nothing less from their providers. Hundreds of thousands of physicians have already seen these benefits in their clinical practice. But inevitability does not mean easy transition. In the US, they had years of the professional agreement and bipartisan consensus regarding the potential value of EHRs. Yet the USA has not moved significantly to extend the availability of EHRs from a few large institutions to the smaller clinics and practices where most Americans receive their health care[9].There are problems encountered when implementing EHR. Ashish K. Jha et al surveyed all acute care hospitals that are members of the American Hospital Association for the presence of specific electronic-record functionalities. Using a definition of electronic health records based on expert consensus, they determined the proportion of hospitals that had such systems in their clinical areas. They also examined the relationship of adoption of electronic health records to specific hospital characteristics and factors that were reported to be barriers to or facilitators of adoption. In this 2009 publication, it

was found that there are very low levels of adoption of electronic health records in USA hospitals. The strategy to resolve this problem was to focus on financial support, interoperability, and training of technical support staff which may spur adoption of electronic records systems in USA hospitals [24].

2.4 Essential Tools

In normal medical care, there are no standards applied when entering data in EHR. In clinical research the most important data standards are provided by the Clinical Data Interchange Standards Consortium (CDISC) and SAS whereas in health care Health Level 7 (HL7) and Digital Imaging and Communications in Medicine (DICOM) are applied. Standard terminologies/classifications in clinical research are Medical Dictionary for Regulatory Activities (MedDRA), Logical Observation Identifiers Names and Codes (LOINC) for laboratory tests or Systematized Nomenclature of Medicine (SNOMED) for the clinical and pathological domain, which complement existing coding systems, like International Classification of Diseases (ICD) and Medical Subject Headings (MeSH) in medical care [18]. But already LOINC and SNOMED-CT are increasingly used in domains, health care, and clinical research. To promote global standardization of health information the International Health Terminology Standards Development Organisation (IHTSDO) was established in 2007 to assume ownership and distribution of SNOMED-CT [18].

2.5 eHealth in South Africa

South Africa started planning and partially implementing of national EHR project in 2002, as a strategy for to improve health systems in South Africa health institutions [3]. Around the world, there is a number of national EHR initiatives that are growing rapidly however in the emerging countries the process is still very slow. In emerging markets such as South Africa, some of the 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 centralized database [42]. 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. However, the evidence is growing that in an economic environment of severe constraints the use of IT in healthcare has the ability to improve capacity and resource utilization precisely because it frees up other valuable inputs [10].

Health information technology, especially EHRs, has the potential to improve the efficiency and effectiveness of health care providers [36]. In first world countries, this process of implementing EHRs has been established and it is lacking in developing countries. EHRs have been implemented and support healthcare delivery in developing countries. Unfortunately, widespread adoption of these systems remains limited by multiple factors, key amongst them being limited human resources and cost of equipment, software, and personnel [43, 59]. Approaches to overcome these barriers are needed before EHRs can support efficient, large-scale healthcare delivery systems in resource-limited settings.

Cline and Liuz conducted a study is South Africa where they investigated how to access health care by large population bases can be improved through more efficient healthcare resource management through the automation of healthcare systems. Their research examined the experience of HIS in two South African hospitals and the perceptions of stakeholders as to its effectiveness in introducing efficiencies into everyday processes. There were three samples of groups observed and their research found differences in the three sample groups of doctors, nurses, and administrators as well as between the two hospital groups. The impact of automation in terms of cost and strategic value in public sector hospitals was shown to have yielded positive outcomes with regard to patient experience, hospital staff workflow enhancements, and overall morale in the workplace. Their research provided 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, they found that sustainable success in these initiatives is as much a function of the technology as it is the change of management function that must accompany the system implementation [10].

It is well accepted that introduction of EHR will improve lives, service delivery, patient management; will reduce medical errors, loss of health records and abundant paperwork. [12,18, 44,45]. If the use of EHR is improved or increased it will enhance service delivery, access to basic services, improves communication amongst medical teams, effective national health care that is based on evidence based medicine which will help all the stakeholders [12,37,45,46]. Implementation of EHR in South Africa is slow and there are significant barriers that lead to the slow adoption. In Eastern Cape, South Africa in the Nelson Mandela metropolitan council, it was found that the barriers to adoption of EHR were a lack of awareness of the existence of EHR system and lack of internet connection [46]. There are also many factors that may positively contribute to the adoption of EHR. It was also noted that most of South Africans are getting their access to the internet via mobile phones and this hold a great promise to the adoption of EHRs and use of EHRs as a platform to engage the patient in self-care [46, 47]. Statistics South 2013 has also indicated that there are more South African households accessing the internet via their mobile devices [46, 48].

The resistance of doctors to use EHRs was also noted in previous studies however, it is confirmed that once they use the system and discover how easy and useful EHRs are, they become comfortable to further use it for other EHRs functions. It is now known that the implementation HIS is not dependent on hospitals and doctors alone but also by other stakeholders, community, and government [45]. Factor holding implementation of HIS is now being addressed by the government and the third parties whereby the players began to reimburse the communication between patients and their doctors. Discussions and agreements on standards that permit data sharing have begun and the exchange of data will be done in a way that ensures security, authenticity, and interoperability. The government is also contemplating to give rewards to doctors that are using EHRs [45]. A well design quality performance incentive system was

suggested, and it emphasized pay for performance and the incentive could help to improve the use of EHRs [49].

It has been confirmed by the Health department's Director Mr. Thami Mseleku that there is no uniform standard for gathering and storing patient health records or data. This makes it impossible for South African hospitals and clinics to share information to reduce duplication and misdiagnosis. The government recently has called for IT companies to bid to tender for EHR system. CMH has adopted to use Medicom software and their HIS but it has mainly been used for the administrative purpose, the CEO confirmed. Western Cape Province has installed a HIS called Clinicom in its large hospitals like Tygerberg, Groote Schuur, and the red Cross Children Hospital but the HIS is still not fully functional and the hospitals are still not linked to each other to share data. The lack of available bandwidth was confirmed to be the problem to link the hospitals. The aim of the Western Cape Province is to introduce Clinicom to all its hospitals and clinics to facilitate a provincial health database that will enable cross-referencing between facilities. According to Mseleku, it is practically impossible at the moment to share or transfer patients records between the hospitals and the facilities across the country because each province uses their own HIS and have their own tender for IT systems. It will be expensive to change all the system and the government is aiming to get the departments to talk to each other rather than replacing IT systems [67].

There is huge value in introducing EHR system in South Africa. It will reduce the burden of administrative load on doctors, pharmacist, nurses and other stakeholders and this has been confirmed by Groote Schuur Hospital CEO. EHRs will enhance confidentiality since paper does not ensure confidentiality. It was also stated that there should be a culture shift amongst doctors since they don't like to share medical records. It is suspected that it caused by treatment strategy used by each doctor and even amongst them, sharing is still an issue. Implementation of ERHs in South African hospitals is sound however, there is a big question whether it will save money or drive costs up. US hospitals implemented an expensive system but still need to maintain paper. Cheaper alternative options and free systems like open-source software (World-VistA) which are

free and might save money were suggested for South Africa [67] but the researcher is not sure if the suggestion was explored.

A study was conducted in South Africa to develop a toolkit that will assess the state of readiness of health organizations in South Arica. This toolkit called CSF which was modified from the United Kingdom's critical success factors (CSF) have the potential to the organisation and hospital to better planning and EHR implementation path. The second tool of called Balanced Score Card (BSC) matrix which is an instrument that will assist with the proactive planning of performance which is in line with the organisational strategy is planned to be tested in the Eastern Cape in a future study. This matrix will guide the organisation to move the strategy to action plan and increase the probability of success [15].

2.6 Medical Informatics challenges in South Africa

There are many barriers to the implementation of e-health solutions that cause delays or hinders its use. The Commission of the European Communities (2004) stated that healthcare systems around the world are faced with major challenges, although their nature and scale differ between developed and developing countries. The challenges and setbacks facing implementation of e-health in rural areas of South Africa are the focus of the present study and warrant further detailing here. The South African health sector faces many challenges, such as epidemics, historical issues, and factors that impact directly on the digital divide between developed and developing countries. Rural communities, in particular, are compromised by lack of infrastructure, services and expertise, limited resources, low literacy levels and professional isolation [12].

Adoption and implementation of e-health solutions are often delayed when underlying problems are not resolved. For instance: According to IT-Online (2007), the four fundamentals of e-health solutions are improved access to health care, improved quality of care, illness prevention and health promotion, and better efficiency (i.e. better healthcare for the same or lower costs). However, the healthcare sector does not fully benefit from these fundamentals due to delays in

reaching agreement on best practice and processes. In South Africa, there appears to be no uniform healthcare approach, let alone a system that can be truly proffered as a proven template for reform that enables by means of technology. Yet the recognised benefits of reform and automation go hand-in-hand. The lack of standardisation and integration between health information systems are major barriers to the full realisation of the benefits of e-health solutions. Further challenges in providing access to healthcare services are due to geographic distribution, as much of the population resides in rural areas [12].

One way to keep information in one place is to implement a card system. A 'smartcard' can be read electronically when a patient goes to a hospital or clinic (IT-Online 2007). ICT infrastructure across the South Africa needs to be improved in order to support not only transfer of information across the country but also a successful e-health solution such as EHR. Some rural hospitals have little or no access to technological resources, a major barrier to implementing solutions. Establishing a unique patient identifier is another challenge. In rural areas, some adults and children do not have ID documents, while those that do might not have ready access to their ID documents when hospitalised. Moreover, some people have the same names. Date of birth can also be problematic, as many of the rural aged population have no idea of their birth date, but know instead that they were born, for example, 'on the day of rain'. Identifying the right person quickly when searching for medical information is essential if the system is to be trusted by those who use it. IT-Online (2007) believes the right search mechanism, which is fast and accurate, should be built into the solutions. In addition to these inherent problems, shortcomings in the knowledge and the skills of patients and health professionals to use ICT solutions represent other challenges. Even when implemented, the benefits of ICT cannot be realised if people are unable to use it. One challenge is to train people in the use of ICT solutions so they can improve their health or quality of service. However, there are other challenges that also need to be addressed before e-health solutions can be implemented in rural areas in South Africa [12].

There are factors perceived to make ICTs less user-friendly, as shown by participants' negative perceptions regarding certain structural variables (especially staff's lack of ICT-related skills, lack of access to ICTs and the Internet at healthcare centres, and the old and unreliable state of

computer equipment). But most of the staff at the healthcare centres had no fear of using computers and nobody thought ICT applications might disagree with their working style. To increase effective use of ICTs that form part of e-health initiatives in the healthcare centres, a vital first step is to address reported perceived shortcomings. Broad-based recommendations to cover shortcomings common across the various centres: special attention be given to improving basic infrastructure: hardware, appropriate software, and telecommunications skills and knowledge development, ICT skills training programs and policies for technology maintenance and support be introduced/upgraded [12].

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 [41, 44]. Simon et al. speculate that the success of new system integration into daily workflow is dependent on how effectively the workplace culture emphasizes 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, computerized scheduling systems, and e-prescribing) [44]. Goldzweig et al. also studied the cultural barriers to system implementations in hospitals 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 [17]. Despite all the cultural and organizational 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 subsidize 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. 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 [50]. 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 [10].

2.7 The benefits of implementing an EHR

There is no doubt that the use of electronic health record will increase the efficiency of healthcare but on the other hand, there are many factors like cost, time, training, fear, security and privacy, lack of standards that stops healthcare practitioners to adopt electronic records [51]. Despite the IT challenges the world is moving towards computerized systems and has in the past decade they have invested heavily in computerization. Today most of the companies and countries are moving towards the electronic system, airline tickets are bought online and check in to flights is online, purchasing of goods on the Web, and even earning degrees online in such disciplines as nursing[52] law, and business, among others [51, 52]. However, Majority of patients are still given handwritten medication prescriptions, and records are still kept in paper format. The patient cannot even schedule an appointment with physician electronically and very few patients are able to email their physician [53] or even schedule an appointment to see a provider without speaking to a live receptionist [54].

EHR systems have the potential to transform the healthcare system to a system that utilises various pieces of information from different sources to assist providers in delivering a higher quality of care to their patients. It has been proven that implementation of EHR will improve the quality of patient care, reduce medical error and other important medical care measures. EHR will also enhance operational performance, save cost in the long run and increase satisfaction among doctors and patients. It will also be easier to do clinical research since information and the clinical database will be available and improved population health [51]. EHR will help in improving the quality of care and safety in the community; will help the health workers to adhere to evidence-based clinical guidelines and effective patient care. Mostly health workers do not have enough time and lack time of reading public health guidelines applicable to certain patients and management of vaccines. EHR will overcome these issues and health workers will able to use the guidelines, keep the patients healthy and low risk of disease outbreak in the communities. It makes it easier access to clinical data. It will also help to gather and analyse patient data that enables outreach to discreet populations [51].

Cost saving is also one of the strong benefits of the EHR since you received all the information required and there will be no need for a physician to perform a test that was already done. More often the resources are wasted in repeating the tests that are already available or done. With the utilisation of EHRs, the results are readily available and the physicians save time and cost in repeating results that were already done [55]. In most of the hospitals using EHRs, there is a reduction of blood test and other repeat tests or diagnostic tests. By having patient's clinical data readily available increases efficiency, lead to cost saving by reducing utilisation of staff resources devoted for patient and records management, reduced need to maintain and supply paper files. No bulky paper records to store, manage and retrieve [51, 56]. The use of EHR was also found to increase operational performance in the hospitals [57]. It was also associated with an increase in physician's career satisfaction because of better prescribing and retention in medical practice [51].

EHR helps to reduce medical error by making medical records more readily available. Medical Notes and prescription are also legible and chances of making errors are reduced. Rates et al found that the use of computerized medical records in the hospital settings has reduced medical errors by 55% and Bates et al confirmed that computerized health records can reduce medical errors by 86%. On the order hand, there were few studies that found that computerized medical records are associated with increased medical errors and the increase was due to poor management, handling of medical records, poorly designed system interface and lack of training of the health worker furnishing data in the EHR system. In clinical outcome studies it was found the use of EHR in the hospital setting, hospital had more desirable rates on a variety of commonly used quality indicators and also they had lower mortality rates and fewer complications compared to hospitals not using EHRs [51].

EHR enhances the security and confidentiality of patient data through controlled access and auditable provider access. With data being readily available through EHRs, researchers are able to easily able to conduct studies based on information being available. The use of EHR was also associated with providing the opportunity to interact seamlessly with affiliated hospitals, clinics, labs, and pharmacies

In South African eHealth strategy, the benefits of implementing EHRs were also tabulated below. South African government is aware that EHRs has the ability to exchange health information electronically can help you provide higher quality and safer care for patients while creating tangible enhancements for your organization. EHRs help providers better manage care for patients and provide better health care by:

- Providing accurate, up-to-date, and complete information about patients at the point of care
- Enabling quick access to patient records for more coordinated, efficient care
- Securely sharing electronic information with patients and other clinicians
- Helping providers more effectively diagnose patients, reduce medical errors, and provide safer care
- Improving patient and provider interaction and communication, as well as health care convenience
- Enabling safer, more reliable prescribing
- Helping promote legible, complete documentation and accurate, streamlined coding and billing
- Enhancing privacy and security of patient data
- Helping providers improve productivity and work-life balance
- Enabling providers to improve efficiency and meet their business goals
- Reducing costs through decreased paperwork, improved safety, reduced duplication of testing, and improved health.

EHRs can transform health care to a better health care by improving all aspects of patient care, including safety, effectiveness, patient-centeredness, communication, education, timeliness, efficiency, and equity. To better health by encouraging healthier lifestyles in the entire population, including increased physical activity, better nutrition, avoidance of behavioural risks, and wider use of preventative care. To Improved efficiencies and lower health care costs by

promoting preventative medicine and improved coordination of health care services, as well as by reducing waste and redundant tests and lastly to provide a better clinical decision making by integrating patient information from multiple sources. To receive all the benefits of EHRs one has to fully implement all modules [58].

2.8 The disadvantages of implementing an EHR

Despite the benefits discussed, there are still a number of researchers that found only small benefit in the use of EHR and some with mixed results [51]. Some of the identified potential disadvantages of EHRs are cost, temporary loss of productivity, changes in workflow, privacy and security concerns, and several unintended consequences. In African countries, the adoption of EHRs remains limited by multiple factors, key among them being limited human resources and cost of equipment, software, and personnel [59]

Cost is a major barrier that affects implementation and adoption EHR in most of the countries. EHRS are so expensive and prevent rapid or easy implementation. In the USA cost is also an issue for the physicians to adapt to EHRs. Cost is a significant barrier to EHR implementation and the cost benefits are actually difficult to prove with the implementation of EHR system [20]. Costing related to EHRs include adoption and implementation costs, costs of maintaining EHR software, loss of revenue associated with temporary loss of productivity, loss revenue during implementation, purchasing and installing hardware and software, changing paper patient notes and charts to electronic ones, and staff training or the end-users. In the early days, the cost was very high however since EHR technology is becoming more common in places over the past ten years, the cost of equipment and implementation is coming down. Maintenance costs are high because hardware must be maintained and or upgraded or replaced on a regular basis and the end-users must have regular training to be efficient and familiar with the upgrades. The cost of implementing EHRs involves hardware and software. The hardware includes network and network support and software includes installation and maintenance costs [51].

Countries like South Africa, Sweden, Germany, France and the Netherland's face insufficient funding. Sweden, France, and South Africa have already moved towards the government funded a national system. However, Germany and Netherlands are still far behind. It has been found that 50% of the implementation plans fails due to poor investment in technology. Some researchers are uncertain about on return on investments regarding the implementation of EHR and in some studies financial return was a great concern. The benefits of adoption can be realised only once the full implementation of the electronic health record is completed. [20].

The other disadvantage of EHR implementation is the interruption of workflow health-workers. These interruptions lead to loss of productivity when the health worker is in training to learn the new system. During this training, there is also a loss of revenue especially for small practices and private practices [51]. The interruptions are mainly at the beginning and few months after implementation or adoption then it normalises. Most of the health workers do not have enough time to spend on their work. Some of the health workers do not have time to work on the implementation of EHR due to lack of time for training and learning the new system. Lack of time is a concern among healthcare practitioners due to their heavy workload. Some of the health institutions do not have human resource to focus on EHRs implementation. Another barrier is a lack of computer skills and fear of using computer However with the introduction of mobile phones most of the health-worker are getting used to computerized systems. [53]. Fear was one of the reasons that stopped healthcare practitioners to adopt and implement EHR. The fear was in many ways, the fear that the productivity will decrease during the transition period between paper-based and electronic based record, fear that their patients have freedom to change their primary care provider easily if they will use electronic record, fear that patient-physicians relationship will decrease due to the indirect care of the patient and lastly fear of learning new systems and computers. [51].

There is a potential risk of patient privacy violations when using EHR system. Security and privacy of patient data have always been a primary concern in the hospitals. With the introduction of EHR, there will be increased the amount of health information exchange electronically and this increased concern to patients on the security privacy of data. Even though

the electronic data are 100% secured, stronger policies are still required to assist in making electronic more difficult to accessed inappropriately. Patients and physicians need to have their patient information very secure so that it cannot be accessed by an unauthorized user and make it very demanding for an unauthorized user to access EHRs. The increase on the privacy improves the reliability of medical data and reduces malpractice by physicians [51, 60]. In US data privacy laws and standards like of Health Insurance Portability and Accountability Act of 1996 (HIPAA) are one the barriers to the adoption of EHR [60]. It causes drawbacks in implementation but also give some advantages when the EHR systems are adopted by increasing the effectiveness, accuracy, accessibility, improve the quality of healthcare services and reduce costs. EHR adoption cannot be accepted unless its privacy and security issues are solved [61]. The privacy and security seem to be major issues in Australia and the USA [62].

The rapid implementation of EHR has brought unexpected risks resulting from the use of EHRs and other forms of health information technology [20,61]. The high pace of implementing EHR poses unique safety risks to patients while health worker is focusing heavily on achieving meaningful use of EHRs [63]. In the USA, it was noted that national EHR-related to patient safety plans are needed to address current problems with existing EHR implementations and failures to leverage current EHR capabilities. Creating unique EHR-related national patient-safety goals will provide new momentum for patient-safety initiatives in an EHR-enabled health system [20].

To save time and costs, there was a lack of training noted in health institutions. In other instances lack of training was cause by the service provider or government not providing training to staff and physicians to easily adopt EHR technology. For proper implementation of the EHRs system, the end users should be well trained. Lack of training will slow down implementation and may create frustration among healthcare staff and most of the end user will not comfortable to use EHR technology [64] Proper training is essential for healthcare personnel to successful implement EHRs. End user motivation and dedication to learning and use EHR is an important factor in the success of EHR. If the end-users are not trained properly, EHRs will increase medical errors, missing data, and unreliable data [20].

The other issue that drawback implementation of EHRs is the lack of standards that makes health personnel to hesitate to implement EHR. The main issue with the standard is a lack of a plan and poor governance. Although many countries have started to set programs to adopt such standards the issue still remains because of these standards are poorly governed, however, other governments maintain good standards like the program that was in Canada for Canada Health Infoway in 2002 [20]. South Africa also came with an assessment toolkit with a validated process called a Balance Score card (BSC) and timing of the development of a toolkit was appropriate for in the context of South African EHR policy and implementation process. The tool is expected to contribute positively towards the success pf EHRs in SA [15].

2.9 Adoption of EHRs and the use open-source software in other countries

The USA started the adoption of EHRs process in 2008. The aim was that the hospital has to at least have a basic EHR system, later to increase functionality to the EHR that possesses a certified EHR that meets federal requirements [19]. USA health professional and leaders are counting on EHR to improve the quality of health care and revitalize practice [65]. USA is confident that EHR will save them money and improve the quality of health care. Physicians in the USA now understand and overcoming the obstacles faced with by small practices to successful use of

EHRs [65] .

The USA also adopted open-Source Veterans Health Information Systems and Technology Architecture (VistA). This system was developed by the US Government's Veterans Health Administration and was used in the military health care and now Vista A is distributed for free by the US government. VistA was also adopted by Mexican Government across 40 large hospitals serving 30 million patients within the health system. VistA was also adopted by Latin America and the US adopted this system because they wanted to save money since the government institutions don't have enough money to invest in technology. VistA was successful

in the USA and it was thought would not meet the objectives of EHRs. The users and the inventors feel that it was a real return on investment. The VistA practice management system was also improved for scheduling, billing and minimize the impact on physician–patient interaction, they also opted for an encrypted wireless network with Tablet personal computers [65].

The adoption of open-source EHRs for use in resource-limited settings has been a step in the right direction. Owning EHR is cheap the use of open-source systems reduce the cost, thus lowering the threshold for EHR adoption [59]. This is supported also in the world report presented by Paul Webster that the use of open source is increasing to save cost for countries that cannot afford the commercial EHR systems. The evidence has grown to prove that health-information systems can improve health care while cutting costs hence the marketplace for open-source EHR systems have increased to about US$60 billion per year. The use of open-source EHRs was successful and most of the end-users were happy with them. However, there was a warning from the commercial software companies that open-source health information systems are more vulnerable to bugs and security breaches than proprietary products. Carl Reynolds of the University College London Medical School's Centre for Health Informatics, UK, and Jeremy Wyatt at the University of Warwick's Institute for Digital Healthcare, UK published a paper that opposed the statement and made it more debatable. In their publication, it was stated that the open-source software is usually more secure from external attack than proprietary software because open-source codes allow independent assessment of the security of a system, which makes bug patching easier and will probably, force developers to spend more effort on the quality of their code. The adoption of open-source EHRs for use in settings that cannot afford commercial EHRs has been a step in the right direction [59, 66].

OpenMRS is a widely adopted open-source EHRs, which has been successfully implemented in a number of sub-Saharan African countries [59] However, even with the availability of well-designed open-source systems, the implementation threshold for EHRs, is too high for most healthcare systems in resource-poor settings. This is because successful EHR implementation also requires appropriate infrastructure, adequate technical support and good integration of the

EHR system into the local clinical workflow. Resource-limited countries have implemented open-source EHRs by two types of model to able to succeed with implementation. Most health institutions have employed their own locally-trained IT personnel, and other health institutions out-source to the expertise from developed countries. Countries like Rwanda, Kenya, and Malawi they are heavily dependent on the expert from the foreign countries [59]. Were et al found that in resource-limited settings an external support resource centred on a national technical expertise supported by the global developer and implementer groups can be effective in successfully implementing and maintaining EHRs at multiple sites. This will address both the cost constraints of implementing EHRs and human resource issues and, to lower the general threshold for implementation, and provide a viable option for scaling up EHRs in resource-limited settings [59].

In Canada, David Chan developed an open-source electronic medical record system known as OSCAR. The OSCAR was designed to help clinicians manage patient diseases and administrative tasks for scheduling and billing patients, prescriptions. Apart from substantial costs savings, the main advantage open-source health technologies hold over commercially secret competitors comes from the fact that the end-users can modify and improve the software. OSCAR was said to outperform the proprietary systems on functionality and cost. Jel Coward (president of OSCAR Canada, also said, when using an open-source product, no-one can hold them , their data or their patients to ransom [66].

There is increased use of EHRs internationally; open-source approaches are gaining traction, especially for those developing countries that cannot afford the commercial systems. In emerging markets open-source software's are giving poor countries the capacity for advanced innovation in the health-information sector and this was stated by the US consultancy that tracks information technology in emerging markets Vital Wave. The open-source assist where local health problems might not match offerings from the software industry aimed at wealthy countries or customers [66].

In a small Latin American country, in Belize with a population of 300 000, they used open-source innovations to develop the most comprehensive national health information system in the world. According to a global survey done by Actuate, a USA software company that promotes open-source concepts; China, the world's fourth largest software market, China is now leading the world in pursuing open-source solutions. Health information systems based on open-source software are proliferating in Asia, However, the government of Thailand is making efforts to contain costs after launching universal coverage spurred the development of Hospital OS, an electronic medical record system implemented in 95 small rural hospitals and 402 health centres. These centres are serving about 5 million patients. According to Chris Seebergets, a specialist in HIV management and informatics with the South African Medical Research Council; Open-source health software is also gaining traction in Africa. He worked on a number of open-source health information systems including the Open Medical Record System. His open-source systems use non-proprietary software to create medical record systems for resource-constrained environments and has been implemented in several countries like; South Africa, Kenya, Ghana, Lesotho, Mozambique, Rwanda, Sierra Leone, Zimbabwe, Uganda, and Tanzania, as well as in various countries in Central and Latin America. Seebregts also helped to develop the District Health Information System (DHIS), a South African electronic system based on open-source software that integrates local clinical data into district summaries. DHIS has been widely adopted in Africa and Asia, with support from the Norwegian Government, as part of a programme backed by the WHO's Health Metrics Network. Seebregts also stated that open-source health information systems have become hugely important in developing countries and it is providing access to health technologies that would have not otherwise been able to afford [66].

India is the biggest implementers of the open-source health information systems and was implemented as a nationwide initiative of the National Rural Health Mission. India introduced a health management information system by employing the DHIS and other open-source tools on a massive scale. This initiative involved hundreds of thousands of health workers who serve hundreds of millions of patients. The EHRs was deployed live in October 2008, involving 18 India's most populous states, and it is planned to expand and cover the entire country. Brazil also implemented open-source electronic health care on a massive scale. The SIGA Saúde Health Information System in Sao Paulo, built and implemented open-source software that served

approximately 14 million registered patients and stores data on 20 million patient encounters from 702 health facilities per annum. The health officials say they achieved and noted that an increase in patient numbers, noted a 30% increase in patient visits and a 50% increase in patient satisfaction. According to the health officials, this was achieved without adding any new resources [66].

Some observers worry that the stampede toward open-source health information systems may be leading to duplication. Joseph Dal Mollin, co-founder and vice president of WorldVista, an American charitable foundation that works with developing nations interested in adopting VistA, the open-source software system developed by the US Veterans Health Administration is worried as open-source health technologies gather momentum and a lot of work have been done on smaller projects in isolation from the bigger projects, like VistA [66].

Dal Mollin worked on implementing VistA in Jordan and integrated WorldVista and OSCAR a platform designed to give patients online access to personal health records within OSCAR. He believed that cross-pollination between open-source projects is all-important and will have more power when they are meshed up. He thinks that is there risk that small-scale innovations might not prove compatible with larger systems, which reduces their clinical usefulness, especially for users in poor countries. More powerful open-source will play a major role in these countries. Several developing nations have joined the revolution in EHRs to improve efficiency in their health system, but at a fraction of the usual cost using open-source innovations [66].

CHAPTER 3

3 MATERIALS AND METHODS

A mixed method approach was followed in this research which consisted of quantitative and qualitative methods. The quantitative research methods have been the methods of choice in evaluating information systems and qualitative research is exploring issues, understanding phenomena, and answering questions.

3.1 Questionnaires Development

There were four types of questionnaires developed. 1. Questionnaire for medical personnel was used for Doctors, Nurses, Laboratory personnel, Pharmacists, Radiology (Radiologists and Radiographers) and managers. 2. Patient questionnaire for patients, 3. IT Questionnaire was used for Management and IT personnel and, 4. Administration staff questionnaire was used for admin staff including the ward clerks. The questionnaires were developed by examining and synthesizing prior healthcare-based surveys of hospitals and e-health, site staff perception, service delivery and other related functionalities that have been administered in the past 5 years. The questionnaire was developed to address issues that the study required to answer the research question and these sets of questionnaires were the instruments that were used to feedback to the researcher. The site data collection form was also designed to capture information about the site and responses from the interviews of participants.

3.2 Identification of hospitals and clinics

The investigator took a list of public hospitals and private hospitals from Netcare and Mediclinic in South Africa. The lists were divided into the 9 provinces of South Africa which are: 1.

Gauteng, 2. Limpopo, 3. North West, 4. Free State, 5. Mpumalanga, 6. KwaZulu Natal 7. Northern Cape, 8. Eastern Cape and 9. Western Cape. The provincial lists of hospitals were further divided into Rural and Urban. From the urban lists three (3) to five (5) hospitals were randomly selected from the list and one to two were randomly selected from the rural list depending on the size of the provinces and number of hospitals in the province. The private hospitals list was also randomised to select at least one hospital in each province depending on the availability in the province and number of hospitals availability in the province.

3.3 Approvals to conduct research

All the selected hospitals were contacted to find out the procedure to conduct research in their facilities. All hospitals provided the information about the approval procedure including provincial ethics committees. For private hospitals, the central private ethics committee Pharma Ethics (Pty) Ltd was contacted to request approval to conduct research in private hospitals. The head office and research office of the private hospitals were contacted to request permission and applications were made to conduct research in private hospitals. For public hospital provincial ethics committees and provincial health departments were contacted to request permission to conduct the study. Once the permissions were granted, the CEOs of public hospitals and the medical managers were contacted to request permission to conduct the study in the public hospitals. For the private hospitals, the head office and research committee of Netcare and Mediclinic were contacted to apply for permission to conduct the study. The managers of the private hospital the hospital were contacted to provide permission to do research in their respective hospitals. The process of approval took longer than expected.

3.4 Research Conduct

The investigator visited the hospitals; 32 public hospitals out of 45 planned and 19 out of 22 private hospitals in South Africa, in the 9 provinces of South Africa between February and

November 2015. In each province, the researcher conducted research in the form of a survey and interviewed hospital management, IT Personnel and some of the participants, assessing the IT and hospital infrastructure and access to hospitals. The candidates in the research were doctors, nurses, laboratory staff, radiology staff, pharmacy staff, IT staff, hospital management and patients. The candidates were randomly selected in the hospitals. The candidates randomised were approximately five (5) Doctors, Seven (7) Nurses, Five (5) Admin staff, at least one (1) IT Staff and Five (5) Patients. Doctors from the private hospitals were not included in the study since they were not employed by the hospital. Only the employees of the private hospitals were selected for participation which were administrative staff, pharmacists, and nurses. The researcher visited all the hospitals and explained the research to the candidates. When a participant agreed to participate, they were given the participant information and informed consent form to read and sign. If there are no questions asked or no further explanation required, the candidates were given the questionnaire to complete. Management and IT personnel and some of the doctors and nurses were interviewed for more information about the e-health system in their facility. The information was recorded on the hospital information form.

3.5 Collection of data

The questionnaires were completed by the candidates for 10 to 35 min depending on how fast the candidates completed the questionnaire. The researcher collected the Informed Consent Form ICF, the questionnaire and site information form for monitoring and data entry. The candidates were randomly selected to participate in a short interview where additional information regarding the hospital was collected. The researcher interviewed 212 candidates (doctors, nurses, IT, administrators, pharmacists, radiographers and patients). The ICF were filed in the study file. Data entry was collected on excel and analysed. There were 829 questionnaires collected, Doctors (n=47), Nurses (n=245), Admin (n=209), IT (n=30), Radiology (n=39), Pharmacy (n=42) and other (n=72) (Lab technician) and patients (n=17).

3.6 Statistical Analysis

Data collected was collected and entered in Windows excel. Data was assessed for normality to guide the use of parametric or nonparametric statistics. The sample size estimation was based on the 10 000 hospitals and Categorical variables were assessed using chi-square; normally distributed site data was analysed using Student's *t*-test or between-groups analysis of variance (ANOVA). Nonparametric between-group differences were tested using the Kruskal-Wallis test. In all cases, tests performed assumed $P < 0.05$ for statistical significance and 95% confidence interval hospitals in South Africa. For accuracy a 5% margin of error would add 5% on either side of the sample size. Taking the above assumptions into consideration, the calculated sample size is 370 surveys. However, not all hospitals and participants agreed to participate in the survey. The sample size of the surveys planned on this study was more than 600 which was far more than the calculated sample size required. Graph Pad Prim 6 version 6.07 and Graph InStat version 3.10 for windows were used to analyse data and detailed statistical reports are presented in appendix V to providing detailed methods for the analyses outlined in this protocol. Results of the survey were also presented in percentages and percentages calculated were used to compare and present survey results.

3.7 Limitations of the study

The limitations of this study were that: The questionnaires were designed to be applicable to all hospitals that have implemented HIS and those that have not implemented. The questionnaires should have been designed two types of hospitals depending on the implementation of HIS in the hospitals. These lead to some of the hospitals confused or refused to participate thinking that this research was mainly for the hospitals that have implemented HIS. The second limitation was for private hospitals, access to doctors and other personnel could not be done but in public hospitals, it was done. Therefore, the analysis becomes more relevant to public and hence comparison with private becomes little bit questionable. Lastly, Access to the patients was limited and could not fully access the perception and the feeling of patients regarding HIS.

CHAPTER 4

4 RESULTS AND DISCUSSION

4.1 Introduction to the results and discussion

In the previous chapter, the methodology used in this study was outlined. In this chapter, the results of the study are presented, interpreted and discussed.

4.2 Profile of the participating health facilities.

The sample of the study included 49 hospitals in South Africa of which 31 were public hospitals and 18 were private hospitals from Netcare and Mediclinic. Thirty-four (34) hospitals were in urban areas, 15 in rural areas and 9 were teaching and research hospitals (Table 4.1).

Table 4.1: Participating facilities per province

	Teaching/Research			Facility Type		Area	
Province	None	Research	Research & Teaching	Private	Public	Rural	Urban
Eastern Cape (n=4)	2	0	2	1	3	1	3
Free state (n=5)	2	1	2	1	4	1	4
Gauteng (n=9)	2	6	1	5	4	0	9
KwaZulu Natal (n=6)	2	2	2	1	5	2	4
Limpopo (n=5)	1	2	2	2	3	3	2
Mpumalanga (n=5)	5	0	0	1	4	2	3
Northern Cape (n=4)	3	1	0	1	3	2	2
North West (n=7)	4	3	0	2	5	4	3
Western Cape (n=4)	0	4	0	4	0	0	4
Total (n=49)	**21**	**19**	**9**	**18**	**31**	**15**	**34**

4.3 Implementation of HIS in South African Hospitals

4.3.1 Observation's results

Table 4.2 to table 4.5 below demonstrates the list of all provinces visited, hospitals and types of hospitals visited in South Africa during this research that has implemented HIS. According to this data, most of the hospitals in South Africa have not fully implemented HIS in the hospitals regardless of the type of the hospital and the location of the hospital. These are the results that were expected by the researcher. Interview and observation results were presented below.

Table 4.2: Implementation of HIS from observations per province

		Teaching/Research			Facility Type		Area	
		None	Research	Research & Teaching	Private	Public	Rural	Urban
EC (n=4)	67%			1		1		1
	56%	1		1		2	1	1
	44%	1			1			1
FS (n=5)	100%							1
	67%			1		1	1	2
	56%	2		1		3		1
	44%		1		1			
GP (n=9)	67%			1		1		1
	56%	2	1			3		3
	44%		5		5			5
KZN (n=6)	100%			1		1		1
	67%			1		1		1
	56%	1	1			2	2	
	44%	1	1		1	1		2
LP (n=5)	67%							
	56%	1		2		3	2	1
	44%		2		2		1	1
MP (n=5)	67%							
	56%			4		4	2	2
	44%			1	1			1
NC (n=4)	67%							
	56%	2	1			3	2	1
	44%	1			1			1
NW (n=7)	56%	4	1			5	3	2
	44%		2		2		1	1
WC (n=4)	44%		4		4		4	

Table 4.3: Use of HIS by Healthcare workers per province

	Doctors		Nurses		Radiology		Dispensing Pharmacist		Stock Pharmacist		Lab NHLS	
Province	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
E Cape	4	-	4	-	3	1	4	-	-	4	-	4
Freestate	5	-	5	-	5	-	5	-	-	5	1	4
Gauteng	9	-	9	-	9	-	9	-	-	9	5	4
KZN	5	1	5	1	5	1	5	1	-	6	1	5
Limpopo	5	-	5	-	5	-	5	-	-	5	2	3
MP	5	-	5	-	5	-	5	-	-	5	1	4
N West	7	-	7	-	7	-	7	-	-	7	2	5
N Cape	4	-	4	-	4	-	4	-	-	4	1	3
W Cape	4	-	4	-	4	-	4	-	-	4	-	4
Total	**48**	**1**	**48**	**1**	**47**	**2**	**48**	**1**	**-**	**49**	**13**	**36**

Table 4.4: Use of HIS by support staff per province

	Admin staff		Finance Staff		Data Clerks	
Province	No	Yes	No	Yes	No	Yes
E Cape	0	4	-	4	1	3
Freestate	0	5	-	5	1	4
Gauteng	0	9	-	9	5	4
KZN	1	5	-	6	1	5
Limpopo	0	5	-	5	2	3
Mpumalanga	0	5	-	5	1	4
N West	0	7	-	7	2	5
N Cape	0	4	-	4	1	3
W Cape	0	4	-	4	4	0
Total	**1**	**48**	-	**49**	**18**	**31**

Table 4.5: Automated systems used per province

	EC	FS	GP	KZN	LP	MP	NW	NC	WC	Total
None				1						1
AS400			2		2	1	1	1	2	9
DHIS				1						1
Delta 9	3									3
Medicom			4		3					7
Meditech		3		2						5
Nootroclin								3		3
PAAB						4	5			9
PADS		1								1
SAP	1	1		1			1		2	6
SORIAN				1						1

The research data confirms that out of 49 hospitals visited, there was only 1 (2%) hospital that has fully implemented HIS. There rest of the hospitals (98%) are partially using the automated system or HIS. However, most of the HIS software (Medicom, Meditech, PAAB, Delta 9 and Nootroclin) used in these hospitals were not linked to each other, they are different from each other and they function individually. In 48 (98%) of the hospitals visited admin staff are using HIS for admission of patients, billing and data capturing of hospital statistics. It was surprising to find that Newcastle hospital (NeH) (2%) located in Kwazulu-Natal province been the only hospital not using an automated system for admissions. The reasons for not using automation were a lack of computer systems and internet connection. However, their counterpart, data administrators were having access to computers and the internet. They were located in a different building within the same hospital and they were collecting the health statistics to be sent to the province monthly. The data send monthly to the province was for statistical purpose only.

In all hospitals (98%) except Inkosi Albert Luthuli Central Hospital (IALCH), doctors, pharmacists and nurses were using the manual (paper) system to record patient data. However, Pharmacists in warehouses and storerooms of the most hospitals are using Rx solution software to manage and maintain their medication stocks but not for dispensing and scripting. These results confirm that 98% medical team (Doctors, Nurses, and Pharmacists) of hospitals visited during this research are not using HIS. The results are presented in Table 4.3.and for more details

in implementation results per hospital please see appendix I. The results in table 4.3 are for both private and public hospitals. The pharmacists in private hospitals (Netcare and Mediclinic) used different HIS software (AS400 and Unisolve) to manage stocks in their pharmacy store which are different from the public centres. All pharmacists were not utilizing the electronic scripting.

In 88% of radiology departments of the hospitals visited, they were not using digital radiology system as they were supposed to use. Despite the availability of the digital system in the hospitals, the systems are still not used accordingly. Radiology departments use digital systems to perform procedures and manually printed the films and not use the digital picture for reporting but the printed films. The digital results are used to archive the results and not for reporting. IALCH and Port Elizabeth provincial hospital (PPH) were the only two (4%) hospitals found to utilise automated radiology systems and when the digital is broken they use the manual system as a backup. CMH uses digital but still print the films and the paper report for the medical team. Some of the private hospitals use digital where doctors can see the results on the system but this area was not fully explored since the research could not access doctors in the private sector and the radiologist.

Our findings confirmed our hypothesis that South Africa has not yet fully implemented HIS in their Hospitals. These results are the same across the public and private sector. The results are also the same, regardless of whether the hospital is located in the rural or urban area, or it is a teaching or not teaching facility or involved in research or not. These findings were different from the findings of Ashish et al, where they found that there was normally higher adoption of HIS in hospitals located in urban areas, teaching hospitals compared to nonteaching, from the research-performing institutions [36]. Our findings did not find a difference in different hospitals regardless the type, size, area, teaching or non-teaching and private or public hospitals. In this study, implementation of HIS was the same throughout the sectors. The government is working on the implementation and has drafted strategy on how to fast track implementation [3]. In general hospitals staff are positively looking forward to use HIS and the proper and faster implementation of HIS. The majority of staff interviewed believe that implementation is too slow and the slowness is caused by slow training, slow installation of computers and inadequate IT

support. Training of staff was one of the essentials mentioned and also fast internet system. See comments from the staff are presented in appendix II: Comments of staff from different sites.

Implementation of HIS in both public and private Hospitals is not fully implemented. The majority of the public hospitals have partially implemented HIS, however, the HIS system implemented is not linked to other departments or other hospitals and the mainframe central server for data storage. These are the same as the comments made by Tamar Kahn and health editor news [67]. There are several different automated systems used across the hospitals and provinces, there is no uniformity of software used. In the private sector, the HIS systems were uniform per private hospital company. The in the public sector the common HIS systems were found across the same provinces and that means each province used a different type of HIS software. The same private hospitals companies use the same HIS throughout the provinces. However, these systems are all not linked each other (Radiology, Laboratory, Pharmacy and so on). There is no data sharing or utilisation evidence-based medicine through HIS.

Automated systems used by the public sector were mainly, Medicom used primarily in Gauteng and Limpopo provinces, Meditech used mainly in Kwazulu natal and Free-state provinces, PAAB in Gauteng, Northwest and Mpumalanga provinces, Delta 9 in the Eastern Cape and Nootroclin in the Northern Cape. Private hospital Netcare and Mediclinic hospital were using SAP and AS400 respectfully. In almost all the hospitals visited, doctors are still using manual systems and write patients notes on paper and refer patients to another department manually. No automation was used except in the laboratory whereby doctors had to register and log into NHLS system to able to see the results. Patient's notes are still on paper and if the paper file is lost, patient information cannot be retrieved unless if it was copied or scanned into a microfiche system in some of the hospitals. When patient files are lost before they are scanned or copied, there will be no follow-up notes to manage the patients. The situation is the same for the nursing staff who also still use paper to write patient notes and vitals. Despite using an automated system to take vitals, nurses will be transcribed vitals to a paper. This practice is common in both public and private sector.

The HIS systems are available in these hospitals and have the clinical modules to be utilised but they are not used by the healthcare teams. The reason for no use was that the systems are not yet implemented in the hospitals or wards; the medical team is not trained on the system, no internet access or point to connect and not enough computers. These reasons were common to all types of hospitals, Private/ Public, Rural/ urban, teaching Non-teaching and large or small. Sometimes lack of personnel was mentioned especially in the rural hospitals. From the results of this research, the hospitals are not yet ready to implement HIS, since the doctors and nurses are not trained on these systems and also there are no computers or tablets to utilise. The facilities to implement HIS are not ready. In some of the hospitals, medical teams are trained but they are still not using the HIS clinical modules. They are waiting for authorisation to start implementing. The medical team are an important part of the hospital and are the personnel driving patient management, priority must be given to them to drive faster implementation of HIS.

Over 92% of hospital staff members interviewed, were positive about HIS and wanted the implementation of HIS to be quicker. However, during the interviews, it was discovered that majority of healthcare workers do not have information about HIS and the benefits it can provide. This finding was also presented by Ruxwana et al. [12]. Also, they didn't know when the full implementation will be done since there is no communication between the implementers and the site staff. To improve implementation of HIS the government and the private hospital management need to communicate with all stakeholders to give updates on implementation. This will help to keep everyone on speed and will improve implementation.

It was very difficult to recruit doctors since there were always busy, however, the researcher is happy on the number of doctors recruited. Doctors felt that it will be time-consuming to use HIS for patient notes and records but will be helpful to receive lab results and other results via automation. The commonest comments from the doctors are; to use digital PACS as soon as possible, Training is conducted and no implementation or very slow, No internet connection, systems not maintained and got infected by viruses. Doctors that are using the system are very positive about the system. A doctor from IALCH said that initially it was difficult to adapt to using the system, however, after using it for a while it became easy and faster to use. It is now very useful and time-saving. Problems encountered include load shedding as well as down time

which causes frustration for doctors. Doctors would recommend this system for more hospitals so that there could be uniformity and a continuation of care of patients. Most of the comments were positive on HIS.

Nurses in both private and public hospitals are not using automation and all patients' notes are still on paper. Nurses were positive that it will help with the backlog of admin and repetition of data. The computer system used by nurses was mainly for ordering goods to be utilised in the wards from the stores within the hospital. Nurses also think that the implementation of HIS will help to reduce high amount of paperwork which some are duplicates which can be resolved by the implementation of HIS. Intensive care units (ICUs) are equipped with electronic systems and are not used electronically. Nurses and doctors still rely on paper. Nurses feel that HIS system is good and will reduce nurse's workload as there is currently a shortage of nurses and doctors in the hospitals. Nurses also commented about the training of staff and said that proper training, proper implementation will help and in the long run the hospital will save money and there will be more information to able medical teams to manage patients better.

In radiology departments and in most of the hospitals, there are digital systems, these systems are not used digitally (list systems used: PACS, RIS, CARESTR, IMPAX, CR, SOS, and PAAB). Most of the hospitals still print films and store the films and also digital scans. The system for electronic radiology information system is not linked to HIS even if the radiology department uses a digital system that has the capability to link with HIS. Doctors still relied on the films and paper reports to review the results. PE provincial hospital and IALCH fully utilise their digital systems and send digital results to doctors where they will login into the computers in their wards or offices to review the results and reports. These were the only two hospitals found to utilise digital radiology system digitally. CHM used digital however, they still print film and reports for doctors and digitals are used for archiving. Radiologists and radiographers would like to utilise the digital system, however, the implementation is very slow and they are not sure when complete automation will be done.

The main reason for the lack of implementation in the radiology department was the link with other departments since the medical team does not have means of accessing the digital radiology

system or HIS. The system is cable to be linked to HIS but it was not done in most of the hospitals. Maintenance of the digital system was also a concern from the staff. When the system is broken it takes a long time for technicians come to repair the system then resort to the old manual system as a backup. Because of delay hospitals were using these manual back up for a long time before the technician arrives to fix the digital system. Most rural hospitals did not have digital systems and are still using the manual system with the films and large storerooms to keep the films. Human resource capacity was also a major challenge in the rural areas. During this research, at Barkley West hospital there was no radiographers or radiologist to use the x-rays system. The patients had to be transferred to Kimberly hospital. There is only one radiographer available if the radiographer is off duty, there are no x-rays done at the hospital. These findings support the finding of Ruxwana that there is an unequal distribution of healthcare professionals between rural and urban areas especial in specialist healthcare [12].

On the other hand, the administration staff confirmed to use HIS to register patients when admitted to the hospitals. However, Newcastle hospital was the only hospital found to still using the manual system to admit the patients. This hospital was located in the urban area and not rural. The main reason for not implementing HIS was a lack of connectivity but the billing and the data management were using automation to bill and register statistics for the hospital to report to the province. The procedure followed by administrators when admitting patients is that the administrators enter data on an automated system then generated in a paper format patient's file for medical staff to use. Medical staff will depend on the paper format and once it is lost there are no medical notes for the patients if the file was not copied. The administrative staff regularly update the dates of visits and follow-ups on HIS and later the diagnosis by data management and billing for the finance department. No medical notes are entered. However, the diagnosis is required for billing and this information sometimes is entered by the billing department or data management. In almost all hospitals the billing department used HIS. According to the administrators, the system works very well and they are happy to use the system. If it was not of HIS the admin staff confirmed that the administration of patients in the hospital will take a long time looking at the volume of patients visiting these hospitals. The system is sometimes slow and most of the time is caused by the slow connection, however, other

hospital did not complain about the slowness of the system. Down time was also mentioned as a challenge by the administrators.

Pharmacies in the public sector are using Rx Solution to manage the stocks in the pharmacy and stores, however, they are using a manual system to dispense the medication. There was no electronic scripting in the hospitals visited except IALCH. At Addington hospital, electronic scripting has started but it is only done by a few doctors and their number was not significant. It is the same with the private hospital as the doctor still send manual scripts. The pharmacists at the private hospital: at Netcare they use SAP and Mediclinic use Unisolve to manage stocks. None of these systems were linked with HIS or used electronic scripting. However, RX solution is capable of being linked with HIS and the same with systems used at the private hospitals. The pharmacists are keen to use the electronic scripting and dispensing, however, the implementation of the system is holding them back. They think implementation of HIS in the hospitals and at the pharmacies will be a good thing and the system will improve the health care services in the country. The challenge is the implementation which is too slow. For example, the systems are installed in the pharmacies but it is not fully working. Internet connection was another issue from the pharmacy site.

All public hospitals are using National Health Laboratory Service (NHLS) as the hospital laboratory, which is fully automated. However, NHLS automated systems cannot be linked with HIS since the systems are not the same or compatible with HIS. According to IT departments, the system cannot be linked and to facilitate the link, NHLS has to change their system to find a system that will be compatible to HIS. It was confirmed by several IT departments that the system used by NHLS is too old to be linked with HIS in the hospitals. The NHLS automation requires the users to log into NHLS system to access the lab results for the patients and not the hospital system. This is not an ideal system because is not incorporated into HIS and cannot be linked to HIS. However, the results can be accessed from any hospital nationwide as long as the user has access to the NHLS system and patient codes. Private hospitals are using private labs which are also not linked to SAP or AS400. The ideal software is still required to link these systems to perform with HIS in both private and public hospitals.

Patients were not recruited as planned due to the policies of the hospitals and also due to the fact that most of the hospital management felt that we won't able to get the information required from the patients since they don't have knowledge on HIS. They also stated that the information required on the questionnaires was more for HIS and HIS was not fully implemented in their hospitals. Only 17 patients (76.5% public and 23.5% private) were interviewed and surveyed in both public and private hospitals. Patients were also positive about HIS and did not have a problem if the doctors' unanimously share their medical information with staff or students for the purpose of training. They think this will help to reduce long queues at the hospitals especially in the pharmacy. Access to the hospital for patients visiting hospitals was easy in most of the hospitals and transport was always available. However, Mzimkhulu, Gelukspan, and Tokollo hospitals access to transport for patients was difficult and access to the hospital was not easy since patients had to walk some distance from the public transport stations or stops to the hospital. Patients were more concern about the shortage of staff in the hospitals, especially in the rural areas. Urban areas were also affected by staff shortage but not to the extent of the rural areas.

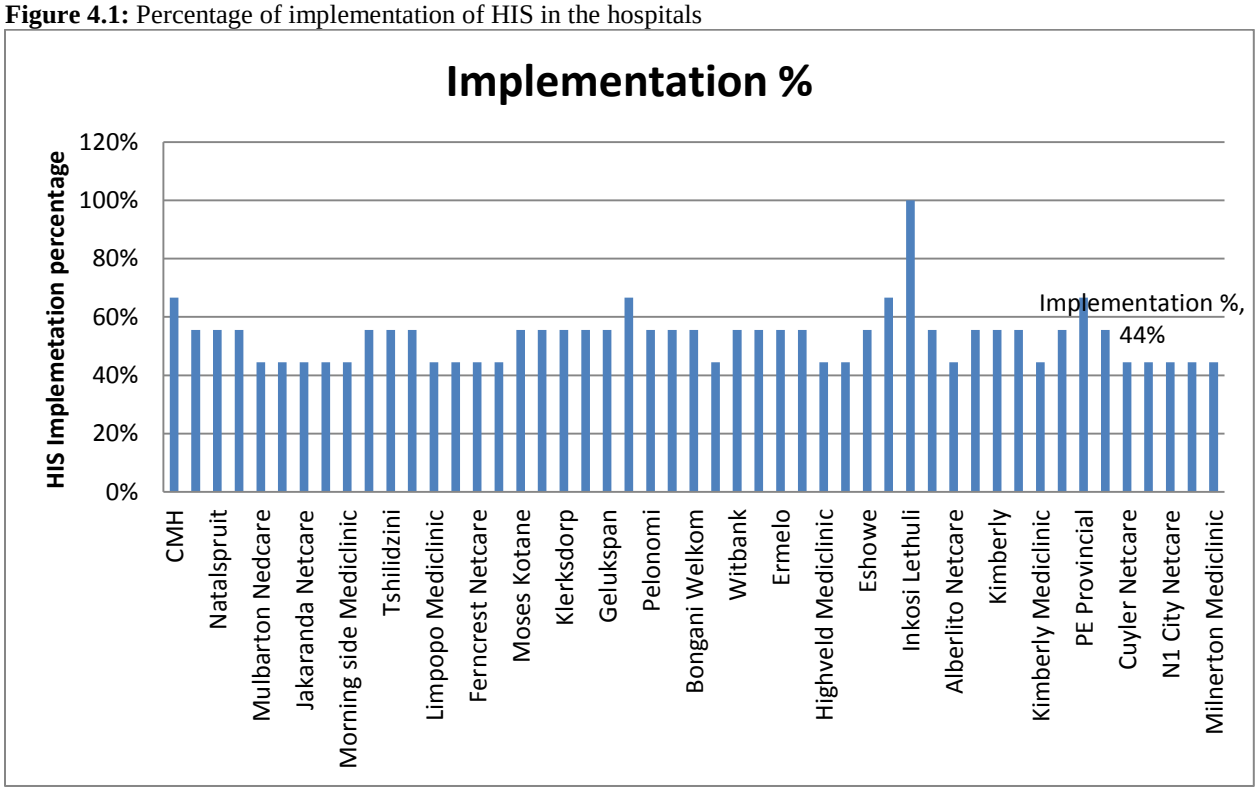
Based on the observations of the research and interviews, there is no difference between rural and urban hospitals as far as implementation of HIS. The stages of implementation were identical to the urban hospital. The difference was noticed mainly in the hospital facilities and staff capacity, where the rural hospitals had fewer facilities and less staff as compared to urban hospitals. Patients are transferred to bigger hospitals for further medical investigations and management. Lastly, the rural hospitals were not close to transport stations or community. The access to the hospital was not as easy as in the urban hospitals where public transport was at the close proximity of the hospitals. Access to the rural hospital must be looked at especially transport to the rural hospitals and state of the roads.

4.3.2 Advances in implementation of HIS

All hospitals in South Africa have partially implemented HIS. Figure 1: Percentage of implementation of HIS in the hospitals. On the laboratory side, South Africa has advanced since

all the public hospitals are using NHLS laboratories which are fully electronic and some of the doctors are registered to the NHLS web and these doctors are able to review and print the lab report. Some of the doctors access the results via their mobile phone internet if the hospital does not have an internet connection. All Pharmacy stores are fully electronic however, the dispensing and scripting is still manual. Only one Hospital that fully utilised automation to a paperless system. 98% of hospital implemented HIS in their reception or admission area. ICALH has 100% on implementation however, other hospitals are above 43% of implementation and the second highest was on 67%. According to the results of this research, South African hospitals partially implemented (53%) HIS in both public and private hospitals. These systems implemented are not linked and the project team still need to find out how these can be linked and able to share information. Data sharing through HIS does not exist in South African hospitals. There are still a number of challenges to be resolved before the implementation and the government and the private sector have to resolve these challenges before the implementation.

Figure 4.1: Percentage of implementation of HIS in the hospitals



4.3.3 Challenges encounter during implementation of HIS

During interviews, staff mentioned that the implementation of HIS in the hospitals is too slow. Sometimes hospital staff are trained on HIS and then are not practicing or using it for a long time and end up forgetting how to use HIS because of the slow implementation. Training is done on certain teams only and not on all the departments and one will find there is only one department that use the system and the others don't. Service providers are not located within the hospitals and if there are issues with the system it takes a long time to fix. Inadequate infrastructure remains a big challenge and lack of antivirus for the computers. Maintenance of computer system is lacking and some departments do not have computers or no introduction to computers. That means the government or the private hospital companies must provide computers and the IT infrastructure before implementation which involve cost. Universitas Hospital started using HIS due to lack of maintenance and budget to maintain HIS, however the hospital stopped using it. When the researcher tried to visit Sebokeng hospital, the access was denied due to the hospital stopping using HIS. The reasons for stopping HIS were not established. The researcher suspects the same reason as Universitas hospital. There might be serious cost implications for implementation of HIS. The government and private hospitals must explore thoroughly the cost implications based on the challenges encountered before implementing HIS in their hospitals, to avoid staring then later stop like Sebokeng and Universitas hospitals.

Lack of internet connection or slow connection contributes to the challenges. Downtime, offline and load shading were also mentioned as one of the challenges. Mobile internet in South Africa is popular and it was said that to hold a potential in mobile-health (m-heath) where patients and healthcare providers can access the internet via mobile devices [22]. Already doctors are accessing NHLS results via their mobile devices if there are no internet facilities or computers in the hospitals or wards. This holds a potential to assist in implementing HIS and requires full exploration. It will help to resolve more of the connectivity and IT infrastructure issues facing HIS implementation. The software in laboratory and pharmacy only work in those departments. NHLS automated systems are not compatible to HIS and too old to link. In finance and Revenue, They use a specialized programme to view budgets and registered company and there is no data

sharing amongst the departments within the hospital or the province. Implementation to link the system is a major concern to IT staff. Linking of the systems will reduce costs because there will be no new software upgrades required. This will require a cost effective bandwidth that will able to link these different systems. There is no standardisation of information and communications technology (ICT) system across the country. The only portion of HIS modules are implemented and not all the modules are used and it is mainly admin, stats, and finance.

Communication seems to be another challenge and this confirmed by the IT departments of different public hospitals. IT departments do not have enough training or information to able to resolve issues on HIS and communication with the stakeholders is not enough because it is not known when implementation will start and the plan. Hospital staff and the patients are not aware of HIS plans or when will it be fully implemented. There is no communication with the stakeholders. The implementers should communication with the other stakeholder for better or faster implementation. The users need to have a buy-in on the product and if there is not communication or promotion of the product it will lead to poor implementation.

4.3.4 Current position of Government regarding Medical Informatics

The government was contacted on the 11 November 2014 to give comments on the implementation of HIS and on the 14 November 2014 the researcher received a letter acknowledging the letter that was sent to the ministry of Health in South Africa (See appendix III). To date ministry of Health has not responded and several follow-ups were made without success. The researcher had researched via the internet, through interviews with IT and on the newsletters of the government about the current position of SA government on implementation of HIS. The South African government has approved the project in the cabinet and is now driven by the National Treasury and Chief Directors in the National Department of Health (NDoH). The budget was increased for each financial year. The researcher could not access figure for 2014/2015 financial year. The SA government supports HIS implementation and has also increased support staff in the provinces and subcontracted HIS to service providers to support the

provinces, whilst Health Support Trust (HST) provides full-time support in the rest. It was also found that the government has fast-tracked the implementation of National Health Insurance Fund (NHIF) for health insurance [3, 50]. These two projects (NHIF and EHRs) were moving hand in hand and it looks like NHIF has been given priority.

Although the office of Ministry of health did not comment, the IT departments of different hospitals and the information from government updates have confirmed that there are ongoing meeting and training on HIS to plan and finalise the implementation of HIS in South African hospitals. The strategy in place was to start with part 1 which will integrate the existing systems, part II to develop the intelligent system to search existing data and Part III to fully implement a functional HIS or e-health which is accessible across provinces, with a governance structure for standards [3].

- A standard-based platform that will integrate the existing Provincial Health Information Systems.
- Core for a comprehensive EHR (both current/ future ; Private/ Public standards)
- Standard based architecture and information model
- Clinical records and Document Management capability in a secure environment
- Different health information systems in provinces with different database systems
- Different levels of sophistication and maturity in implementation

According to present information from the government the provinces are using the following HISs:

Medicom	:	KZN, Gauteng, Limpopo
Nootropics	:	Northern Cape
Clinicom	:	Western Cape
Meditech	:	KZN, Free State
Unicare	:	Western Cape, Limpopo, Eastern Cape
PAAB	:	Gauteng, Mpumalanga, North West, KZN

PADS : Free State

4.3.5 Data Sharing and Data Privacy Law in South Africa

Data privacy law in South Africa is clear and well explained. It states that a person should have control over his personal information. When people provide information they should be clearly explained for what purpose the information will be used for. If there is additional information that the information is used for the service provider should request permission to use the data or information. In terms of the proposed legislation, the (i) processing of information is limited which means that personal information must be obtained in a lawfully and fair manner and may only be used for the (ii) specified purpose it was originally obtained for. The information must be processed in terms of the law and in a manner not to intrude upon the privacy of a person to an unreasonable extent. This entails, among other things, for personal information to be processed only in very specific circumstances, for example where prior consent has been obtained, and also for the information to be destroyed once the purpose of the collection has been achieved. The other important principle is (iii) the limitation on further processing: data should not be shared unless the individual has given permission or unless it is in the furtherance of a legitimate private or public interest. The further processing of data is accordingly limited and it must not be further processed in a way incompatible with the previous purpose it was obtained for. The party processing the data must (iv) ensure the quality of the information by taking reasonable steps to ensure that the information is complete, not misleading, up to date and accurate; and in terms of the principle of (v) openness, notify the Commission (see below) and individual that the data is being processed. Such party furthermore has the obligation to implement appropriate (vi) security safeguards and measures to safeguard against loss, damage, destruction and unauthorised or unlawful access or processing of the information [16].

The majority of South Africans don't know this law and personal information is often abused. However, data privacy does not delay or impact on the implementation of HIS. The majority of patient's interview agreed that the medical information can be used for the medical purpose and training of medical personnel. According to the results of this study, the medical team or hospital staff require training on data privacy and handling of personal information.

4.3.6 Flow of data to central database

At the present moment, there is no data flow to the central database. Each hospital is keeping information in-house and data managers are keeping statistics of the hospital and are sent to the central provincial database. For electronic health records, there is no data flow implemented. This was not explored in the private sector.

4.4 The survey questionnaires results and discussion

4.4.1 Perception of staff on Advances and Implementation of HIS

Results of the survey about the implementation of HIS in the hospital by hospital staff are presented in the tables 4.6 to 4.8 below. According to questionnaire's results; IT staff (67%), Doctors (70%), Nurses (65%), radiographers and pharmacists (69%) confirmed that their computer systems do not capture patient medical notes or data. Only the Administrative staff (56%) confirmed to use the automated system when admitting patients and it also includes billing department and data management. The survey from IT (57%), doctors (70%), nurses (65%) and pharmacists (62%) confirmed that computer systems in the hospitals do not capture patient health records. The survey confirmed that 69% of doctors, 76% of nurses, 83% of pharmacist did not agree with the statement that patient database and health records are only kept in a computer. These results confirm the interview and the observations results above. It is also confirmed by the medical team and IT department are not using HIS for billing and payment. However, the results confirmed that doctors are receiving laboratory results online. IT departments (58%), Doctors (50%), pharmacist (74%) and nurses (65%) confirmed that doctors received laboratory results electronically. Doctors at hospitals have to register to gain access to the results online. The online lab results are not linked to the hospital automated system, Doctors have to login National Health Laboratory Service (NHLS) website, to download and view the results.

Regarding evidence-based medicine and decision making by the use of HIS, the statement was disagreed by 58% of doctors, 75% of nurses and 43% of Pharmacists. Some doctors confirmed that they use their personal computers in a private capacity for learning from evidence base medicine. Doctors (49%), Nurses (54%), pharmacists (62%) and admin (74%) confirmed that health records in the hospitals are kept both in paper and electronic format. This means data in the hospitals in SA are kept in different systems and this does not mean it is the same data as medical notes are only kept in paper or scanned handwritten documents.

Table 4.6: Healthcare workers perception regarding implementation of HIS

	Doctors				Nurses				Pharmacist			
	Disagree	Neither	Agree	Don't	Disagree	Neither	Agree	Don't	Disagree	Neither	Agree	Don't
PC capture patient information and contact details	59%	3%	29%	9%	58%	3%	35%	4%	69%	2%	26%	2%
Capture all pt. information including health records	70%	2%	24%	5%	65%	5%	28%	2%	62%	7%	29%	2%
Use computer only for billing & payment.	79%	4%	8%	9%	77%	1%	18%	4%	79%	0%	19%	2%
Received pt. lab results online	50%	1%	48%	1%	65%	3%	28%	3%	74%	5%	19%	2%
Use computer for computerised prescription to the pharmacy	88%	3%	7%	2%	86%	1%	9%	4%	67%	0%	33%	0%
Use computer to refer patient to radiology dept & for digital imaging	74%	0%	26%	0%	80%	3%	15%	2%	83%	5%	5%	7%
Patient database & health records are only kept in the computer	69%	5%	21%	6%	76%	4%	16%	4%	83%	2%	7%	7%
Patient database & health records are only kept in the paper format	43%	2%	51%	4%	39%	4%	55%	2%	50%	5%	38%	7%
Patient database/health records are kept in paper & computer	40%	6%	49%	5%	39%	3%	54%	4%	29%	0%	62%	10%
Use computer for evidence based medicine/clinical decision making	58%	3%	33%	6%	75%	3%	14%	8%	43%	5%	45%	7%

Pharmacies (67%) are still running manually and there is no electronic scripting in the South African Hospitals visited during this research. Doctors (88%), pharmacist (67%) and Nurse (86%) supported the statement that there is no electronic scripting in South African hospitals. Doctors still write a paper script to the pharmacy. Radiology departments are also not using

digital imaging, Doctors (74%), Nurses (80%), Pharmacists (83%) and IT (67%) confirms through the results of this survey. Doctors are receiving radiology results with films and paper report. Most of the hospitals visited used radiology digital image but the films are also used and digital only used for archiving. Most of these hospitals have digital systems but are not used fully. The survey results have confirmed. Only IALCH that was found to be fully automated which doctor's notes, nurse's note and all other information is kept in an electronic system called SORIAN. However, PPH and IALCH are the only two hospitals utilising digital imaging and to transfer pictures or films electronically.

Table 4.7: IT personnel perception regarding implementation of HIS

	Disagree	Neither	Agree	Don't
Our computer system capture only patient information and contact details	67%	22%	11%	0%
It captures all patient information including health records.	57%	5%	38%	0%
Computer system is only used for billing and payment.	55%	0%	41%	5%
Doctors receives online lab results	58%	4%	31%	8%
It is used for computerised prescription to the pharmacy	40%	5%	50%	5%
Ii is used to refer patient to radiology department and for digital imaging	67%	4%	25%	4%
Patient database and health records are only kept in the computer	65%	4%	26%	4%
Patient database and health records are only kept in the paper format	77%	5%	18%	0%
Patient database and health records are kept in both paper and computer	60%	15%	25%	0%
There is Improved systemic utilisation of evidence-based medicine	36%	8%	44%	12%
Make clinical function better by proving computerised prescriptions/online lab results/digital radiological imaging	25%	11%	46%	18%

Table 4.8: Administrator's perception regarding implementation of HIS

	Disagree	Neither	Agree	don't
Our computer system capture only patient information and contact details	39%	3%	56%	1%
I use computer system is only for billing and payment.	58%	5%	35%	2%
Patient database and health records are kept in both paper and computer	23%	0%	74%	3%

Admin (74%) and Pharmacy staff (62%) agreed to the statement that patient database and health records are kept in both paper and computer system. Most of the medical team recorded their patient medical records on a paper system where at the administrators enter their data and diagnosis in the system. The only diagnosis is recorded on the system for billing and statistical purpose and not for medical management reason. In all the hospitals it is confirmed that the patient's records are kept in both paper and electronic format. As discussed in the observations and interview discussion. The administration staff will register all their patients on HIS and prepare a paper file for the use by healthcare personnel. In the pharmacy, the stocks are kept electrically and only the dispensary and scripting are manual. Kruskal – Wallis Test p-value (0.7344) was not significant when the median of responses the groups was compared for the statement; patient database and health records are kept in both on paper and computer. This means all the groups responses had the same median, meaning they all support the statement that health records are kept on both paper and computer. These results support the results of the observations and interview results that in most of the South African hospitals (private and public) the patient's database and health records are kept in both on paper and computer.

Medical team (58%) confirmed in the survey that the screenings of patients for clinical trials are also not done in an automated system. Data collected at the hospital are not kept in a central database to be accessed outside the hospital and it can only be accessed within the hospitals. The provinces only share the hospitals patient statistics on the central database system but not medical records. All hospital staff (74%) believe that patient information will be more organised in the automated system as compared to a paper system. It will also reduce duplication of records and reduce the number of lost records (65%). IT staff (60%) and Medical team (65%) confirmed that it is easy to work with the automated system as compared to paper and will increase effective communication between the departments. Doctors (72%), IT staff (76%) and Admin (79%) believe that introduction of automation will save the hospitals money. The staff is keen to use the automation and confirmed that they don't fear using a computer through the survey and they prefer computer as compared to paper.

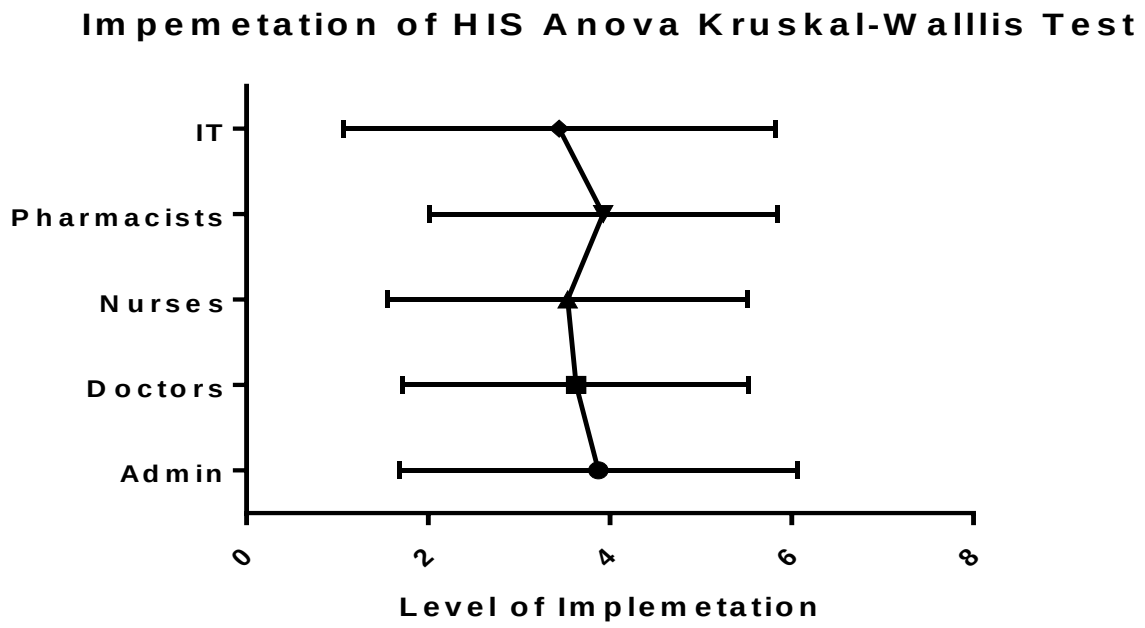
According to the survey, administrators (86%) follow the same standard when entering data and their computer systems are secured with login and password. The information entered confirmed

to be reliable and accurate (76%). The procedure followed by the administrators; they enter data on an automated system that are then generated in a paper format for medical staff to use. Medical staff depend on the paper format. Medical team (76%) and Admin team (48%) do not use automation to communicate medical information to other departments. However, the IT team (80%) confirmed that they use an automated system to communicate with other departments including medical staff. The researcher confirmed that this communication was more based on the email system of the hospital and not HIS. In the interview, doctors were not supporting the use of HIS in writing patient notes but supported the receiving of results via automation. However, they confirmed in the survey results that might save time and patients records will be more organised with a computer system as compared to the paper system (P= 0.0002 and Z ratio = 4.344). This shows mixed reaction between doctors on the use of HIS and majority of doctors (75%) would like to use HIS for their patient notes and to move completely to a paperless system.

The survey findings and the interview findings were the same as far as implementation of HIS concern. The Tamar Kahn Science and health editor news confirmed that Western Cape medical notes are also on paper and not on the computer and HIS is normally used for administrative tasks. It has confirmed that it makes it difficult for the health department to receive reliable data on countries disease pattern [67]. On the Tamar Kahn Science and health editor, it is confirmed that IALCH is the only paperless public hospital in South Africa. Kruskal- Wallis test (Nonparametric ANOVA) p-values was 0,2265, considered not significant. Variations of medians are not significant because all the hospital departments somehow mentioned that they use the computer in the hospital. The administrators for admitting and billing the patients, Doctors for electronic lab results, Nurse to order wards materials, pharmacists to manage their stock in the stores and radiologist using digital imaging. However, the two-tailed P value between administrators and nurses was significant at 0.0314 and for other groups, the p values were not significant. This data confirms that the nurses are the least in implementing HIS or the use of computers in their daily function in both private and public hospitals. These results reveal that a special priority must be focused on the nurses and the next team to be doctors. The ANOVA Kruskal-Wallis test results below presented the difference in implementation of HIS by deferent hospital staff. In both public and private hospital, most of the nurses are not required to

use the computers since all the systems and conducted manually. Some never used the computers in their workplace.

Figure 4.2: The use of computer in the hospitals by different hospital staff



4.4.2 Data sharing and data privacy laws

According to the survey IT (64%), Doctors (38%), Nurses (44%), pharmacists (40%) and Admin (43%) do not consider data privacy being an obstacle in the implementation of HIS. However, there is a high percentage of hospital staff that don't know if data privacy law will have effect in the implementation of HIS. There are Medical teams (Doctors 43%, Nurses 34%, and Pharmacists 29%) and Admin 31% who didn't know if data laws will hinder HIS implementation. This gave the researcher the impression that there is a high number hospital staff that do not know or understand data privacy laws in South Africa hence working on patient personal information. There is also a high percentage of IT (64%) and Admin staff (43%) who perceive data privacy laws in South Africa prevent proper utilisation of computer systems in the hospitals. Results of data sharing and privacy laws are represented in table 4.9 to 4.11.

Table 4.9: Perception of health workers regarding data privacy law

	Doctors				Nurses				Pharmacist			
	Disagree	Neither	Agree	Don't	Disagree	Neither	Agree	Don't	Disagree	Neither	Agree	Don't
Data privacy law in SA prevent proper utilisation of computer systems	38%	8%	11%	43%	44%	8%	15%	34%	40%	7%	24%	29%
Enhanced security around patient confidentiality	24%	6%	64%	6%	23%	5%	66%	7%	19%	10%	67%	5%
Computer systems is secured with username and password	28%	1%	54%	17%	27%	1%	60%	11%	21%	0%	74%	5%
Information on the computer is not secure or confidential	65%	5%	20%	10%	68%	3%	17%	11%	80%	5%	10%	5%
Patient do not allow staff to share their info through e-health	62%	8%	9%	22%	51%	6%	19%	24%	43%	5%	14%	38%
There is restricted amount of data to entered in the system	56%	11%	18%	16%	50%	7%	18%	25%	61%	5%	12%	22%

Table 4.10: Perception of IT personnel and administrators regarding data privacy law

		Disagree	Neither	Agree	don't
IT personnel	Enhanced security around patient confidentiality	20%	0%	70%	10%
	Computer systems is secured with Username and password	22%	0%	72%	6%
	Information on the computer is not secure or confidential	96%	0%	4%	0%
	Data privacy law in SA prevents proper utilisation of computer systems	64%	7%	21%	7%
Administrators	Information on the computer is not secure or confidential	73%	5%	20%	2%
	Data privacy law in SA prevents proper utilisation of computer systems	43%	10%	17%	31%
	I have confidence that information is more secure and confidential in electronic compared to paper	9%	5%	83%	2%

Table 4.11: Perception of staff regarding data sharing

		Disagree	Neither	Agree	Don't
Information collected available to researchers and clinicians	Doctors	43%	4%	35%	19%
	Nurses	48%	4%	28%	20%
	Pharmacist	43%	7%	38%	12%
	IT	13%	7%	60%	20%
	Med	41%	4%	37%	17%
Information collected is available for education and training	Doctors	40%	8%	37%	16%
	Nurses	44%	6%	39%	11%
	Pharmacist	43%	10%	38%	10%
	IT	13%	9%	50%	28%
	Med	43%	6%	38%	12%

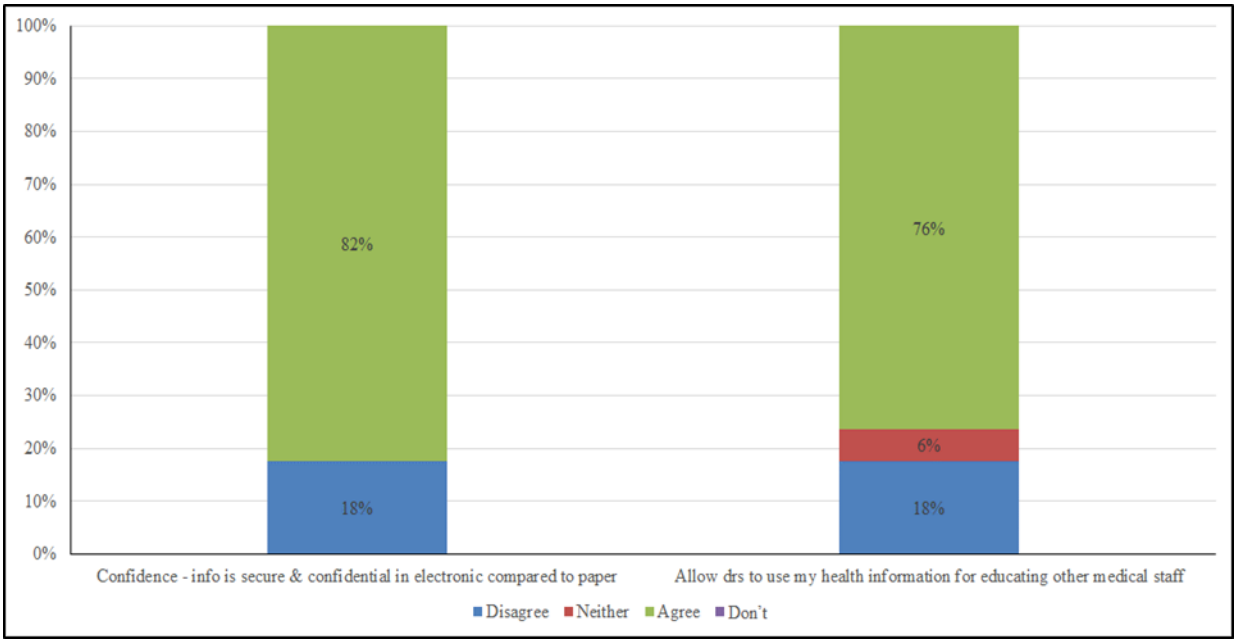
Over 60% of Hospital staff confirmed through the survey that computer systems or HIS will enhance security around patient confidentiality and the hospitals computers are secured with username and password. It was also confirmed that information that is saved in HIS is secured and confidential as compared to paper format. Security of patient's data is important especially for complying with our data privacy laws. All hospitals using HIS and the manual system should ensure that data is safe that they comply with data privacy law of South Africa.

Medical team (62% of Doctors, 51% of Nurses and 45% of Pharmacists) do not agree with the statement that patient do not allow staff to share their information through e-health systems. This statement contradicts the survey that was done on patients which state the patients are happy for the medical team to share their health information for training and education purpose. This leaves the opportunity to explore this area in future researches. The medical team also did not agree with the statement that there is a restriction on the amount of data to be entered on HIS. At the present moment, the medical team is not using HIS and their perception on HIS might be negative since they don't have enough information about it. The medical team also confirmed that information collected in HIS is not readily available to researchers and clinicians. Information collected it is not used for education and training because the majority of the hospital are not using HIS to collect medical information. At the present moment, there is no medical data sharing in a form of HIS in the hospitals.

Most of the hospitals in SA are not linked to each other to enable cross-referring and data sharing. Sharing of data across the hospital and provinces is impossible. These hindered the possibility of evidence-based medicine and electronic referrals. Some companies have started re-reimbursing healthcare workers that are using electronic communication between patients [45]. Reimbursing user might be an option to promote the use and improve implementation of HIS and data sharing. Patients (82%) also have confidence in electronic systems that their medical data will be more secure as compared to paper and 72% will allow doctors to use their health information for education and training of other medical staff. Figure 4.2 present patients perception on data sharing. Patients were not recruited as planned due to the policies of the hospitals and also due to the fact that most of the hospital management felt that we won't able to get information required from the patients since they don't have knowledge on HIS and the information required on the questionnaires was more for HIS and was not fully implemented in their hospitals.

Only 17 patients (76.5% public and 23.5% private) were interviewed and surveyed in both public and private hospitals. Patients were also positive about HIS and did have a problem if the doctors' unanimously share their medical condition with staff or students for the purpose of training.

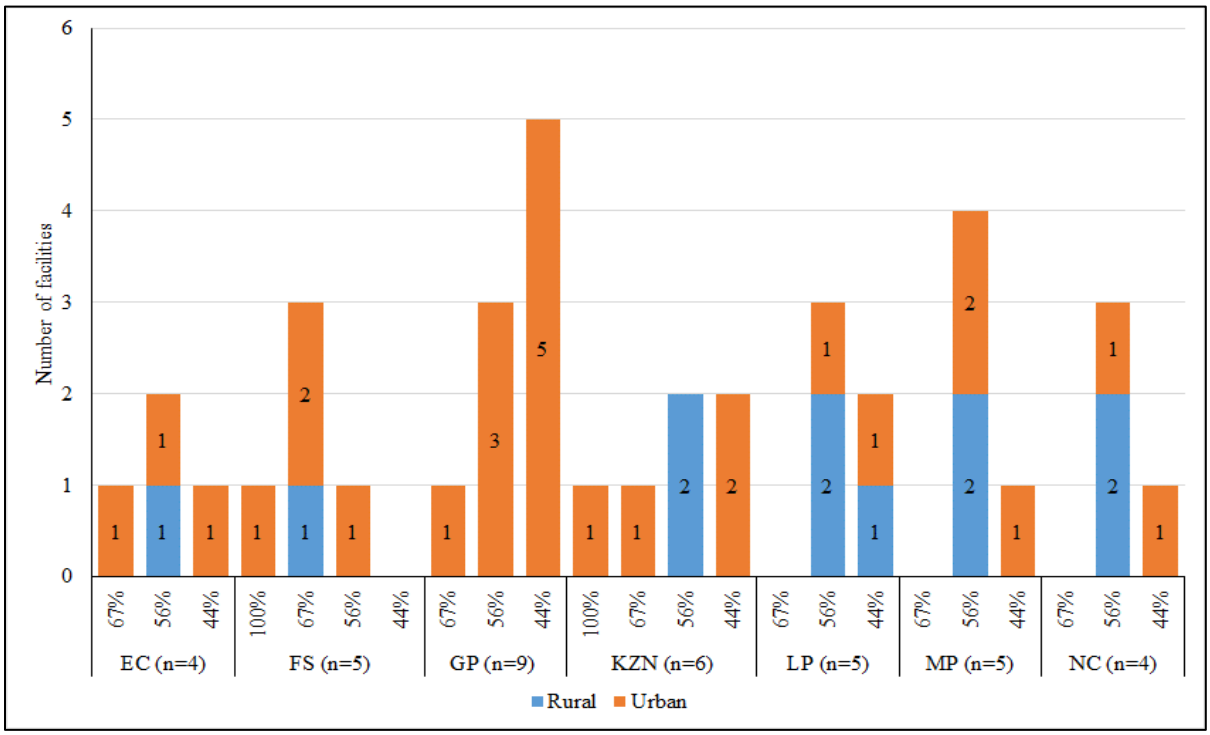
Figure 4.3: Perception of patients on implementation of HIS in the hospitals



4.4.3 Comparison of Medical Informatics implementation in Rural and Urban hospital

All rural hospitals vested implemented HIS at the same rate as in the urban areas. There were no differences between rural and urban hospitals as far as implementation of HIS is a concern. The survey also confirmed the interview and observation results. These findings do not support the findings of Ruxwana et al where stated that the implementation of HIS in the rural areas of SA was behind compared to urban area, however, it supports the findings on the need to improve rural hospital infrastructure and lack of information regarding HIS [12]. All modules that are implemented the urban areas are also implemented in rural areas. There is not difference noted during this research. Ruxwana also looked at the clinics in the Eastern Cape and this might be applicable to the clinics. In this research, there were no clinics involved and there were only hospitals and the findings were different.

Figure 4.4: Comparison of Medical informatics implementation in Rural and Urban hospitals



4.4.4 Perceptions on service delivery after implementation of HIS

IT and medical team could not confirm if the patient waiting time has decreased since the implementation of HIS because they have not started using HIS. Only the admin staff could comment and the hospital staff that are currently using HIS. The admin staff were the only team found to use HIS, Admin staff (65%) confirmed that patient waiting time has decreased and for doctors and nurse it was not applicable since HIS was not used. Admin confirmed that delivery service has improved and patient care has increased. Admin staff (58%) are satisfied with overall working conditions since the implementation of HIS and enjoyed improved service delivery. The administrators (62%) confirmed that there is a reduction of duplication of information at the administration section of the hospital since the records are both kept in paper and electronic. If the file cannot be found, the electronic system is available to confirm the creation of the file and the date when the file was created and the team will know if the file was created or not. The admin team are able to know if the file was lost on not created. Admin staff (79%) were eager to learn the new automated system, as a result of the new computer system the staff morale and level of professionalism have improved or increased in a workplace (69%). Administrators (60%) believe that patient discharge times have improved, automation increased patient confidentiality (83%). It is easier to locate the records and staff are confident that patient information is more secured and confidential in an electronic system compared to paper. These results confirm that the admin teams in the hospital are happy with HIS and the benefits that it brings.

4.4.5 Challenges encountered and Perceptions on the challenges

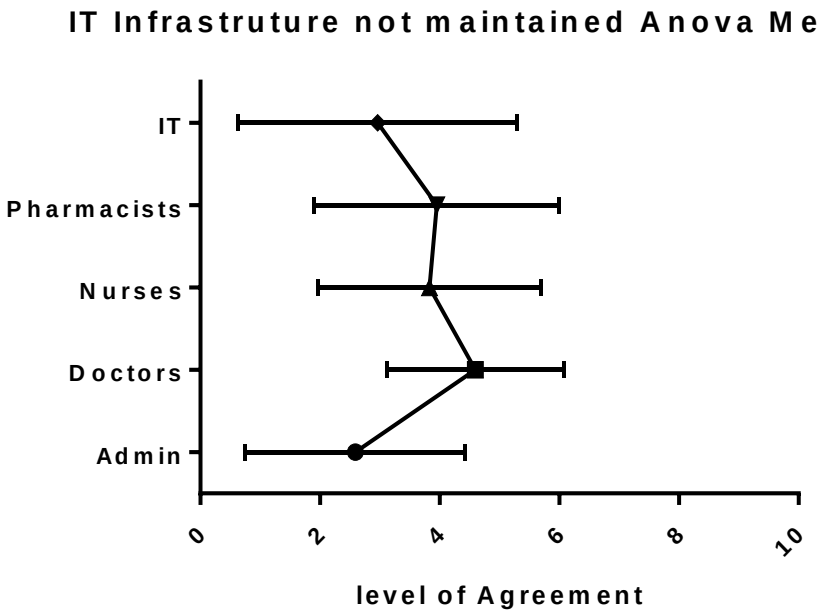
The results for perception on challenges encountered during HIS implementation in the hospital are presented in table 4.12 to 4.14. Majority of staff are keen to learn the automated system. According to IT (61%) perceives that staff members are eager to learn new systems. Doctors (49%), nurses (55%), pharmacist (55%) and admin (79%) supported the statement that staff is eager to learn the new system. IT also confirmed that there are few staff members that initially didn't like to move to a new computer system, however. the medical team (71% doctors, 71%

Nurses, 74% pharmacists) and 74% admin staff did not support the IT perception. Medical and admin teams disagree with the statement that there was insufficient training provided when first to use HIS in the hospital, however, the IT team (72%) agreed with the statement. Since HIS systems in the hospitals are outsourced to the private company, the IT team feels that the information provided to them was not enough to help staff when there are problems with HIS. Often technicians are called from the outsourced companies to resolve HIS and sometimes they take too long to visit the hospital to resolve the issues. This was one of the challenges that were noted during the interview and observation results and discussion. Lack of information on HIS implementation and information was a major finding of Ruxwana's research on ICT application research done in the eastern cape province of South Africa [12]. This might highlight that there is lack of communication across the provinces and the government regarding implementation of HIS

Admin (55%) confirmed through the survey that they welcomed the new system and only 26% were resistant at the beginning. The other main challenge was the lack of enough human resources to utilise the new automation system. However, the majority feels that will only be at the beginning and in the long run will reduce workload. Of course at the beginning human resources need to be increased and have a dedicated HIS expert that will foresee implementation of HIS. This comes with a cost which implementers need to explore. Medical staff (42%) also mention frequent downtime on the internet however, most of the IT department (58%) did not support the medical and admin staff perception. The administrators confirm that there is frequent downtime which sometimes slow down the admissions and progress. Most of the staff did not consider the cost of IT equipment as a challenge, however, 50% of doctors think cost will affect quicker implementation. IT department did not consider the state of IT infrastructure as a challenge and the medical team perceive it as a challenge. The comparison on Kruskal –Wallis test results were extremely significant $p < 0.0001$ for a challenge on IT infrastructure. Comparison of groups also revealed a significant difference between Admin versus doctors, Admin versus nurses, Admin versus Pharmacists, Doctors versus IT with p-value <0.001for all. This reveals that IT infrastructure in South Africa hospitals needs a serious revamp. The revamping of the IT infrastructure might increase the budget for implementation of HIS significantly, moreover still having to find the bandwidth to connect the different HISs. South

Africa might also find itself spending too much money on HIS and this brings cost as one of the major challenges. This results support the research done by Miller et al whereby some practices experienced some financial risk in the implementation of HIS [49]. And South Africa is not immune from this challenge since there are number of it equipment and the IT infrastructure to be sorted out.

Figure 4.5: Comparison of group's responses on IT infrastructure challenge



Data privacy and historic issues in South Africa were not regarded as a challenge. However, the medical team perceived them as a challenge. The difference in infrastructure reflects back to the historic issues of South Africa. Most of the hospitals that lack good infrastructures and staff are more from the previously disadvantaged communities. According to the observation, it is possible that historic issues of South Africa might have an effect on the implementation of HIS, especially in the rural areas. The hospitals are not well maintained and will need an extra budget to bring the infrastructure to the level of the hospitals in urban areas.

According to hospital staff, they don't have a fear of having to use the computer as compared to paper and they also confirmed through the survey that they prefer to move to the computer system. These are the advantages for the implementation of HIS. The medical team perceive that

implementation of automation to be very slow. The implementation talks started in 2002 and 13 years later the implementation is still stalling. According to this survey, training and slowness of the computer systems were not among the challenges of implementing automated system. 81% of admin staff disagreed with the statement that their computer system is slow. The survey revealed that 60% of the medical team want to move to a paperless system and 88% of HIS users found it to be user-friendly.

Table 4.12: Challenges as perceived by Healthcare workers

	Doctors				Nurses				Pharmacist			
	Disagree	Neither	Agree	Don't	Disagree	Neither	Agree	Don't	Disagree	Neither	Agree	Don't
Staff are eager to learn the new system	32%	8%	49%	11%	31%	5%	55%	9%	21%	10%	55%	14%
Initially I did not want to move to the new computer system	77%	3%	18%	2%	71%	4%	19%	7%	74%	5%	19%	2%
There is enough human resources to utilise the new computer system	53%	7%	30%	10%	56%	5%	29%	10 %	44%	2%	39%	15%
Initially the staff did not want to move to the new computer system	60%	5%	17%	18%	65%	5%	18%	12 %	57%	10%	21%	12%
Insufficient training was provided when I first had to use the system	62%	5%	27%	6%	61%	6%	24%	9%	67%	2%	31%	9%
I have a fear of having to use a computer instead of paper	86%	3%	7%	4%	78%	3%	14%	5%	88%	5%	7%	2%
I found the system difficult to use (Not user friendly)	80%	6%	9%	5%	78%	3%	12%	7%	81%	5%	14%	2%
I find the system slow	58%	6%	29%	7%	71%	5%	15%	9%	61%	7%	29%	2%
I prefer using a paper based system	77%	7%	13%	3%	72%	5%	18%	4%	79%	10%	10%	2%
The IT infrastructure is not well supported and maintained	41%	7%	36%	17%	56%	5%	21%	19 %	60%	2%	33%	5%
Implementation of computed system is very slow	42%	6%	45%	7%	54%	6%	23%	16 %	50%	0%	38%	12%
Historic issues of SA affect utilisation of the new computer system	50%	4%	25%	22%	50%	7%	18%	25 %	52%	0%	24%	24%
Data privacy law in SA prevent proper utilisation of computer systems	38%	8%	11%	43%	54%	6%	23%	16 %	40%	7%	24%	29%
There is limited/no funds to run the systems in this facility	34%	5%	26%	34%	44%	8%	18%	30 %	49%	5%	34%	12%
High cost of IT equipment	31%	8%	31%	29%	36%	5%	25%	33 %	34%	0%	41%	24%
There is frequent down time or internet not available	40%	5%	44%	11%	42%	7%	29%	21 %	55%	7%	31%	7%

Table 4.13: Challenges as perceived by IT personnel

	Disagree	Neither	Agree	Don't
I believe the computer systems will save the facility money	22%	0%	61%	17%
Staff are eager to learn the new system	30%	0%	61%	9%
Initially I did not want to move to the new computer system	36%	8%	44%	12%
There is enough human resources to utilise the new computer system	74%	0%	26%	0%
Initially the staff did not want to move to the new computer system	36%	4%	48%	12%
Insufficient training was provided to staff	22%	0%	72%	6%
Staff have a fear of having to use a computer instead of paper	71%	0%	25%	4%
I find the system slow	81%	0%	19%	0%
Staff prefer to use a paper based system	96%	0%	4%	0%
The IT infrastructure is not well supported and maintained	34%	13%	31%	22%
Implementation of computed system is very slow	48%	4%	33%	15%
Historical issues of South Africa affect utilisation of the new computer system	74%	4%	17%	4%
There is limited/no funds to run computer systems in this facility	36%	8%	40%	16%
High cost of IT equipment	41%	7%	41%	10%
Increase of workload for staff	38%	10%	38%	14%
There is frequent down time or the internet not available	56%	11%	22%	11%

According to the above results on the perception of staff, there are a number of challenges in South Africa for HIS implementation. The cost of IT equipment was not considered to be a challenge by the teams, however, the purchasing of new computers and revamping IT infrastructure will require a big budget. Most of the US sites had to find a way of cutting cost when implementing HIS since the budget was getting too much. South Africa also needs to be careful when budgeting for these upgrades. It will also require more staff who will be dedicated to work on HIS implementation. Despite issues of budget, the staff did not consider the cost of IT upgrades as a challenge to implement HIS in the hospital. However, in Cline's study doctors had a concern regarding the cost of IT equipment. In this study only 31% of doctors thought, the cost is a challenge. The group that came higher and agreeing to a challenge that IT cost might be a challenge was IT and pharmacists both at 41%. Lack of internet and down time in the hospital was raised from doctors (44%), IT (41%), admin (42%) and pharmacists (31%). The results lack of internet and downtime were less expressed in the survey as compared to other researches that

expressed disadvantage of HIS implementation in South Africa [12, 46, 67]. The majority of hospital staff perceive the use of HIS will save money for the hospital and the government. The challenge of training of staff was strongly expressed by IT group at 72% and admin at 41%. The medical team did not perceive it as a challenge. The researcher thinks that they did not perceive it as a challenge because they have not started using HIS. The IT team and admin have already started with HIS and perceive it as a challenge through their experience of using HIS. Upgrades of IT equipment will impact on the budget. According to the researcher, implementation of HIS will have serious implications on the budget.

Table 4.14: Challenges as perceived by administrators

	Disagree	Neither	Agree	don't
I find it easy to work with electronic system than with paper records	10%	3%	85%	2%
Management encourages staff to use the computer system	13%	4%	81%	2%
Staff are eager to learn the new system	14%	3%	79%	3%
Initially I did not want to move to the new computer system	74%	5%	19%	1%
The is enough human resources to utilise the new computer system	46%	9%	37%	8%
As a result of the computer systems, my overall level of professionalism has increased	17%	5%	72%	5%
Insufficient training was provided when I first had to use the system	50%	7%	41%	3%
There is no need for continuous training on the system as its easy and intuitive to use	61%	5%	31%	3%
I have a fear of having to use a computer instead of paper	90%	0%	9%	1%
I found the system difficult to use (Not user Friendly)	88%	5%	4%	2%
I find the system slow	61%	6%	32%	1%
Information on the computer is not secure or confidential	73%	5%	20%	2%
There is restricted amount of data to entered in the system	53%	9%	28%	9%
Implementation of computed system is very slow	56%	7%	29%	7%
Data is not accurate and there is missing data	61%	10%	25%	4%
Computer system has increased Staff workload	69%	6%	19%	5%
There is frequent down time or the internet not available	42%	9%	42%	7%

4.4.6 Perceptions on Government and management support to implement HIS

IT (81%), medical team (52%) and administrative staff (81%) perceive that management is supporting departments to use HIS in their departments. IT departments (81%) are convinced that South African government is supporting the use of HIS in the hospitals. However, 60% of the medical teams are not supporting the idea that the government is supporting the implementation of HIS. Medical team may not support the statement because there is no implementation of HIS in their departments and they are keen to start. Secondly, there is no communication on when implementation will occur. According to the researcher's investigations, the government of South Africa support implementation of HIS and has met in 2012 to discuss the strategy on how to implement it successfully [3]. There are also ongoing meetings and training to find a faster and easier implementation of HIS. The researcher thinks that the delays in implementation of HIS are caused by perceived challenges expressed in this research.

4.4.7 Overall perceptions and beliefs of staff on implementation and use of HIS

Overall result on staff beliefs and perceptions are presented in the table 4.15 below

Moving to HIS is perceived as it will save the hospitals, private hospital companies, and government money. This statement was supported by 76% of IT staff , 79 % of admin staff, 81% of Doctors and 83% of nurses. Hospital staff (93%) interviewed and surveyed (Medical team (72%), Admin (81%) and IT (80%) would like to move to a paperless system as soon as possible. The results of the survey confirmed that the hospital staffs (IT – 69%, Doctors – 68%, Nurses – 73% and 81%) perceive the use computer system in their facilities will be faster to use when managing and serving patients as compared to a paper system. Doctors (85%), Nurses (74%), Admin 78% and IT (81%) believe that automation will help to improve healthcare and streamline operational effectiveness. It will also save the hospital money. Admin confirmed that patients records are more organised with automation system as compared to a paper system. 71% of overall hospital staff member participated in the survey want to move to paperless as soon as possible. In both private and public hospital staff are keen to move to HIS and believe that it will resolve most of administration and patient management problems encounter in the hospitals.

These results show that hospital staff and patients are generally positive about implementation of HIS in South African hospitals and would like to move as soon as possible.

Table 4.15: Overall staff believes and perceptions

Statement		Disagree	Neither	Agree	Don't
Staff would like to move to a paperless system as soon as possible	Doctors	19%	3%	75%	4%
	Nurses	19%	5%	73%	3%
	Pharmacist	21%	2%	76%	0%
	IT	10%	5%	80%	5%
	Admin	24%	4%	71%	1%
I find the computer system faster to use compared to handwritten notes	Doctors	23%	5%	68%	5%
	Nurses	17%	4%	73%	6%
	Pharmacist	20%	5%	76%	0%
	IT	19%	6%	69%	6%
	Admin	14%	3%	81%	2%
I believe that it improves health care and stream lining operational effectiveness.	Doctors	11%	1%	85%	3%
	Nurses	17%	4%	74%	5%
	Pharmacist	15%	0%	83%	2%
	IT	13%	0%	81%	6%
	Admin	13%	2%	78%	7%
I believe the hospital will save money as a result of moving to the new system	Doctors	6%	5%	81%	8%
	Nurses	16%	5%	73%	7%
	Pharmacist	14%	2%	79%	5%
	IT	6%	12%	76%	6%
	Admin	12%	3%	79%	5%

CHAPTER 5

5. SUMMARY

Despite enormous investment worldwide in computerized health information system, their overall benefit and cost have not really been fully accessed. Implementation is slow and the cost was found to be the major issue. e-Health implementation in developing countries like South Africa (SA) is very slow. Current models for implementing electronic health records (EHRs) in resource-limited settings may not be scalable because they fail to address human resource and cost constraints. In 2012 South Africa came with eHealth Strategy South Africa (eHSSA), to guide the government from the current status to an integrated and well-functioning national information system, based on agreed scientific standards for interoperability, which will improve the efficiency of clinical care, produces the indicators required by management and facilitates patent mobility. The minister also emphasised that the system should able interphase with other transferable systems used in the health sector and able to support and help implementation of National Health Insurance (NHI). The ten strategic priorities were identified for the key activities required for implementation of eHealth in South Africa.

This research investigated the status and implementation of e-health in 32 public hospital and 19 private hospitals in South Africa (SA). Furthermore, the study looked at the challenges encountered during the process, issues regarding data sharing and data privacy laws in South Africa, rural and urban comparison on medical informatics and the current position of South African government regarding medical informatics or e-Health. Hospitals and hospitals staff were randomly selected to participate in the study. The healthcare providers, IT and admin staff were targeted in this research and 212 candidates were interviewed and 829 questionnaires were collected. South Africa has partially implemented HIS in their hospital and majority of health providers don't use HIS to record patient information, only the admin staff and laboratories use HIS in both public and private hospitals.

The main challenges South Africa encountered in the implementation of HIS are different software's that are used in different hospitals and make it impossible. Training, data privacy knowledge, IT infrastructure, lack of communication with stakeholders and finance are the major challenges encountered. Positives are that healthcare workers and patients are ready to start working on HIS and perceive that it will help to save cost. The challenges counter by SA tremendously increase the cost when trying to implement IS. South Africa will have to look at and an alternative method that is cost effective to implement HIS in the hospitals. The source of bandwidth, open-source and m-Health might be an alternative that SA is required to investigate.

CHAPTER 6

6. CONCLUSION

This study has revealed that the implementation of HIS in South African Hospitals both private and public is not fully implemented and as expected there is partially implementation without data sharing. The main domains of HIS were not implemented especially the clinical modules or the electronic health records. The administrative module was implemented in almost all hospitals visited during this research in SA. The research was predominantly focusing on the domain of electronic health records and consumer health informatics. It is clear and confirmed that little has been done on the implementation of these modules. No patients could access their health record electronically, health workers are still recording health records on paper and data sharing does not exist. The medical team is an important team of the hospital as far as patient care is a concern and they are the least in using HIS which leaves South Africa with high potential for medical errors. Priority must be given to the medical team for implementation of HIS to drive faster implementation. This study confirms that there is only one hospital is South Africa that is regarded as a paperless hospital, however, data sharing with other hospitals is still impossible.

The research has proved that South Africa is still not yet ready to fully implement HIS in their hospitals and this conclusion includes private hospitals as well. There was no difference in implementation between Mediclinic and Netcare hospitals. In all private and public hospitals, the only team that has advanced in the implementation of HIS is the administration team. However, the hospital staff and patients are ready to move and are keen to move to HIS as soon as possible. The government is not ready yet and it is still in the process of finding a suitable service provider in each province to implement and most important to deal with the challenges.

There are a number of challenges to be resolved before full implementation happens. According to this research, the main challenge for the delay or slow implementation is uncommon automation systems used in the hospitals across the provinces. South Africa has to find a system that can be used uniformly by all hospitals to able to smoothly implement HIS that is functional

and enabling data sharing. Alternatively, to find bandwidth that will able to link these systems together like HL-7. This kind of system will facilitate data sharing and manage data storage. The second main challenge for SA is a lack of personnel in the hospitals. This challenge was noted in most of the hospitals, especially in the rural areas. Lack of personnel in hospitals will hamper implementation of HIS. The government needs to relook at how it can increase human resources in the hospitals. Incentivising doctors and nurses might be an option or rural deployment with good housing and bonuses. For implementation, there should have a dedicated person who will drive the implementation and may incentivise the users of HIS. In private this challenge does not exist. The third other important challenge was the lack of facilities in the hospitals, especially in the rural hospitals. For implementation equipment must be available and that means it will increase spending in the hospitals. The government should invest in the research to find out how much is required to address these challenges and maintain HIS in the Hospitals. It was noted that some of the hospitals in SA started using the clinical modules and stopped due to lack of maintenance and due to lack of funds. Research to look at the costing of HIS implementation is crucial for SA.

Training of staff is important and the most worrying is that there is a high number hospital staff that do not know or understand data privacy laws in South Africa while working on patient personal information. This places a risk on patient data, especially with a high number of doctors not knowing the data privacy laws and this will increase lawsuits in SA. Therefore, this suggests training on data privacy law is needed for all hospital staff. This will also increase financial burden on the government for HIS implementation. Spending should be clearly scrutinised since there are a number of challenges that include internet upgrading in most of the hospital and new IT equipment which will increase the budget for implementation of HIS. There is also a new challenge of load shedding which was not experienced in the previous papers. This will also have an impact on the budget and implementation of HIS.

The government should also explore m-health since mobile communication and the internet in SA holds a strong potential to assist in accessing HIS. Lack of communication was noted as a challenge and the government is advised to clearly communicate timelines and plan with the

major stakeholders and involve community regarding implementation of HIIS. This will help implementation since patients and staff are positive about HIS. Regular meetings should be held regularly to explore the challenges and progress on implementation with all parties that should be involved. South Africa still need to a cost effective way of implementing HIS since some of the efforts made were halt by the budget and maintenance. Majority of challenges encountered in South Africa regarding the implementation of HIS are financial related. Therefore, the main halt in the implementation of HIS in South Africa might be for a financial reason and the government should go back to the drawing board to find new cost-effective ways of implementing HIS in SA.

CHAPTER 7

7. CONTRIBUTION TO KNOWLEDGE

This study has given South Africa and the world the current status of HIS implementation in South African regardless of the type of the hospital and area location. It has also stated the challenges in both public and private hospitals. It has suggested next plan to for South Africa is to relook at the plan on how they can implement HIS in a cost effect way since it looks like the implementation of HIS in SA is delayed by finance more than any other challenge

There are few SA publications on HIS and this publication will increase the number of publication and give current information on the status of HIS for SA which include for both Private and public Hospital status. Rural and urban hospitals.

To give government other options of exploring the implementation of HIS and way forward.

Outline additional challenges for HIS in South Africa

The government needs to pay attention to the cost of implementation which might be higher than expected and if not well budgeted for, HIS will collapse like in some of the hospitals that have collapsed because of budget constraints.

Provided information to SA how hospital staff perceive HIS and how soon they want to move to HIS. This will help the implementers to know where to focus and when need to speed up HIS implementation

CHAPTER 8

8. RECOMMENDATIONS FOR FUTURE RESEARCH

After the research is over this “title”, it is recommended that in future:

- To explore and research different system of HIS in South Africa for the country to select one uniform system that can be used for the country.

- Research looking at cost effectiveness of implementing HIS in South African Hospitals

- To explore the use of open source system that was suggested to save money for South Africa

- Explore bandwidth that will link SA deferent HIS software’s

- Look at how can South Africa resolve infrastructure and human resource capacity in the hospital especially in rural areas.

- To further investigate the willingness of patients to provide their medical information for teaching and training.

- To explore how m-health can contribute in speeding up the implementation of HIS and saving cost in implementation.

CHAPTER 9

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CHAPTER 10

10 APPENDIX

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Appendix I: The use and implementation of HIS by staff in different hospitals

Hospital Name	Admin	Finance & Billing	Data	Drs	Nurses	Pharmacy	Pharma Store	Lab	Radiology	implementation	No of Units Implemented	Total	Implementation %
CMH	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	3	**6**	**9**	**67%**
Jabulani	Yes	Yes	Yes	No	No	No	Yes	Yes	No	3	**6**	**9**	**56%**
Natalspruit	Yes	Yes	Yes	No	No	No	Yes	Yes	No	4	**5**	**9**	**56%**
Tembisa	Yes	Yes	Yes	No	No	No	Yes	Yes	No	4	**5**	**9**	**56%**
Mulbarton Nedcare	Yes	Yes	Yes	No	No	No	Yes	No	No	5	**4**	**9**	**44%**
MilparK Netcare	Yes	Yes	Yes	No	No	No	Yes	No	No	5	**4**	**9**	**44%**
Jakaranda Netcare	Yes	Yes	Yes	No	No	No	Yes	No	No	5	**4**	**9**	**44%**
Sandton Mediclinic	Yes	Yes	Yes	No	No	No	Yes	No	No	5	**4**	**9**	**44%**
Morning side Mediclinic	Yes	Yes	Yes	No	No	No	Yes	No	No	5	**4**	**9**	**44%**
Polokwane	Yes	Yes	Yes	No	No	No	Yes	Yes	No	4	**5**	**9**	**56%**
Tshilidzini	Yes	Yes	Yes	No	No	No	Yes	Yes	No	4	**5**	**9**	**56%**
Louise Trichardt	Yes	Yes	Yes	No	No	No	Yes	Yes	No	4	**5**	**9**	**56%**
Limpopo Mediclinic	Yes	Yes	Yes	No	No	No	Yes	No	No	5	**4**	**9**	**44%**
Tzaneen Mediclinic	Yes	Yes	Yes	No	No	No	Yes	No	No	5	**4**	**9**	**44%**
Ferncrest Netcare	Yes	Yes	Yes	No	No	No	Yes	No	No	5	**4**	**9**	**44%**
Brits Mediclinic	Yes	Yes	Yes	No	No	No	Yes	No	No	5	**4**	**9**	**44%**
Moses Kotane	Yes	Yes	Yes	No	No	No	Yes	Yes	No	4	**5**	**9**	**56%**
Rusternburg	Yes	Yes	Yes	No	No	No	Yes	Yes	No	4	**5**	**9**	**56%**
Klerksdorp	Yes	Yes	Yes	No	No	No	Yes	Yes	No	4	**5**	**9**	**56%**
Vryburg	Yes	Yes	Yes	No	No	No	Yes	Yes	No	4	**5**	**9**	**56%**
Gelukspan	Yes	Yes	Yes	No	No	No	Yes	Yes	No	4	**5**	**9**	**56%**
Universitus	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	3	**6**	**9**	**67%**
Pelonomi	Yes	Yes	Yes	No	No	No	Yes	Yes	No	4	**5**	**9**	**56%**
Tokollo Heilbron	Yes	Yes	Yes	No	No	No	Yes	Yes	No	4	**5**	**9**	**56%**
Bongani Welkom	Yes	Yes	Yes	No	No	No	Yes	Yes	No	4	**5**	**9**	**56%**
Pelonomi Netcare	Yes	Yes	Yes	No	No	No	Yes	No	No	5	**4**	**9**	**44%**
Witbank	Yes	Yes	Yes	No	No	No	Yes	Yes	No	4	**5**	**9**	**56%**
Evander	Yes	Yes	Yes	No	No	No	Yes	Yes	No	4	**5**	**9**	**56%**
Ermelo	Yes	Yes	Yes	No	No	No	Yes	Yes	No	4	**5**	**9**	**56%**

Piet Retief	Yes	Yes	Yes	No	No	No	Yes	Yes	No	4	**5**	**9**	**56%**
Highveld Mediclinic	Yes	Yes	Yes	No	No	No	Yes	No	No	5	**4**	**9**	**44%**
Newcastle	No	Yes	Yes	No	No	No	Yes	Yes	No	5	**4**	**9**	**44%**
Eshowe	Yes	Yes	Yes	No	No	No	Yes	Yes	No	4	**5**	**9**	**56%**
Addinton	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	3	**6**	**9**	**67%**
Inkosi Lethuli	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	0	**9**	**9**	**100%**
Umzimkhulu	Yes	Yes	Yes	No	No	No	Yes	Yes	No	4	**5**	**9**	**56%**
Alberlito Netcare	Yes	Yes	Yes	No	No	No	Yes	No	No	5	**4**	**9**	**44%**
Dr Harry Surtie	Yes	Yes	Yes	No	No	No	Yes	Yes	No	4	**5**	**9**	**56%**
Kimberly	Yes	Yes	Yes	No	No	No	Yes	Yes	No	4	**5**	**9**	**56%**
Barkly west	Yes	Yes	Yes	No	No	No	Yes	Yes	No	4	**5**	**9**	**56%**
Kimberly Mediclinic	Yes	Yes	Yes	No	No	No	Yes	No	No	5	**4**	**9**	**44%**
Mtata Nelson Mandela	Yes	Yes	Yes	No	No	No	Yes	Yes	No	4	**5**	**9**	**56%**
PE Provincial	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	3	**6**	**9**	**67%**
CeMH	Yes	Yes	Yes	No	No	No	Yes	Yes	No	4	**5**	**9**	**56%**
Cuyler Netcare	Yes	Yes	Yes	No	No	No	Yes	No	No	5	**4**	**9**	**44%**
UCT Netcare	Yes	Yes	Yes	No	No	No	Yes	No	No	5	**4**	**9**	**44%**
N1 City Netcare	Yes	Yes	Yes	No	No	No	Yes	No	No	5	**4**	**9**	**44%**
Cape Gate Mediclinic	Yes	Yes	Yes	No	No	No	Yes	No	No	5	**4**	**9**	**44%**
Milnerton Mediclinic	Yes	Yes	Yes	No	No	No	Yes	No	No	5	**4**	**9**	**44%**
Not Implemented	1	0	0	48	48	48	0	18	43	206	**235**	**441**	**53%**
Implemented	48	49	49	1	1	1	49	31	6				

Appendix II: Comments from the Hospital staff

Comments from IT department staff

- Would like development to be quicker and is good to move to electronic
- Inadequate infrastructure remains a big challenge
- The software in laboratory and pharmacy only work in those departments. In finance and Revenue, They use a specialized programme to view budgets and registered company
- To implement the link between PAAB system and DHIS system
- All facilities must have an IT Department on site, not centralized as clinical users work 24/7 365. Staff must be made up of: Nurses, doctors, pharmacists, finance staff and Technical staff
- Provide more training to Nursing Staff regarding of computer system
- Request full implementation of the system EHIS as currently, only ward clerks are using the system.
- Standardisation of ICT systems across the country, integrating the country systems.
- IALCH will he moving to Meditech in the next financial year

Comments from Patients

- Would like development to be quicker and is good to move to electronic
- For improvement if you can hire more doctors I think people will spend less time at hospital

Comments from Doctors

- Want PACS to be fully operational as soon as possible
- Currently, the system is not being used at our hospital and only a few medical staff members are aware of this system. There used to be training for staff members which has now been stopped
- Network slow or sometimes not working

- Implementation of e-health is very slow, they do not consult heads of department, they are not prepared for the system, and more research is needed.
- Virus galore in the systems and no maintenance
- We do not have enough computers in the hospital
- I doubt if many colleagues are sufficiently computer literate to use the system (especially nursing)
- No questions regarding ecological impact of paperless system. We need more and dedicated IT professional
- Implementation is slow. Many times not internet not available, then we revert to hand written notes
- No IT support
- PACS has recently stopped working.
- X-rays should change from hard copy printouts to e-system
- Our Facility needs a computer system
- There are no computer system used in our facility
- The doctors don't have access to computers in the hospital. It is still a paper based hospital
- Radiology department requires a RIS system. PACS will also be beneficial to the dept. filmless radiology will be cost effective in the long run.
- Initially it was difficult to adapt to using the system however, after using it for a while it became easy. It is now very useful and time saving. Problems encountered include load shedding as well as down time, is frustrating. I would recommend this system for more hospitals so that there could be uniformity and a continuation of care of patients.
- I prefer to use computers

Comments from Nurses

- I believe it would save a lot of time for us if we can move to a paperless system
- ICU monitors have capability to monitor/ record patient data electronically instead of paper records. I look forward to the changeover soon

- For legal processes, still wondering if completely electronic files will have legal substance
- The computer system in the facility is not used by nurses for patients but used by admin clerks for patients and office use only
- I do not use a computer
- Yes if we can move from paper work to computer system that will be much better as there is always shortage of staff in the hospitals the computer system can save a lot
- Our facility does have computer systems but most are not functional and do not have access to internet. Anti-viruses are not activated regularly and there is no training provided regarding the use of the computer systems
- Sounds like a good idea if can be correctly implemented
- Paperless system will be more profitable for 1. Privacy 2. Accuracy and Financial Stability and thrift.
- Sometimes internet is not working
- Personnel trained on computer system and not used and we lose the skill
- The system is not implemented yet at our institution but I have a strongly believe that it will be useful in terms of saving time and data collection of a patients
- For the fact that our hospital does not use computer system record, I think it is still not a problem to our hospitals to continue to do paperwork as we used to.
- More training to staff. Better computer access
- A definite upgrade to a computer system is evident that will speed up processes and be more efficient
- Yes each person must have individual codes as his/her password to open or access information on the computer.
- To provide more computers in our facility
- There are fewer computers to work between doctors and nurses. The hospital requires more computers or laptops.
- Only one computer in a ward. Have to queue to use computer. Causes unpleasantness cause staff need to use computer for important nursing, so do the doctors.

- Netcare Alberlito has no computer system in place for nursing staff. I feel if a computer system comes into place it would make nursing much easier.
- This system allows us to get lab results quicker will help to identify infectious patients and isolate and treat quicker. Able to identify outbreaks quicker
- Would like to move to paperless
- I look forward to it
- There is an urgent for computer training in the institution. Starting with the senior personnel
- One computer for a unit is not sufficient as one would wait for others to finish. Some programmes not available e.g. discharge summaries, doctors have to utilize computers of other units
- Computer system is much easier and relevant when it comes to time keeping the records; if all hospitals can change from paper to computer.
- X-rays of patients are accessed by doctors on computer, also laboratory results are accessed by doctors from computer
- Only the doctors use a computer system to access patient x rays and blood results, further, no computers are used in patient care or management
- A database of drug therapy problems, adverse drug reactions and medication errors to improve overall care and reduce harm
- Used computer for ordering equipment, Pharmacy and see test - so easy

Comments from the Pharmacists

- E-Health to be used in the hospital and at the pharmacy is a good thing and the system will improve the health care services in the country. The challenge is the implementation which is too slow. For example they have installed the system but it is not fully working in the pharmacy.
- No internet in our facility only Intranet

- When more than 8 items are loaded per prescription it gives an error and the program restarts itself and after some prescriptions done (10) to restart it manually.
- With respect to patient information, dispensing, history, records, data to be used for research etc, referrals, and everything to do with patients, all done on paper. No computer system used in the pharmacy. Only computer is used is for ordering medication and storing orders and stock levels. A computerised system will drastically change the entire dispensing process and efficient flow of healthcare in a positive manner.
- Our hospital doesn't have yet a computerised system. It will be quite good to have a computerised system in order to improve service delivery.
- I think moving towards electronic record keeping and doing anything per computer will assist in making work easier
- Yes, I would like to move an electronic system where each patient has a lifetime case number, throughout RSA. Thus a patient number has a personal card (like eg clicks) and can see it anywhere at any hospital or clinic (both private and state facilities possibly) card can be linked to I D number. Confidentially must be maintained.
- Challenges with printers, often faulty
- Patients records still in paper file, prescriptions, issues from pharmacy etc, only paper based

Comments from the Radiology

- Want PACS to be fully operational as soon as possible
- Network slow or sometimes not working
- We don't have computer systems but we would like as a Radiology department to have computer system to reduce our work load and improve our time management to our patient
- Computer systems still need to be introduced
- PACS system if possible
- I would like the whole department to be computerised because it decreases patient waiting time, and there will be space because there won't be a need for storing old films

Comments from Management

- Sounds like a good idea if can be correctly implemented
- Personnel trained on computer system and not use it, loose the skill
- PACS system if possible
- Challenges with printers, often faulty
- Most of the staff are not computer literate (not know how to use computer)there is a need for staff to be orientated in terms of how does it work. Only limited people are using or use computer in the department especially in the ward where patients are.
- Only concern is if there is a system failure, it can hamper operation.
- My market, Kronos, Intranet
- It is fast and easy to use. Only downtime slows.
- Would like development to be quicker and is good to move to electronic
- Positive
- Using computer systems saves time and reduces risks of paper work going missing and saves paper which is eco-friendly, record can be kept for a long time with easy access, it also improves IT skills of staff
- Regular maintenance of computer systems by having full time computer expert on site.
- Training to be offered to all staff for work to be easy
- The computer system is not well established in the hospital
- Great way to save time, control data collected, communicate directly to fellow health professionals. If the IT system is up to date and maintained well, it could mean effortless, efficient and effective patient care.
- It would be fantastic to communicate patient related information to other medical professionals electronically.

Comments from Administration staff

- Would like development to be quicker and is good to move to electronic

- I think the community needs to be informed on the new systems, especially with the new paperless system
- I would like to send Medical Aid patient accounts electronically to the Medical Aids
- Positive
- The world is changing we really need to change, computer makes our job easy
- Computers are fast and advanced
- Maybe upgrade the program to a more 21st century look/ layout
- Hopefully a computer system will be implemented quicker
- EBT (Electronic Banking Transfers) we receive via Email
- If the department can Implement one system for the whole department units e.g. admin, revenue, SCM, Finance, it will be easy for all, it will be owned by the hospitals and have IT personnel within the hospital, unlike the current situation whereby we use PAAB and technicians are not within the hospital, we have to call them each time we have a problem.
- I prefer the new system, punctual and less down time
- Our systems are very slow, it takes a lot of time just to capture only 1 patient information
- Most of the staff are not computer literate (not know how to use computer) there is a need for staff to be orientated in terms of how does it work. Only limited people are using or use computer in the department especially in the ward where patients are.
- This system will make us to be faster than computers
- It can be more advance in how to classifying patient non-paying and paying and even in the sickness so that you won't keep asking one question every visit
- From an IT point of view, a simple programme (application) to link to home affairs to verify residential addresses and ID numbers to make it easy for patient tracking in case of death
- To provide patient record health to the province
- Important, Electronic Process
- Only concern is if there is a system failure, it can hamper operation.

- Computers currently out of date, or broken, not replaced. There does not seem to be a standard re computers e.g. some staff using windows 8 and some windows 10, some windows 7. No uniformity
- Patient information should be fully electronic
- More staff
- The system is sometimes slow and it stuck
- Computers are too exposed. For everyone to tamper with and as a result are exposed to contracting viruses
- Insufficient computers for mobile computing, connection issues with frequent down time, Problems with supply chain management with regard to computer paper and printer toner.
- It is fast and easy to use. Only downtime slows.
- None at the moment or can't think of anything at the moment
- SAP entitled you to see information at other Netcare Hospitals only which decrease risks
- Better training should be provided to all employees. Faster internet
- The system to be faster.
- Prefer Electronic system than paper system.
- Patient on trials to provide ID doc on Admission, Go paperless - Save trees, Recycle - recycle and thank you
- Implement systems when there are 100% fully ready not partially
- There is frequent down of our system and delays the work done.
- System very slow

Appendix III: Acknowledgment of receipt letter from Minister of Health South Africa

MINISTRY
HEALTH
REPUBLIC OF SOUTH AFRICA

PRETORIA

Private Bag X829, PRETORIA, 0001, 28th Floor, Civitas Building, Cnr Thabo Sehume and Struben Street, PRETORIA, 0001

Tel: (012) 395 8086 Fax: (012) 395 9165

CAPE TOWN

Private Bag X9070, CAPE TOWN, 8000, Room 413, 120 Plein Street, CAPE TOWN, 8000 Tel: (021) 465 7407/8 Fax: (021) 465 1575

Ref 3/17/40

Mr Sello Seahloli
Graduate Student
Texilla America University

Fax: 086 502 5592

Dear Mr Seahloli

Re: medical informatics questions

On behalf of the Minister, Dr Aaron Motsoaledi, this serves to acknowledge receipt of correspondence dated 10/11/2014, contents of which have been noted.

Kindly be informed that the correspondence is receiving attention.

Yours Sincerely

Ms Mamaleka TF
Receptionist / Secretary
Date: 13/11/2014

Received: 2014/11/14 08:07:12 AM [South Africa Standard Time] Page 1 of 1 on 665592

Appendix IV: Presentation of survey results in percentile

10.1 Percentage Distribution of Survey Results for Hospital Management (Charts)

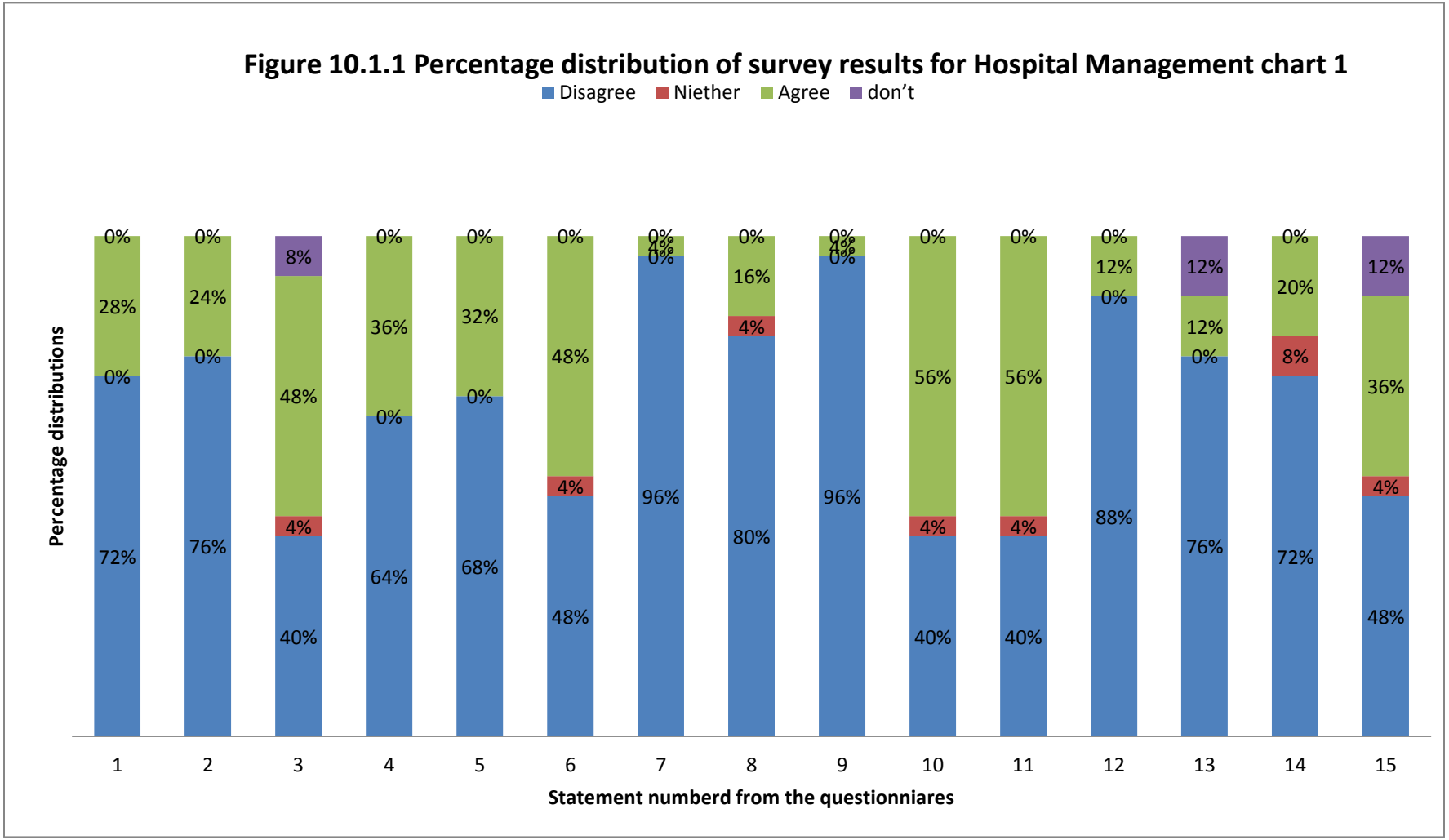


Figure 10.1.2 Percentage distributon of survey results for Hospital Management Chart 2

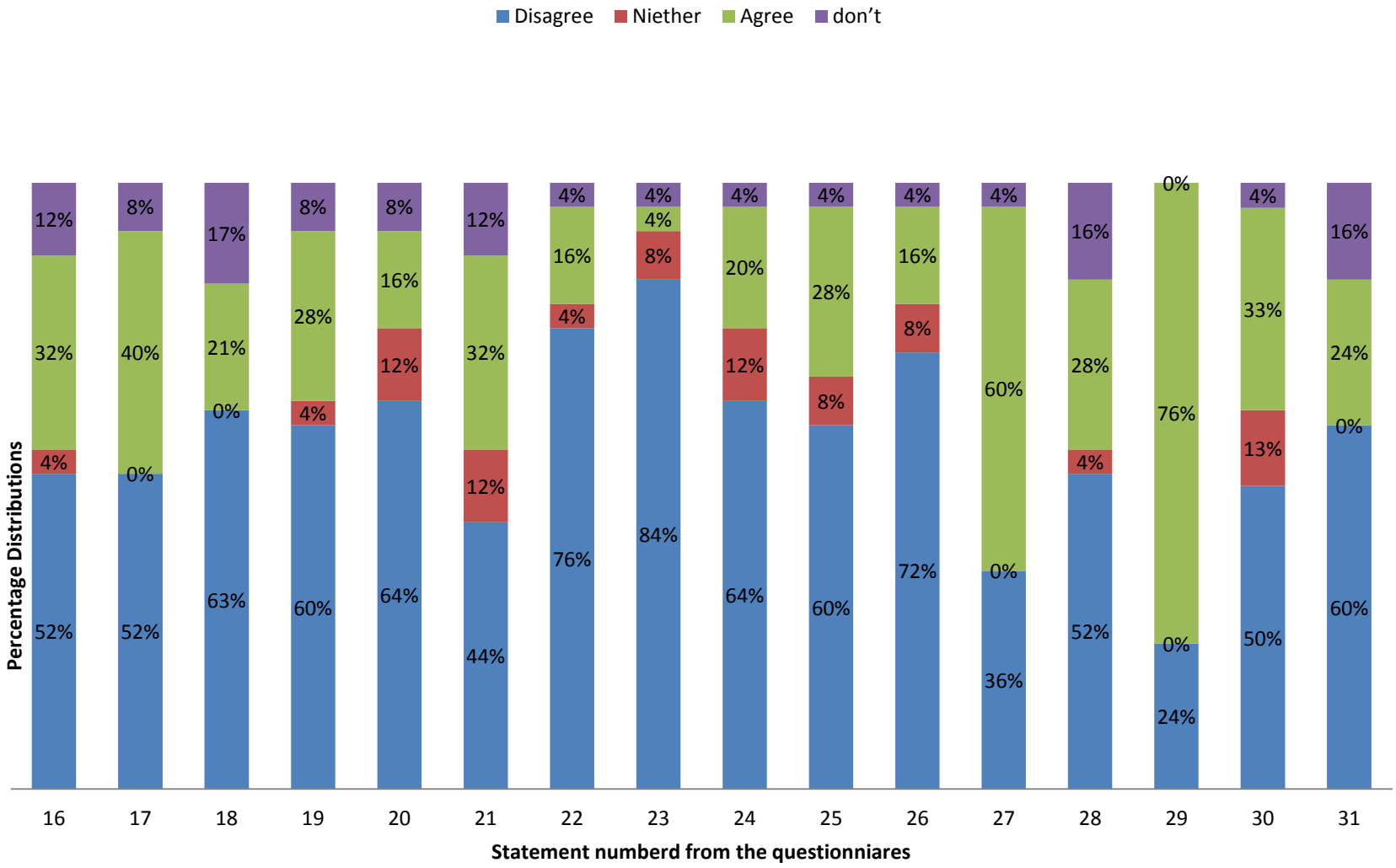


Figure 10.1.3 Percentage distribution of survey results for Hospital management Chart 3

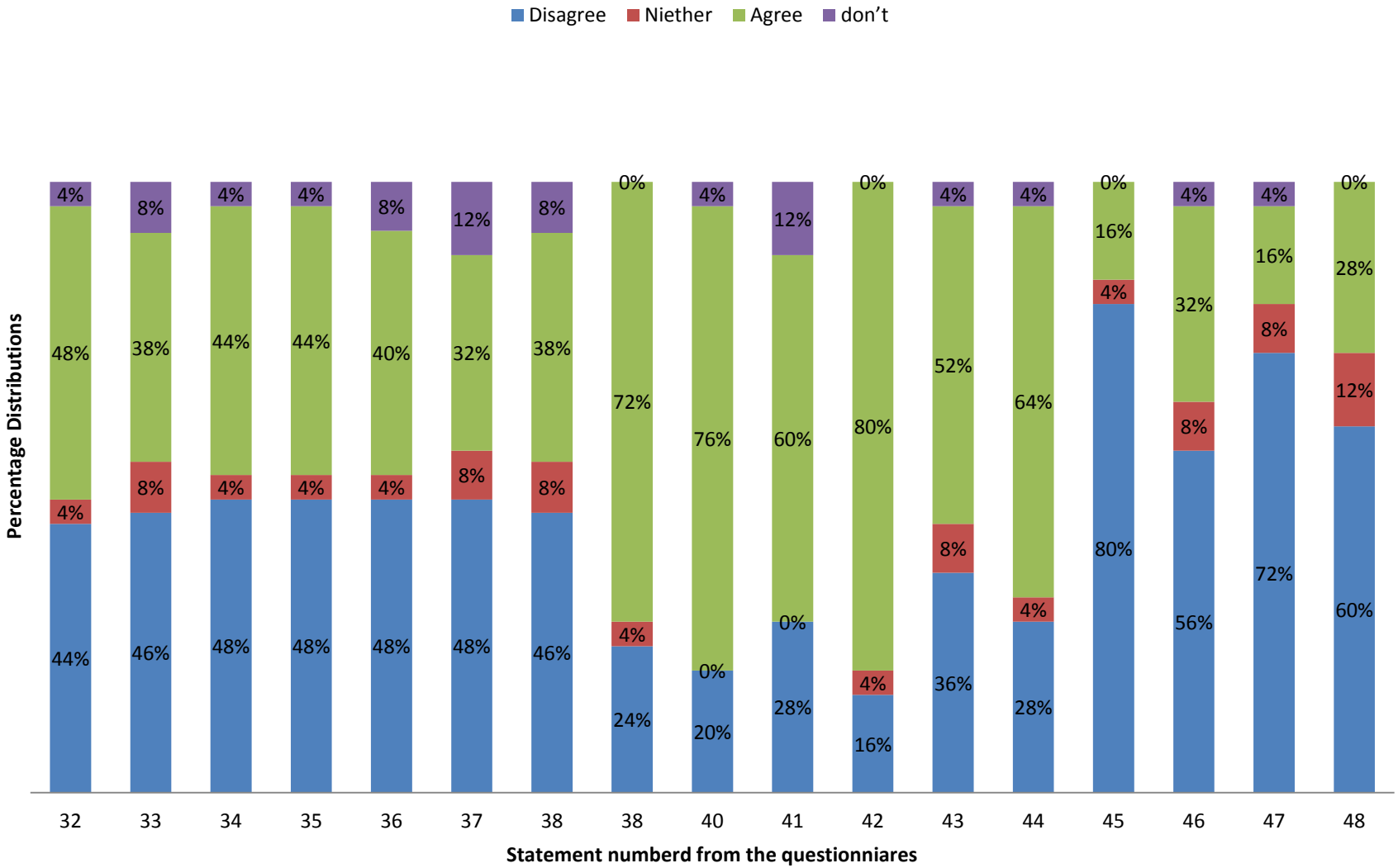


Figure 10.1.4 Percentage distribution of survey results for Hospital management Chart 4

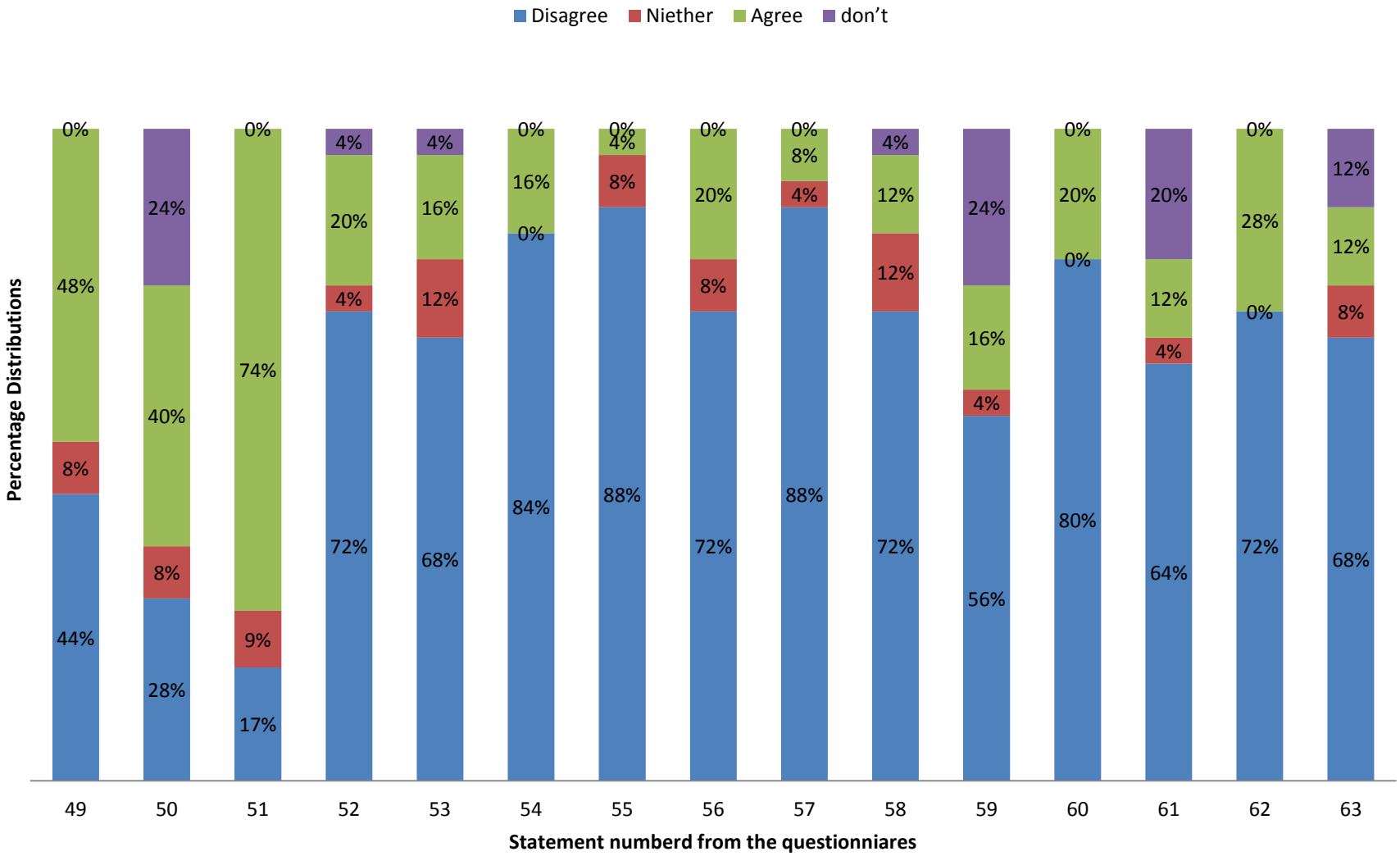
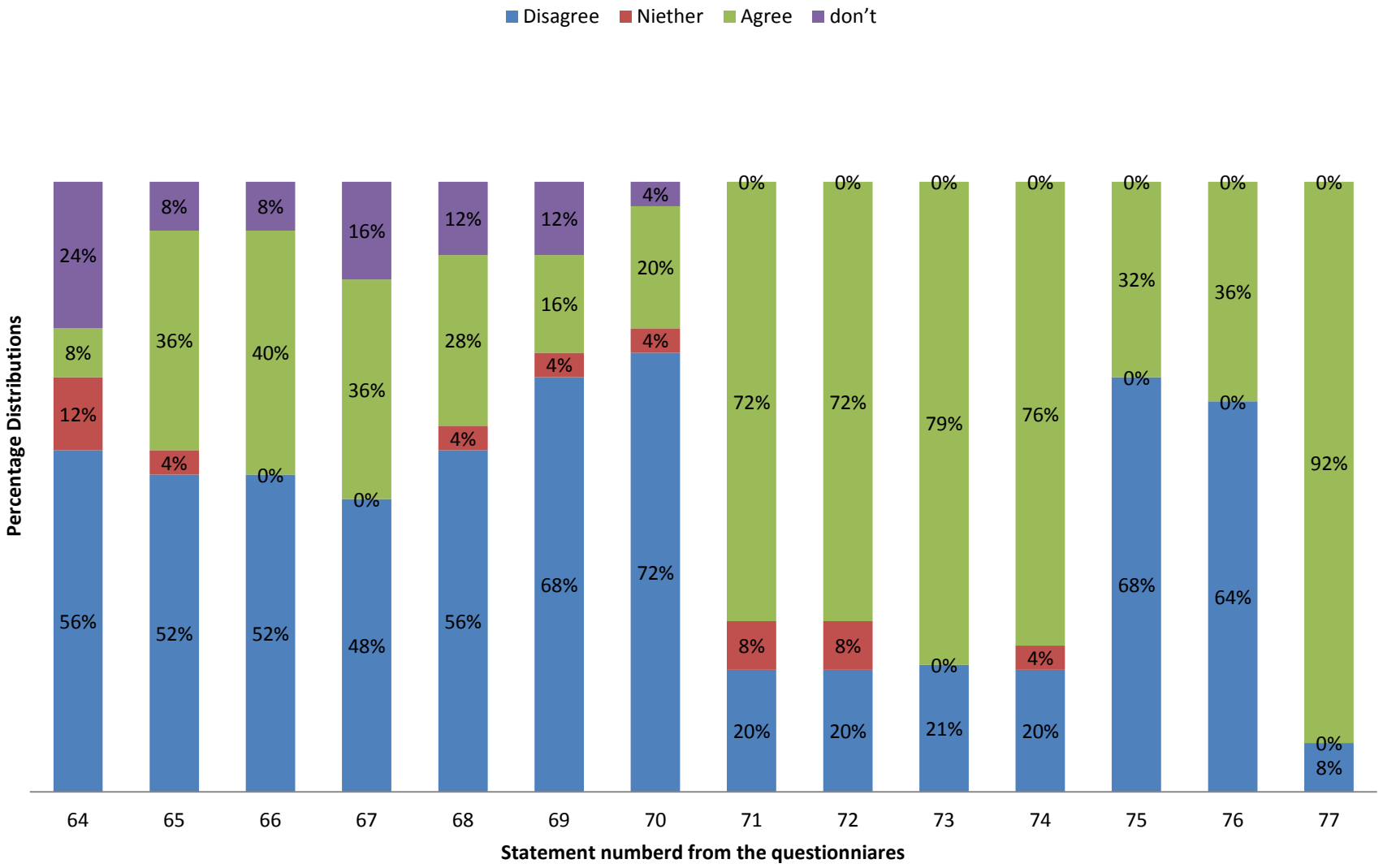


Figure 10.1.5 Percentage distribution of survey results for Hospital management Chart 5



10.2 Percentage Distribution of Survey Results for Pharmacists (Charts)

Figure 10.2.1: Percentage distributions of survey results for Pharmacists
Chart 1

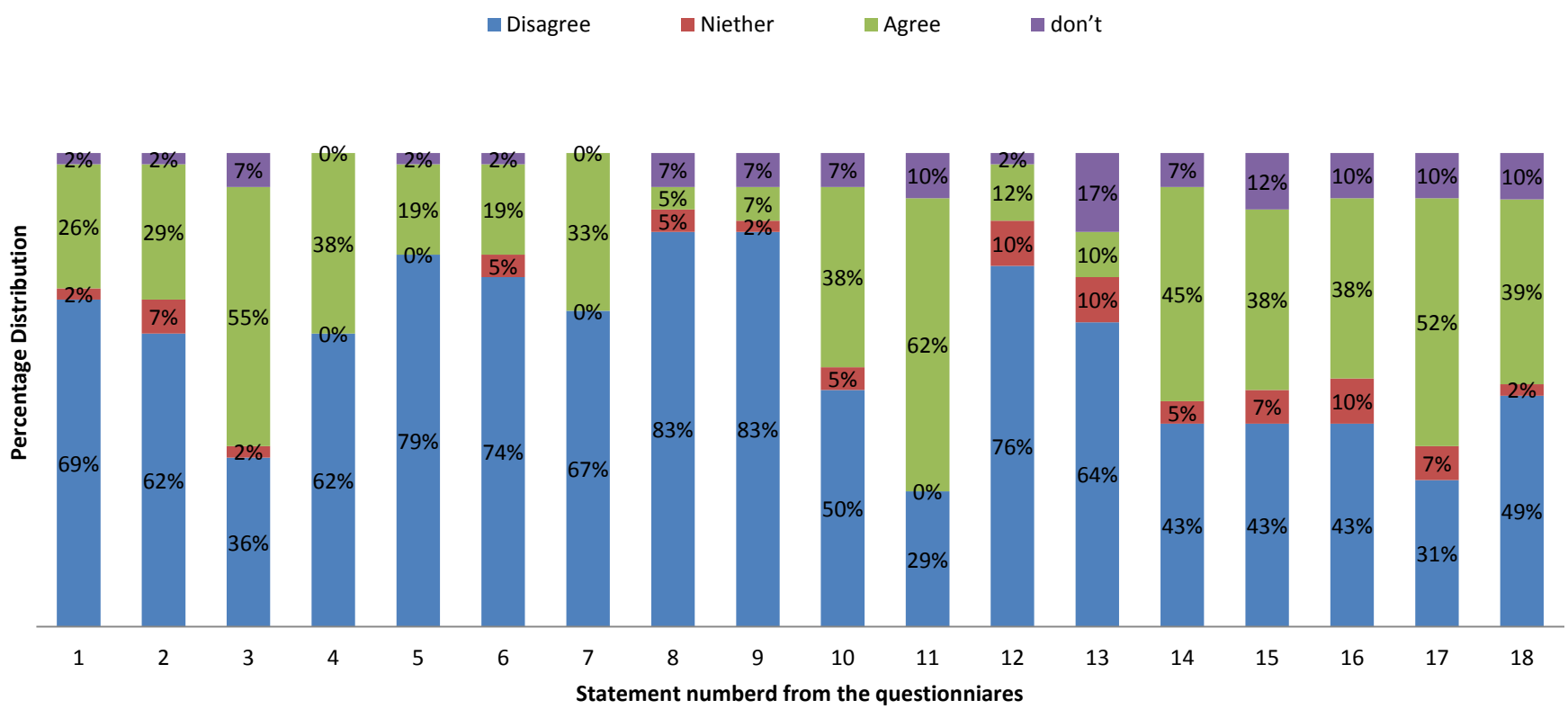


Figure 10.2.2: Percentage distributions of survey results for Pharmacists

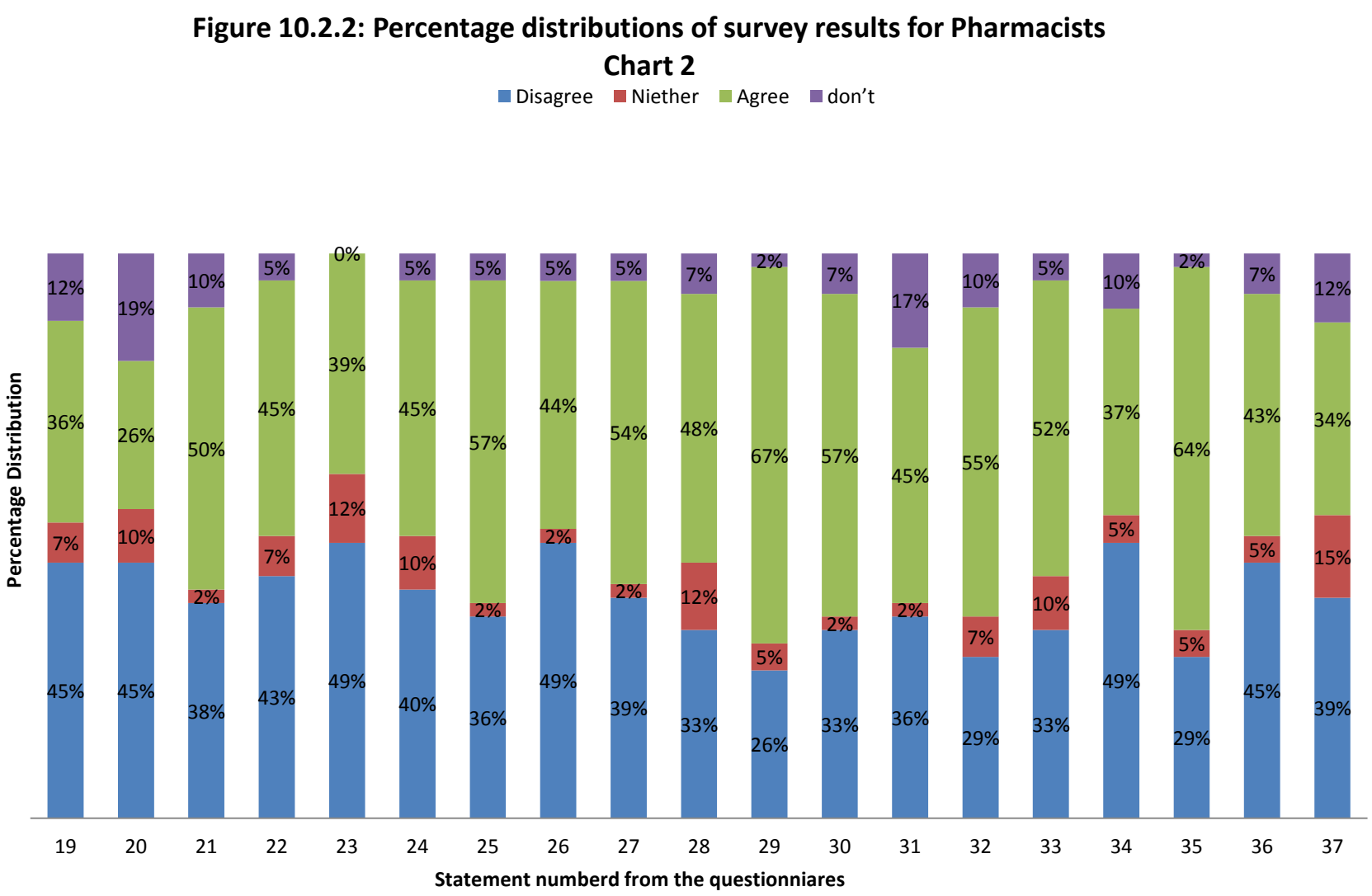


Figure 10.2.3: Percentage distributions of survey results for Pharmacists
Chart 3

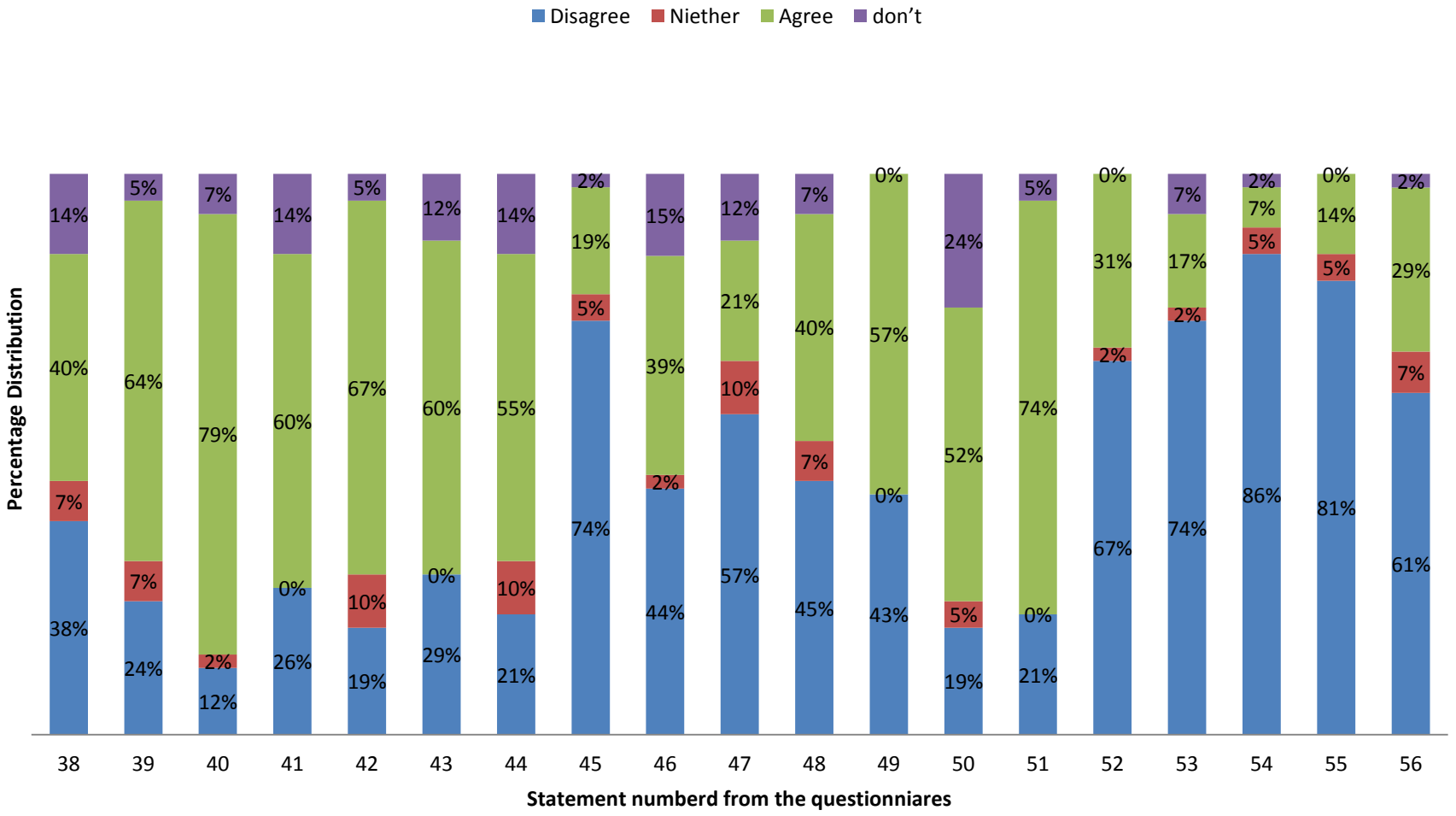
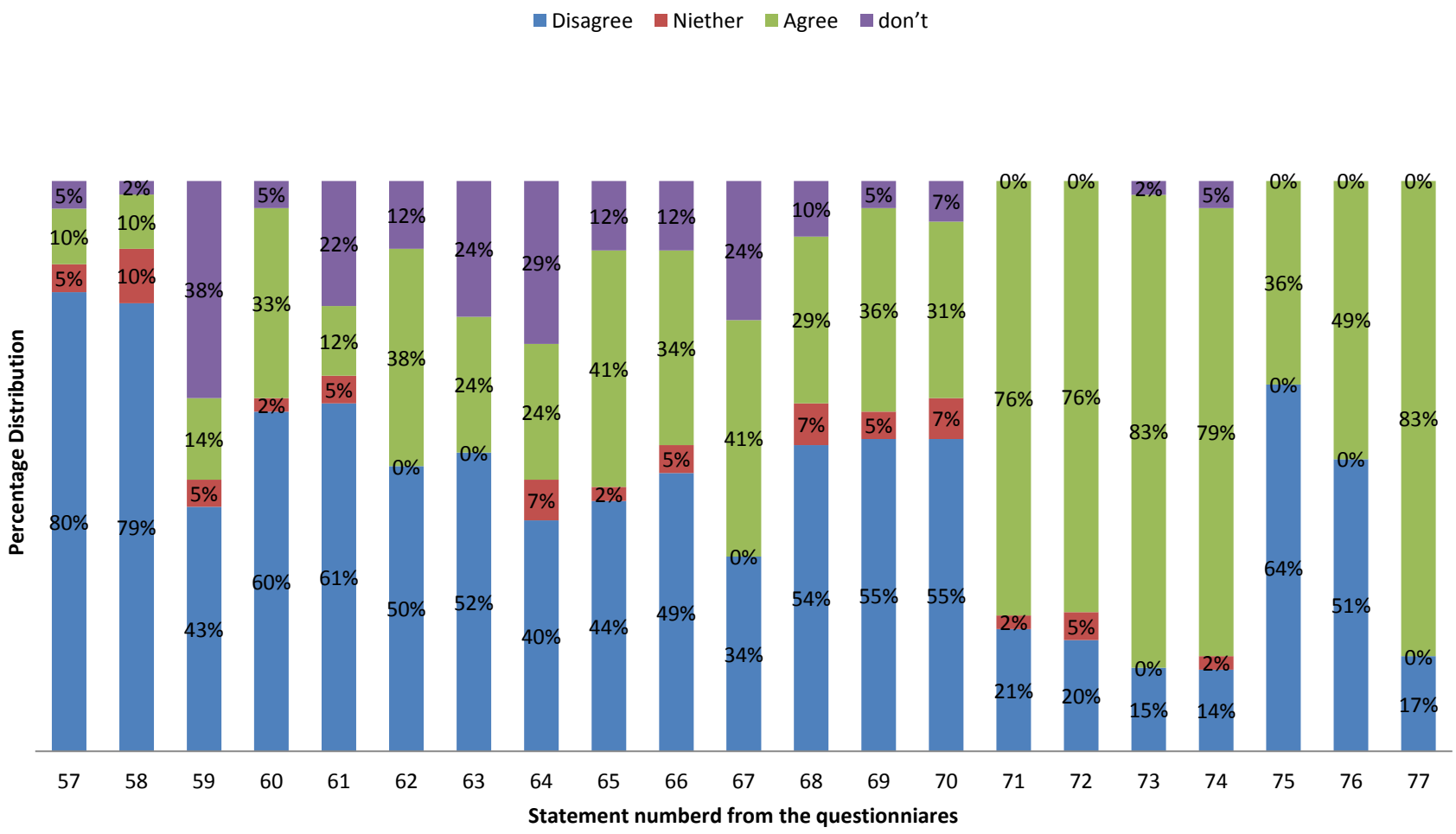


Figure 10.2.4: Percentage distributions of survey results for Pharmacists
Chart 4



10.3 Percentage Distribution of Survey Results for Nurses (Charts)

Figure 10.3.1: Percentage distributions of survey results for Nurses
Chart 1

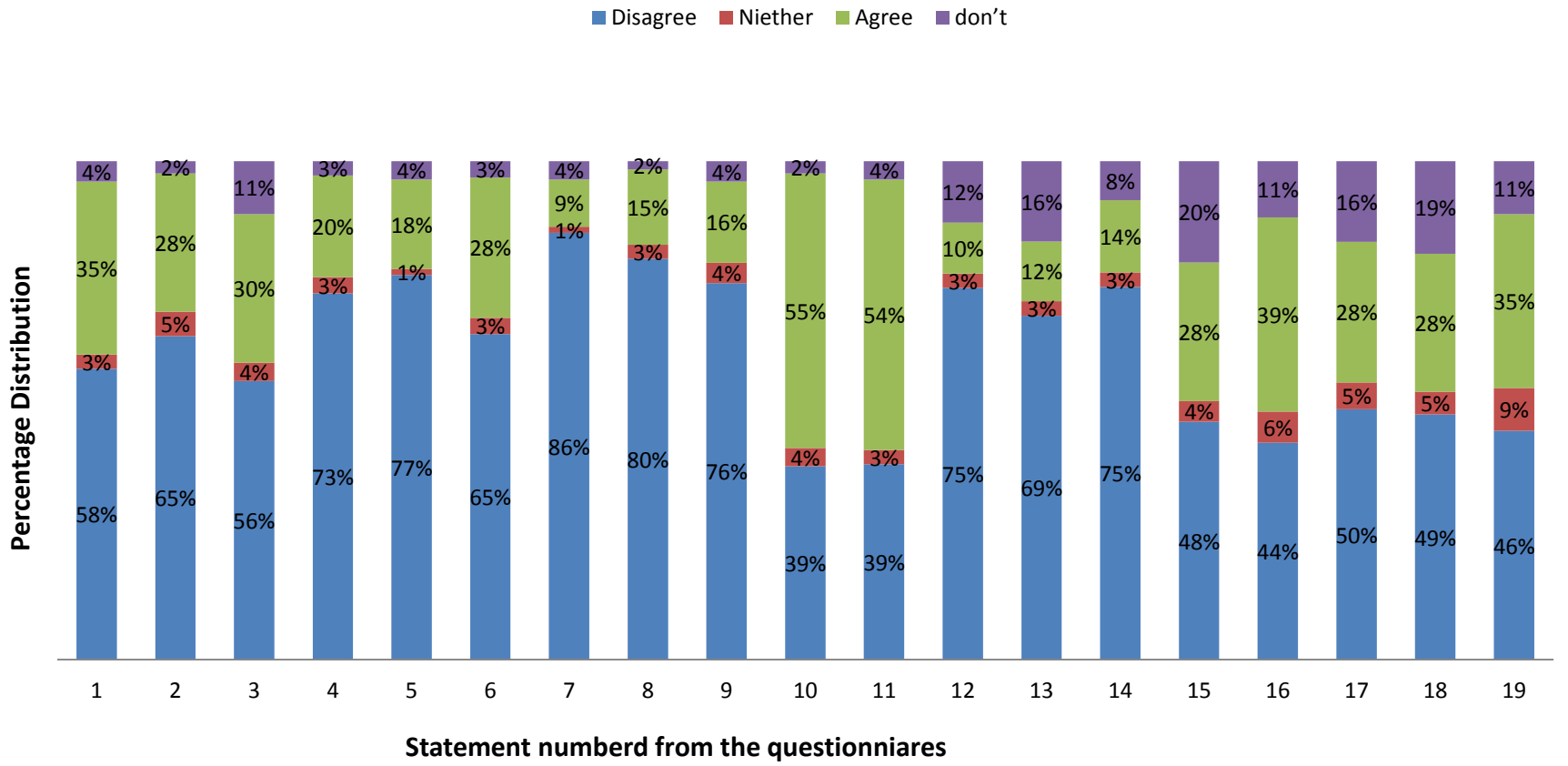


Figure 10.3.2: Percentage distributions of survey results for Nurses
Chart 2

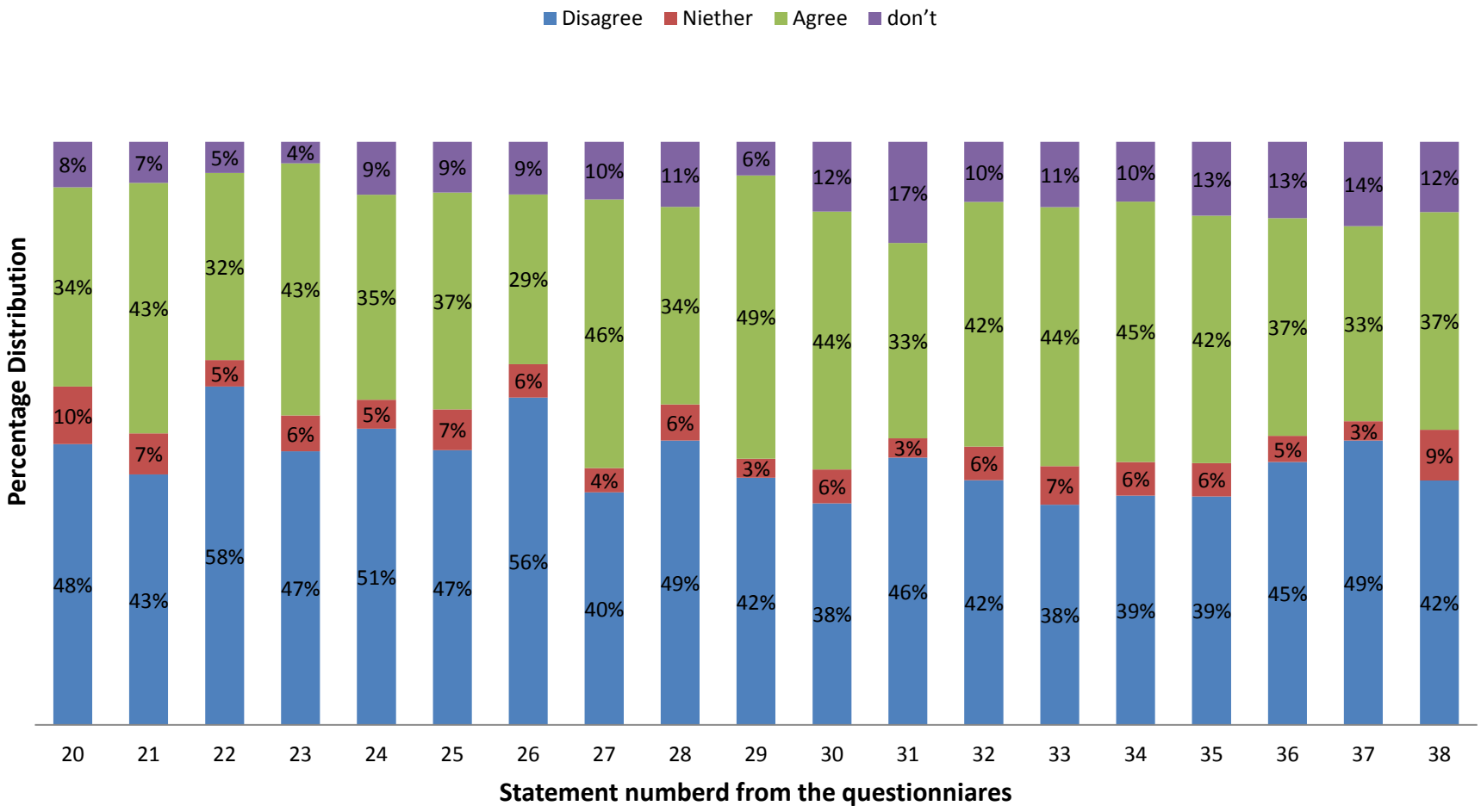


Figure 10.3.3: Percentage distributions of survey results for Nurses
Chart 3

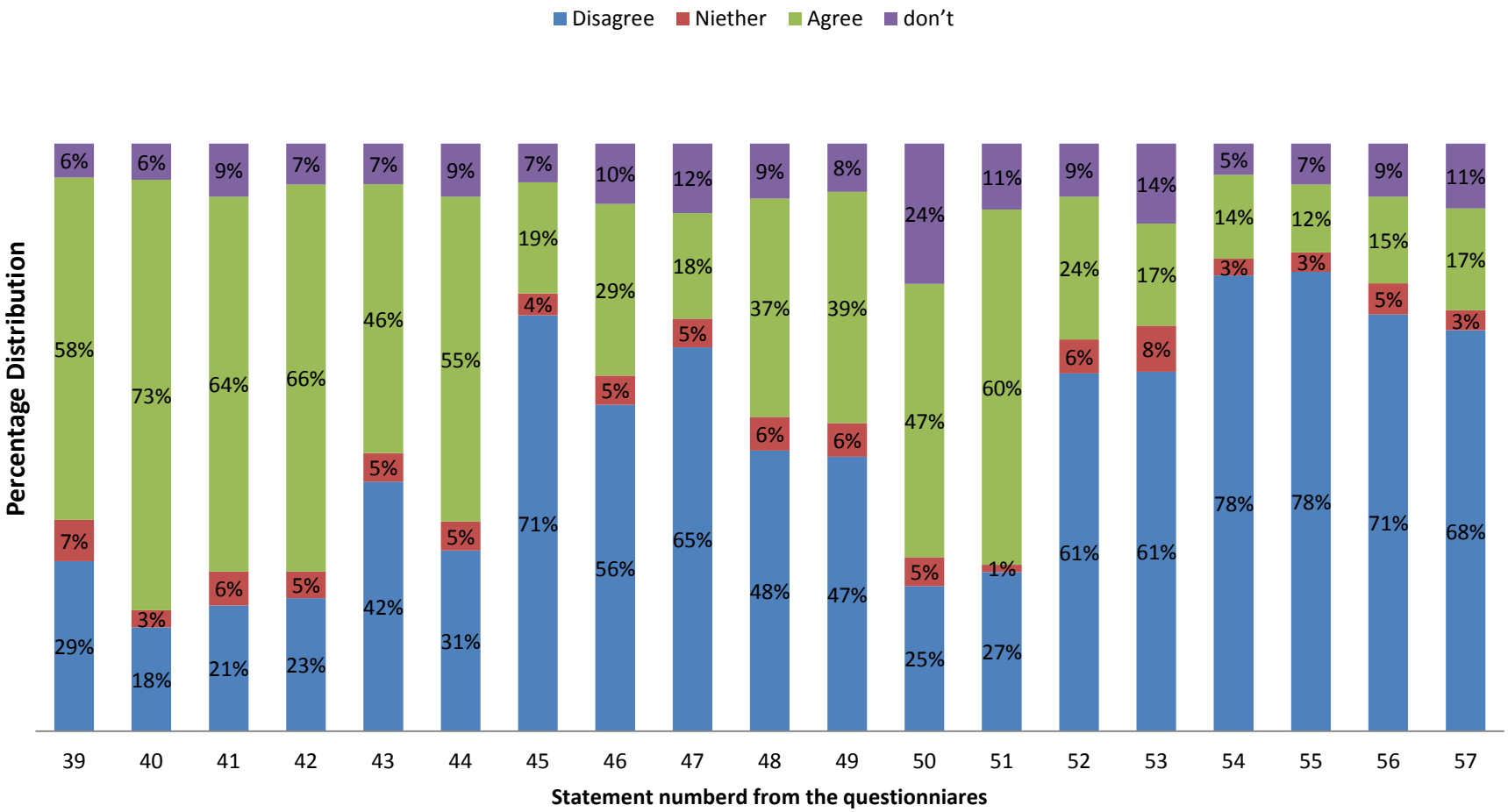
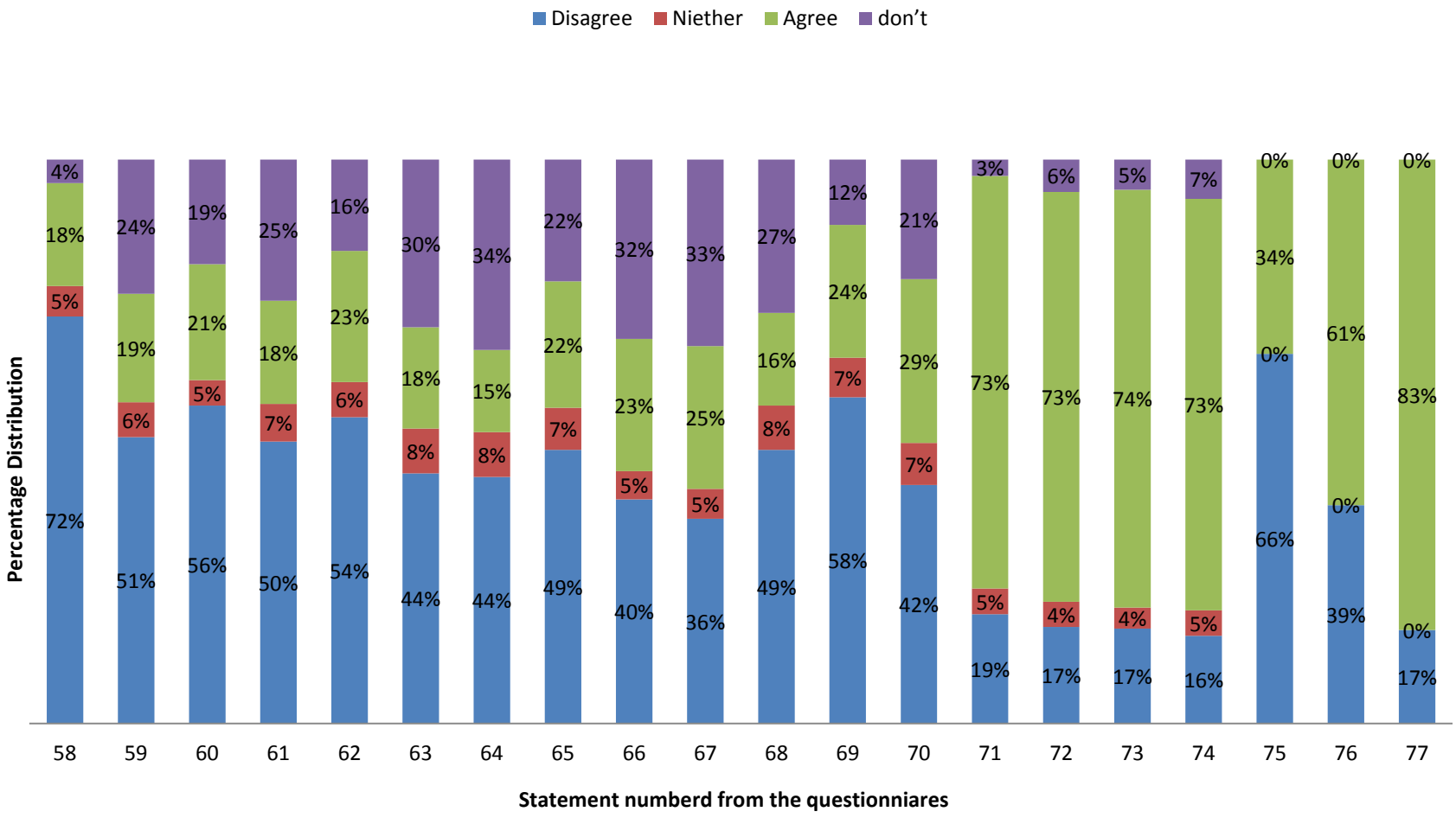


Figure 10.3.4: Percentage distributions of survey results for Nurses
Chart 4



10.4 Percentage Distribution of Survey Results for Doctors (Charts)

Figure 10.4.1: Percentage distributions of survey results for Doctors

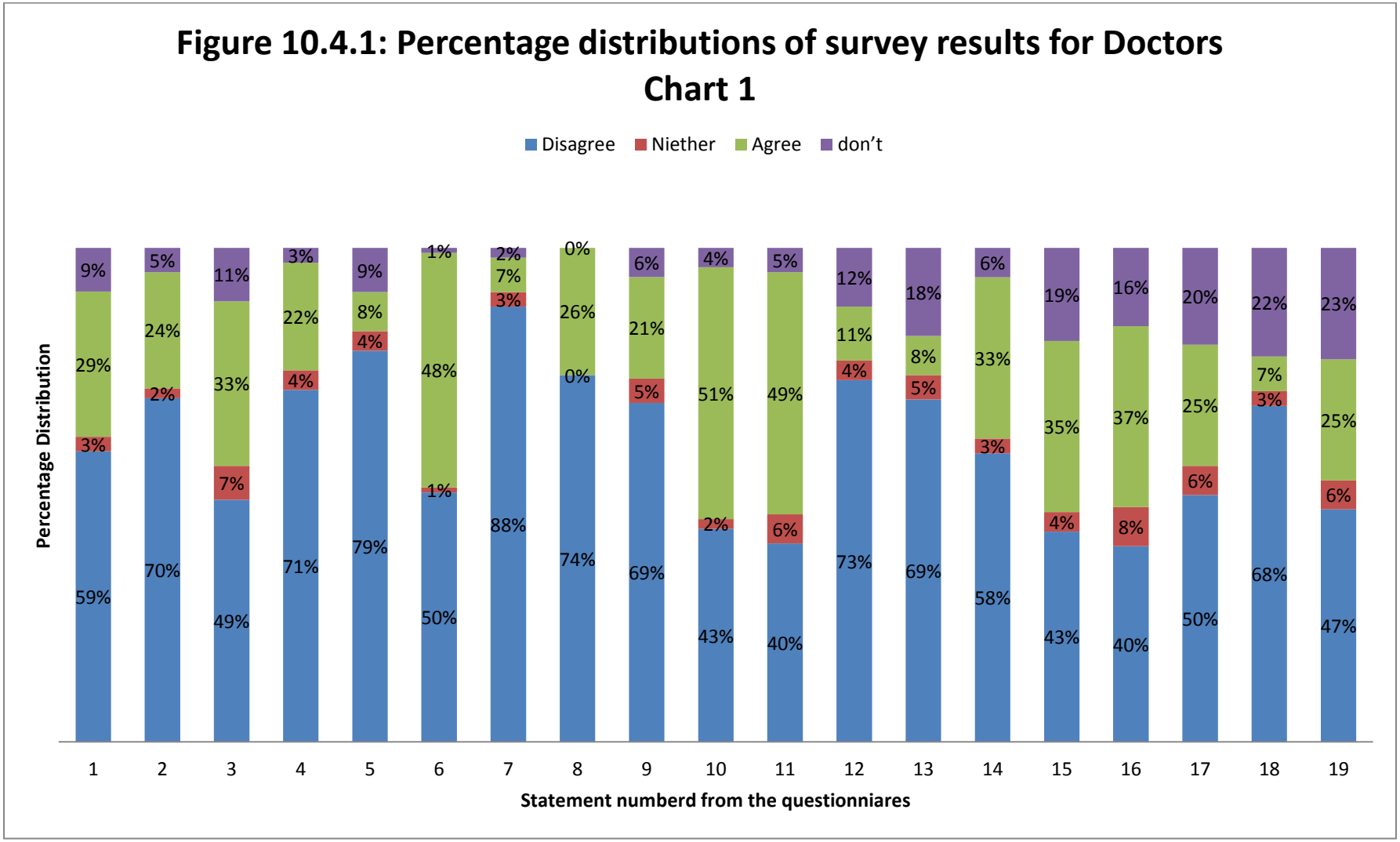


Figure 10.4.2: Percentage distributions of survey results for Doctors

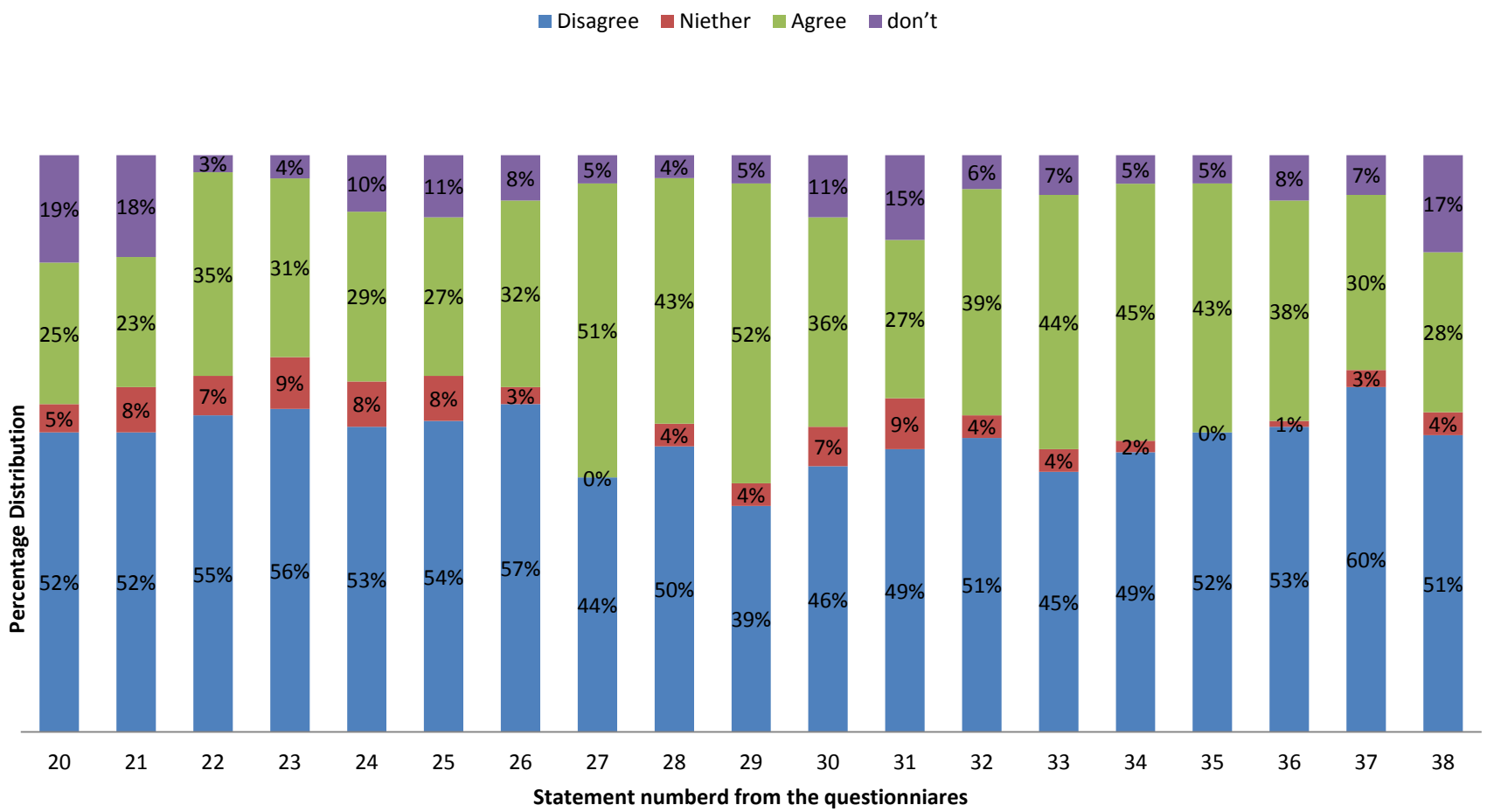


Figure 10.4.3: Percentage distributions of survey results for Doctors Chart 3

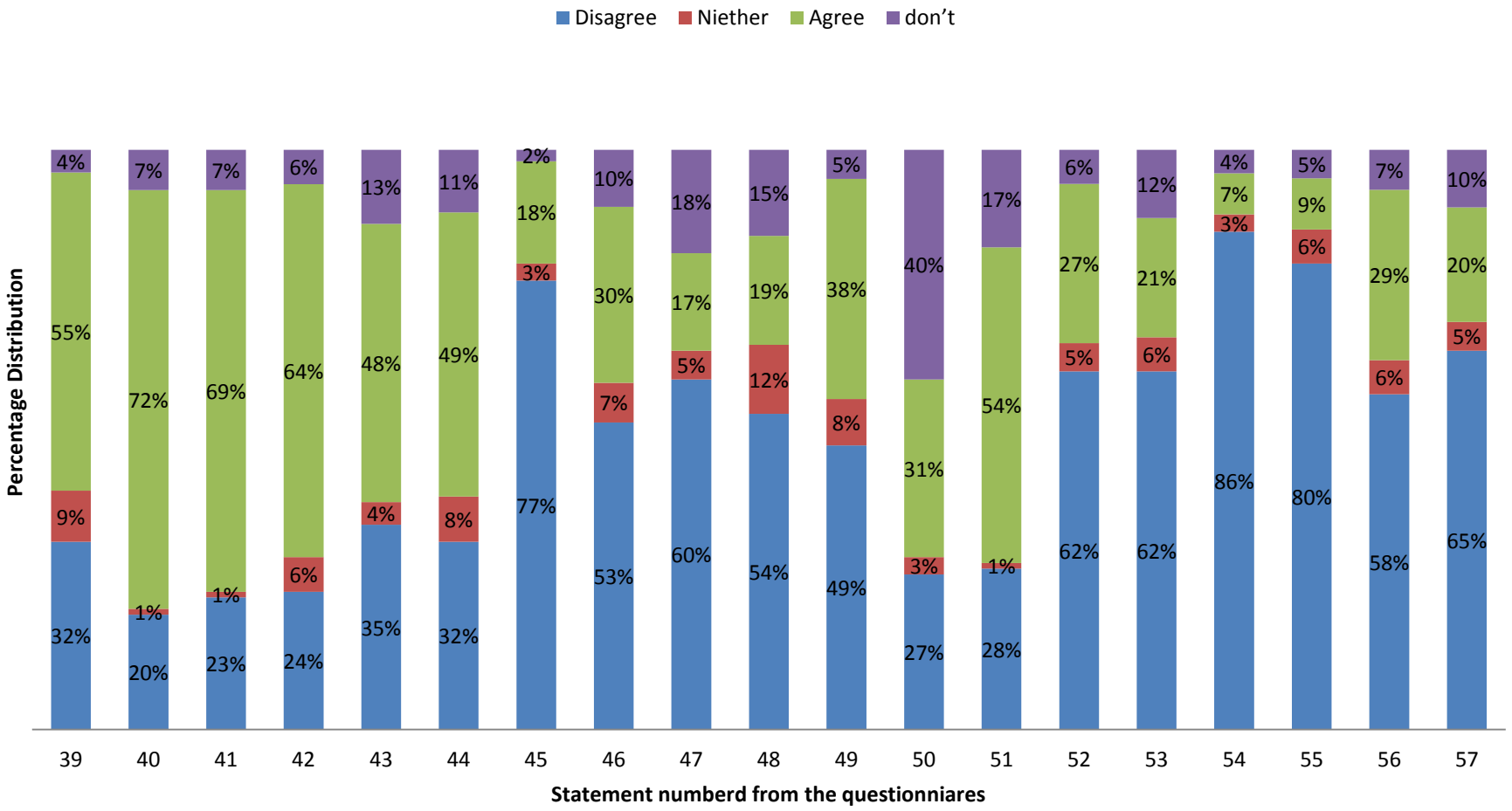
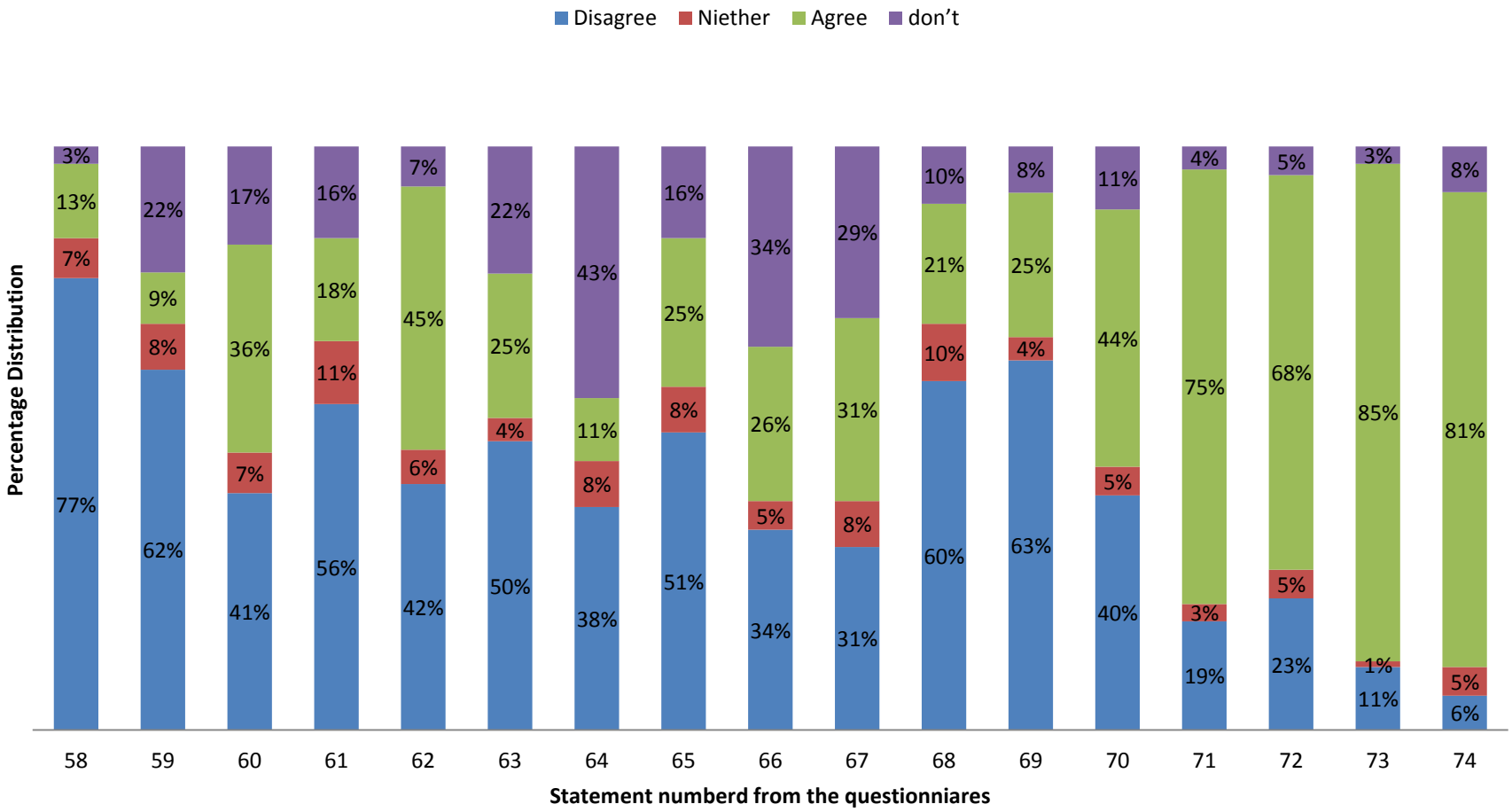
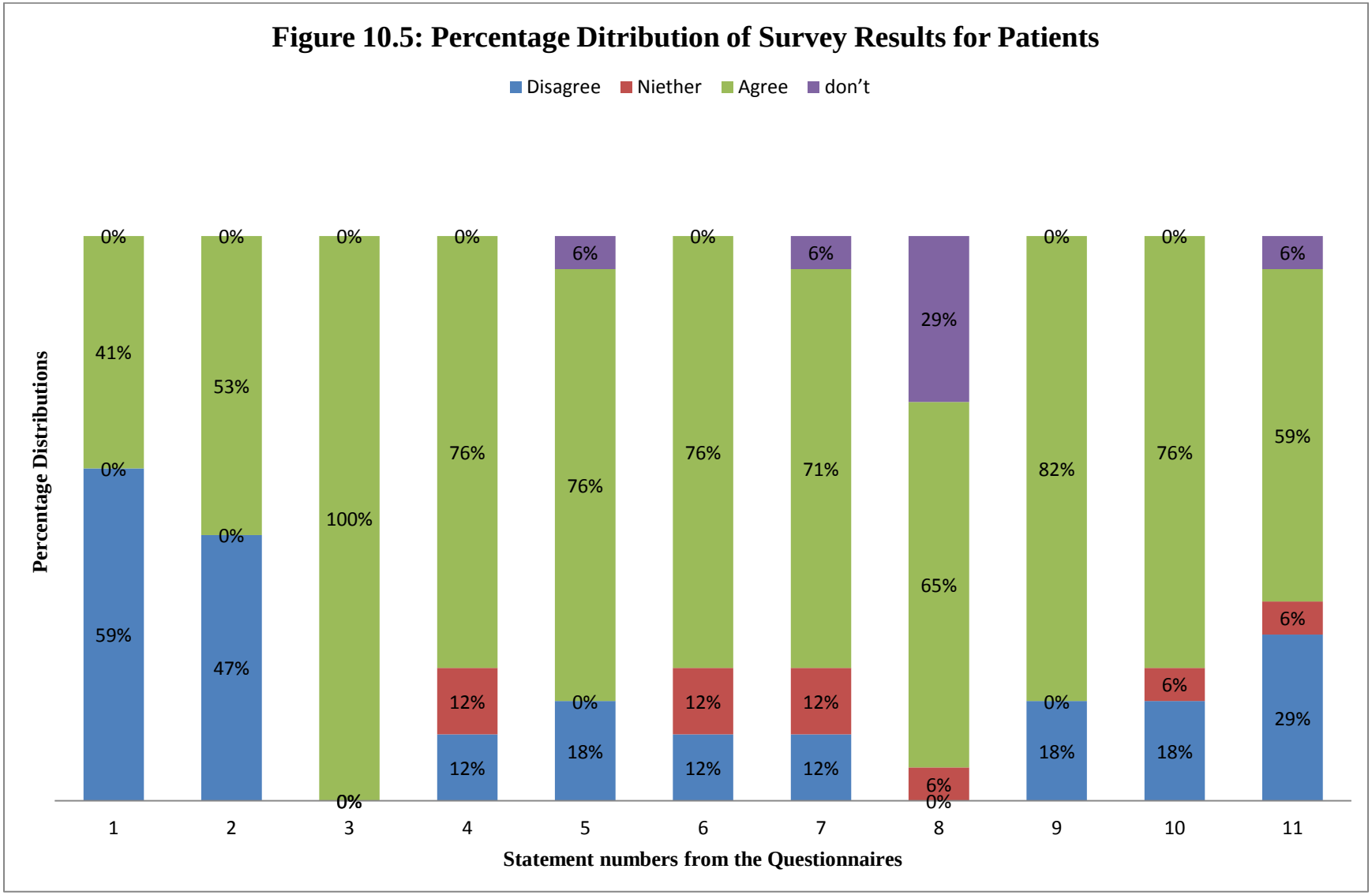


Figure 10.4.4: Percentage distributions of survey results for Doctors Chart 4



10.5 Percentage Distribution of Survey Results for Patients



10.6 Percentage Distribution of Survey Results for Admin Staff (Charts)

Figure 10.6.1: Percentage Ditribution of Survey Results for Admin Staff (Chart 1)

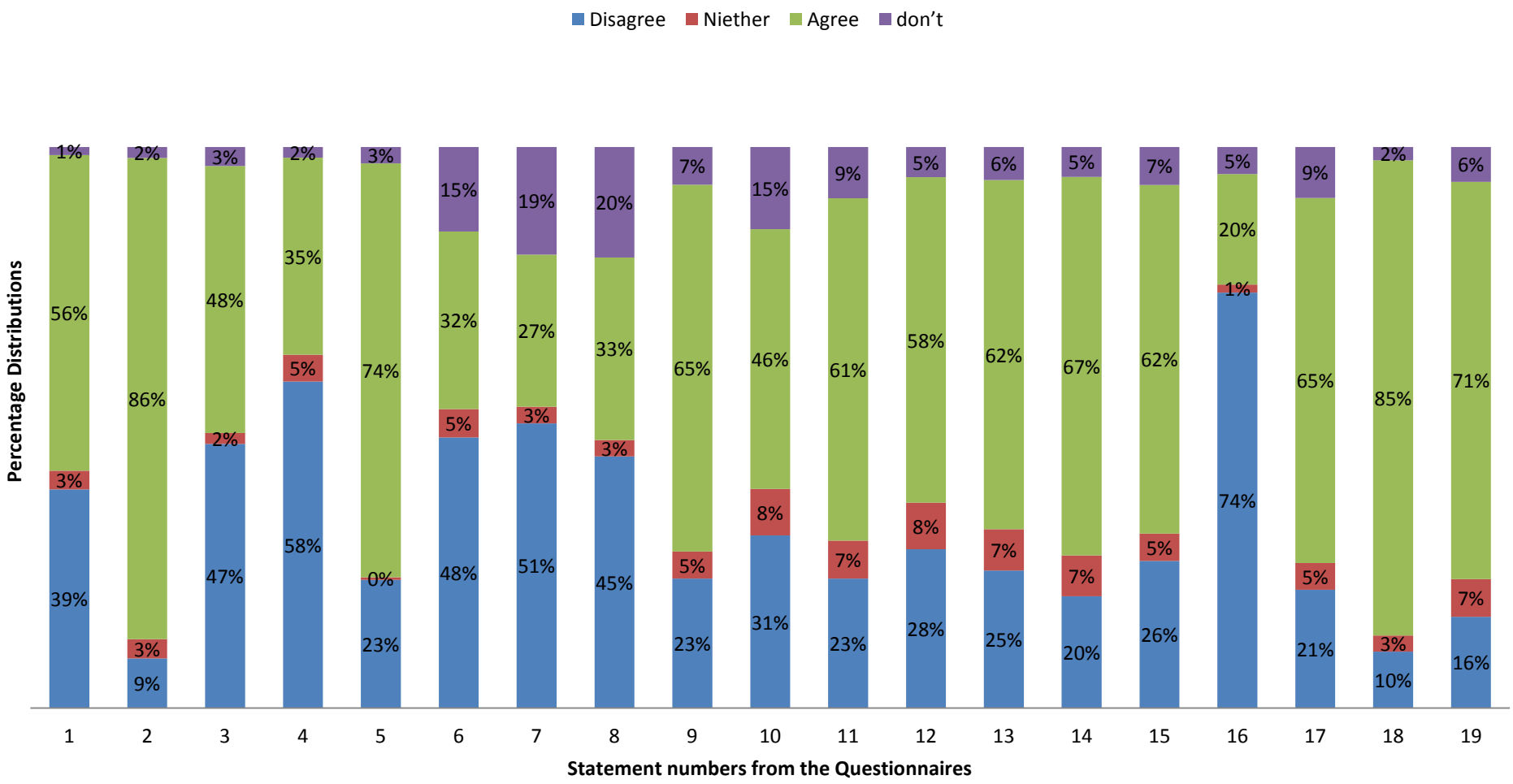


Figure 10.6.2: Percentage Ditribution of Survey Results for Admin Staff (Chart 2)

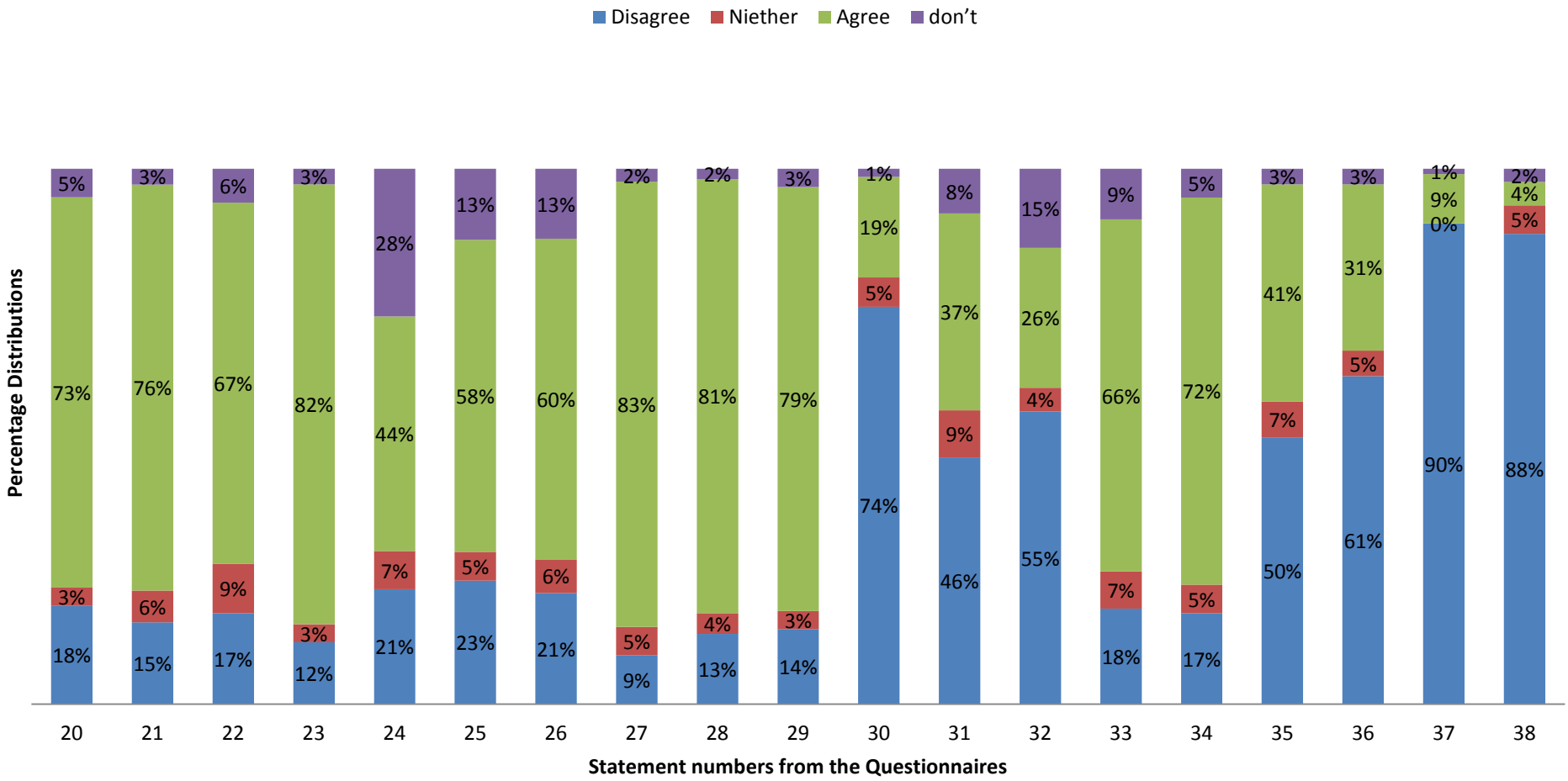
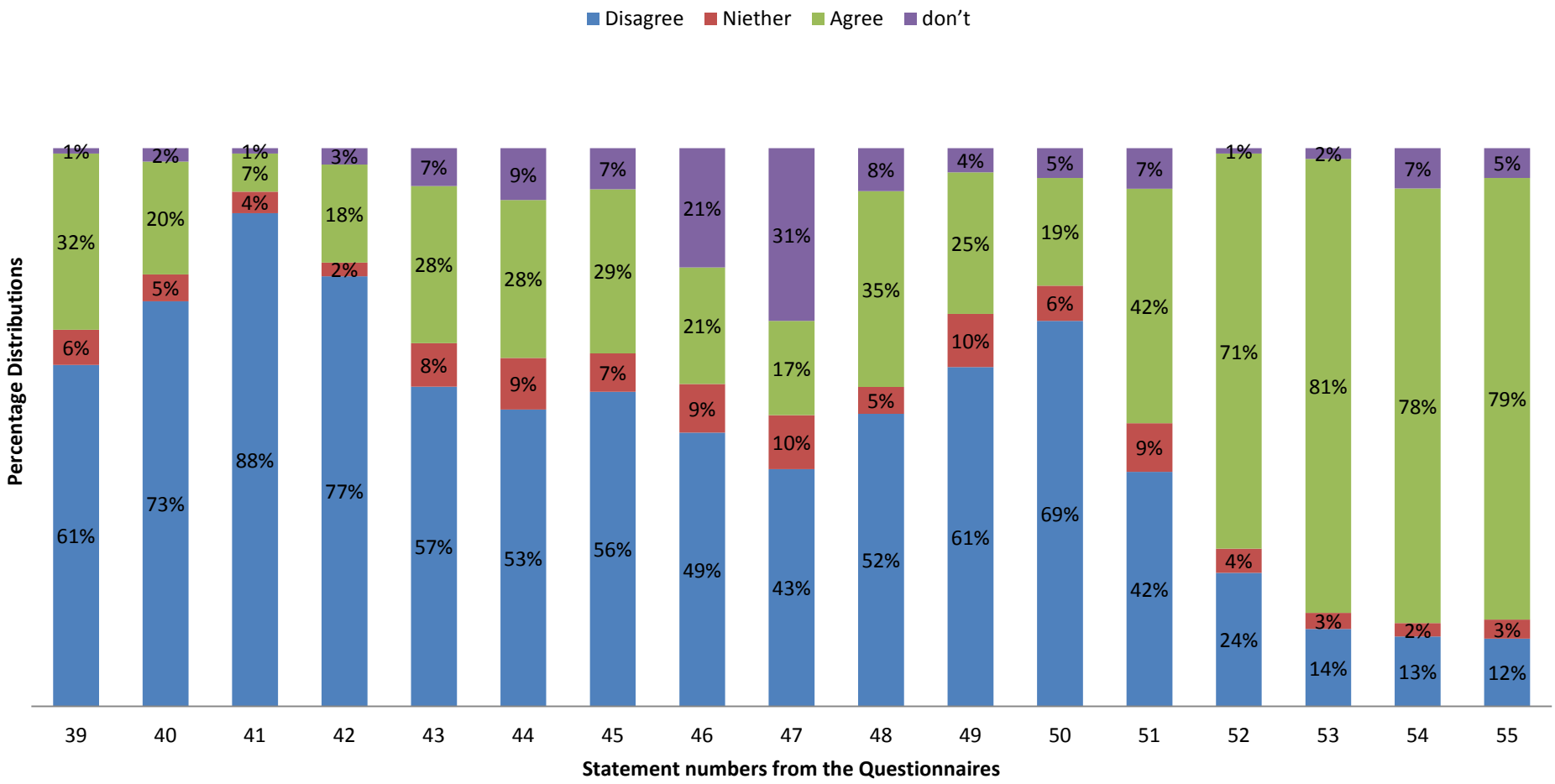


Figure 10.6.3: Percentage Ditribution of Survey Results for Admin Staff (Chart 3)



10.7 Percentage Distribution of Survey Results for Medical Team (Charts)

Figure 10.7.1: Percentage Distribution of Survey Results for Medical Team Staff Chart 1

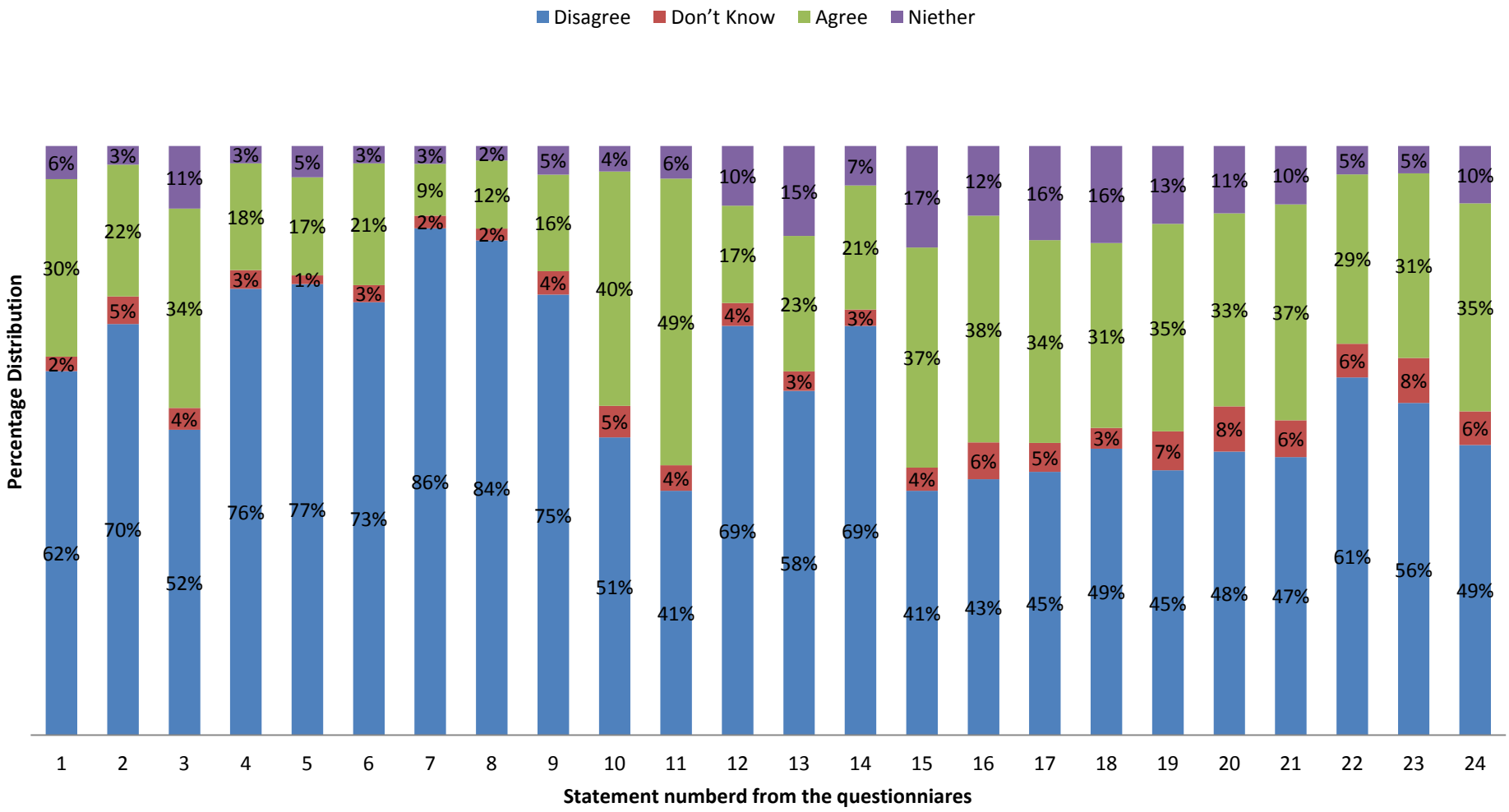


Figure 10.7.2: Percentage Distribution of Survey Results for Medical Team Staff Chart 2

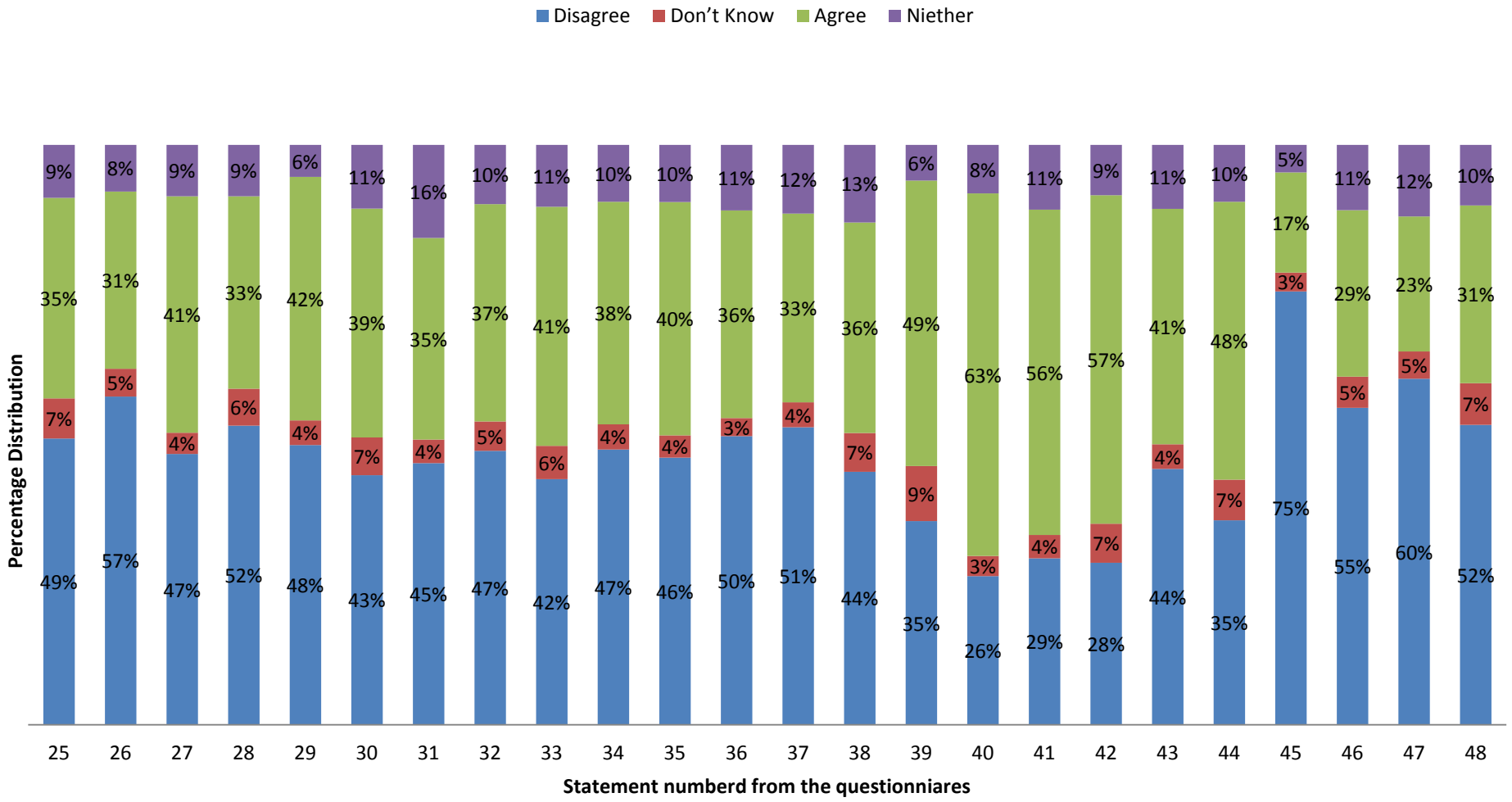
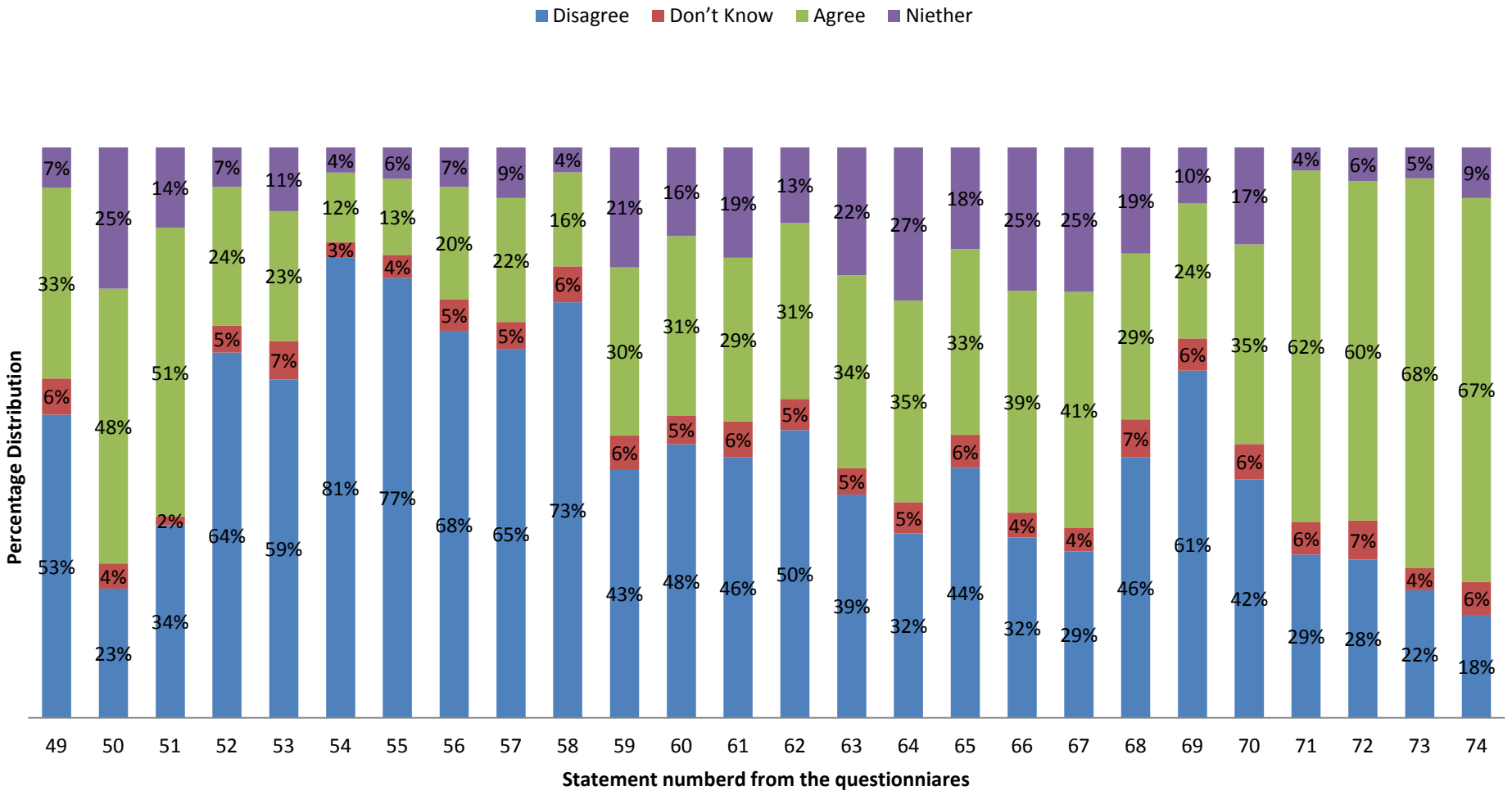


Figure 10.7.3: Percentage Distribution of Survey Results for Medical Team Staff Chart 3



10.8 Percentage Distribution of Survey Results for IT Team (Charts)

Figure 10.8.1: Percentage distributions of survey results for IT Team

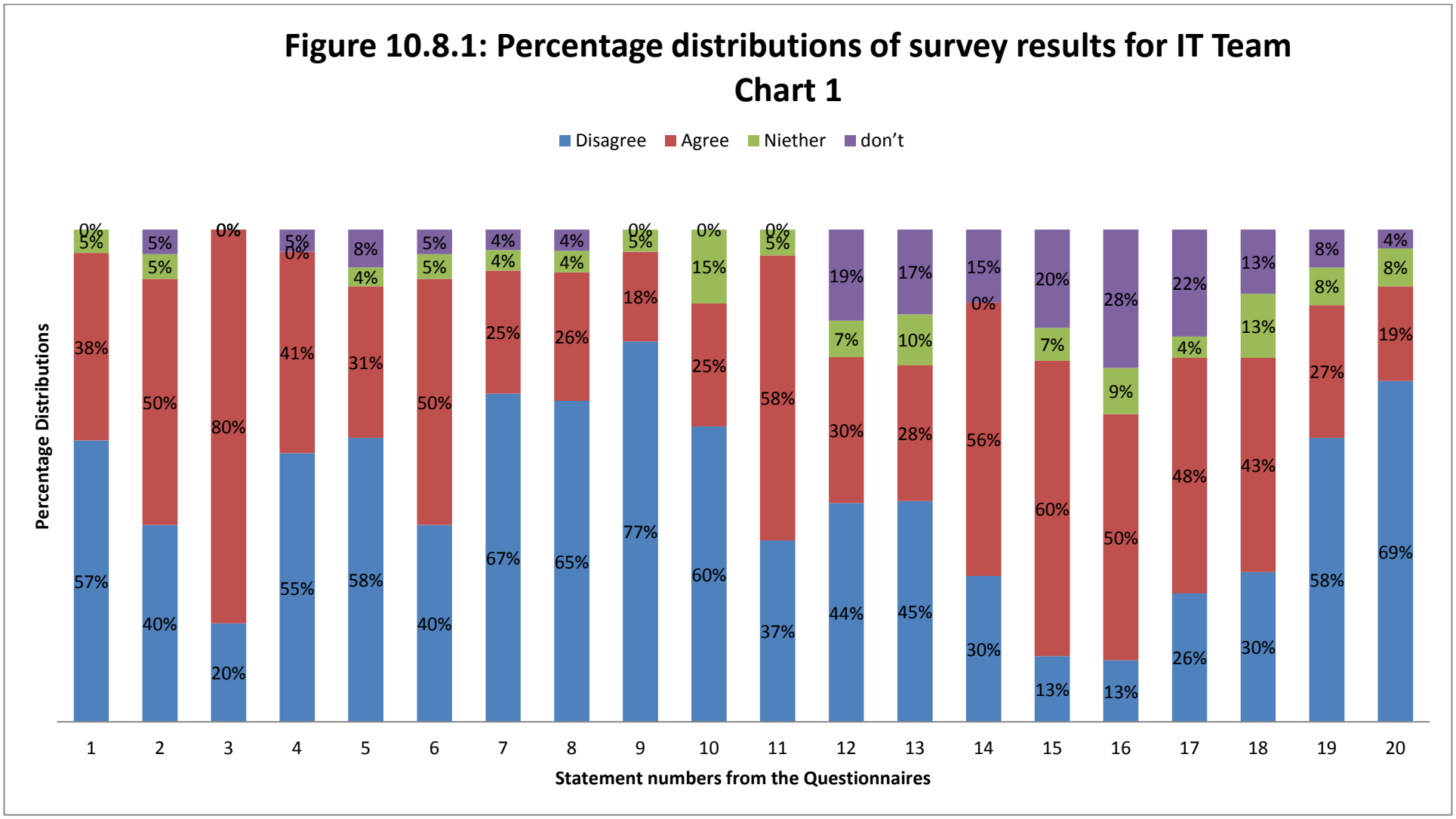


Figure 10.8.2: Percentage distributions of survey results for IT Team Chart 2

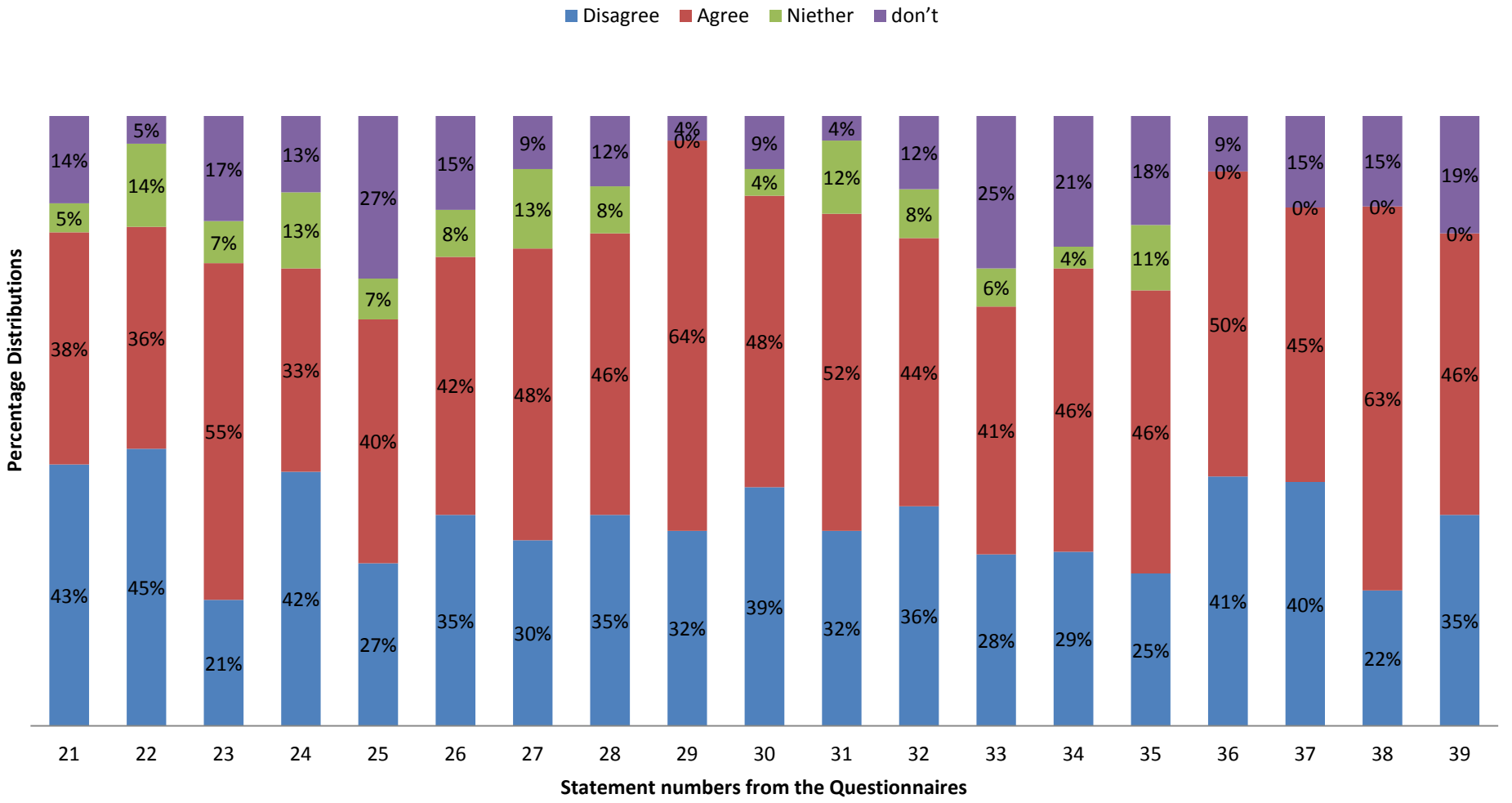


Figure 10.8.3: Percentage distributions of survey results for IT team Chart 3

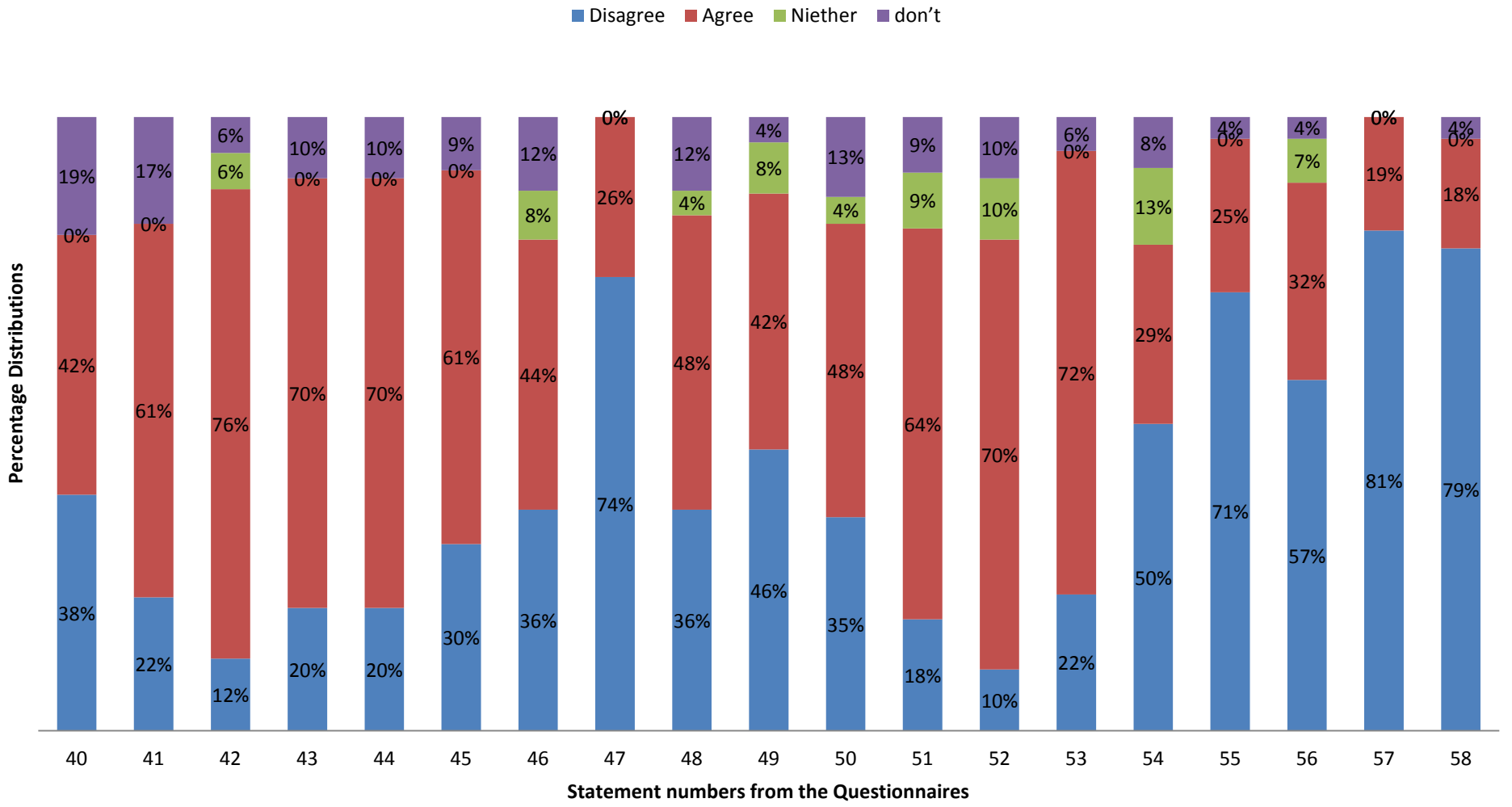
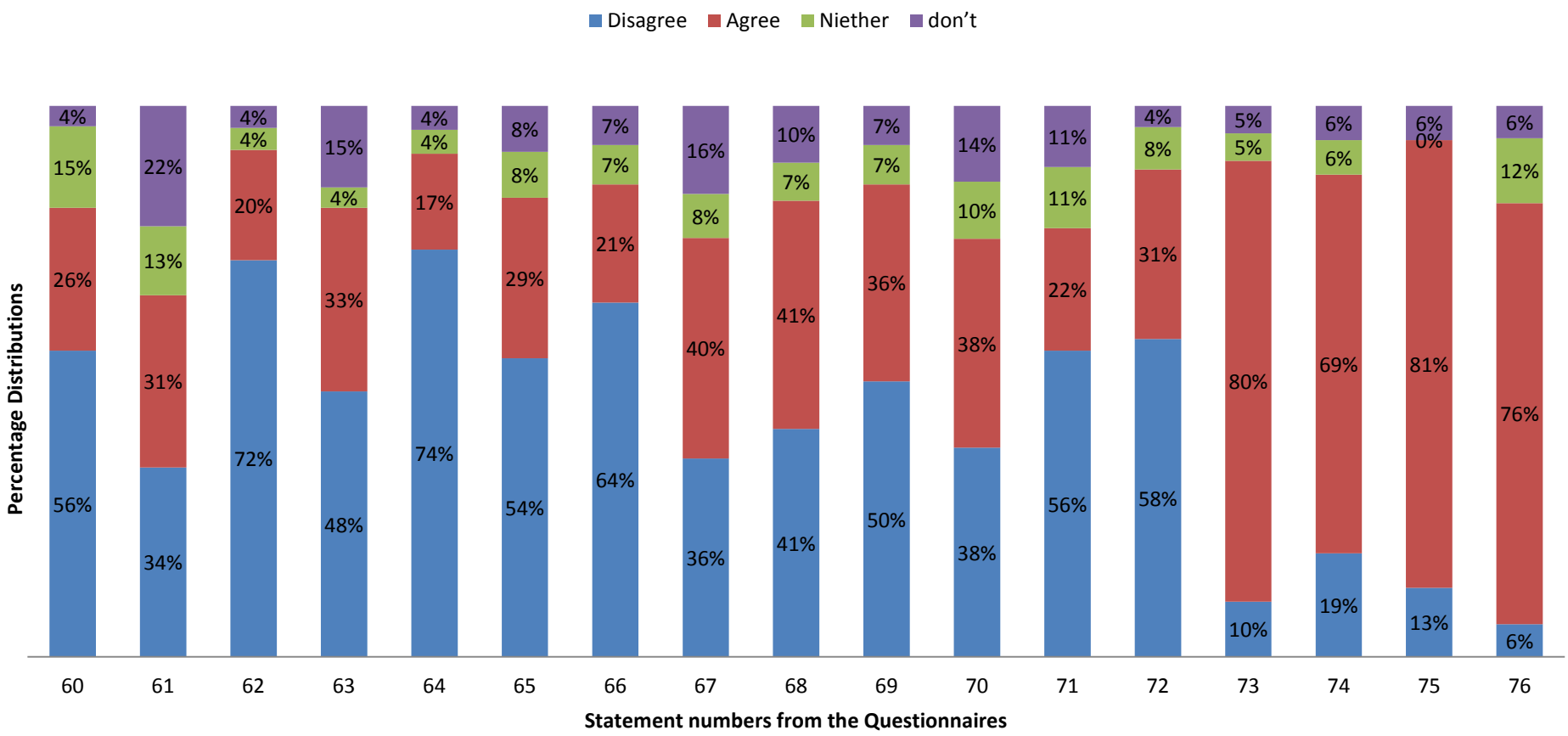


Figure 10.8.4: Percentage distributions of survey results for IT team Chart 4



Appendix V: References to the numbers on survey results graphs

Reference 1: Statement references from Medical Questionnaire

	The use electronic system in your facility / centre
1	Our computer system capture only patient information and contact details
2	I capture all patient information including health records.
3	We follow the same standard when entering data in our computer system
4	I use computer system to communication medical information with other departments
5	I use computer system is only for billing and payment.
6	I received patient online lab results
7	I use computer system for computerised prescription to the pharmacy
8	I use computer system to refer patient to radiology department and for digital imaging
9	Patient data base and health records are only kept in the computer
10	Patient data base and health records are only kept in the paper format
11	Patient database and health records are kept in both paper and computer
12	I use the same computer system for clinical trial patients
13	Patient data base is used for screening clinical trial patients
14	I use computer system for evidence based medicine or clinical decision making
15	Information collected available to researchers and clinicians
16	Information collected is available for education and training
17	Same standards are used when entering data on the computer system or eHealth records
18	Information is readily available at any health care facility in the province
	Impact of automation: As result of the computer system
19	Patient waiting times for administration have decreased
20	Patient waiting times to be seen by a doctor or nurse have decreased
21	Patient overall satisfaction with care received is higher (Improved access to care)

22	I have superior access to patient record information when compared to paper based
23	I am treating more patients per shift in the outpatient/ward/where I work
24	There is increased satisfaction with the overall working conditions in the facility / centre
25	The facility has enjoyed improved service delivery
26	There is a reduction of duplication of information which means cleaner patient records and less time spent entering information
27	Patient information is more organised with the computer system compared to the paper system
28	Fewer records are lost and record management has improved
29	I find it easy to work with electronic system than with paper records
30	Quality of care for patients has improved
31	There is improved systemic utilisation of evidence-based medicine
32	There is improved communication between healthcare professionals (Data sharing)
33	Information collected is accurate and reliable
34	Make clinical function better by proving computerised prescriptions, online lab results and digital radiological imaging
35	Information is readily available in the same hospital facilities
36	The new computer system plays a good role in academia
37	The referral process between hospital departments is improved
38	I believe patient discharge times from hospital is quicker
39	I have confidence that information is more secure and confidential in electronic compared to paper
40	I believe the computer systems will save the facility money
41	I believe it is easier to screen patients clinical research studies
42	Enhanced security around patient confidentiality
	Organisational Influence and security
43	Patient waiting times for administration have decreased

44	Patient waiting times to be seen by a doctor or nurse have decreased
45	Patient overall satisfaction with care received is higher (Improved access to care)
46	I have superior access to patient record information when compared to paper based
47	I am treating more patients per shift in the outpatient/ward/where I work
48	There is increased satisfaction with the overall working conditions in the facility / centre
49	The facility has enjoyed improved service delivery
50	There is a reduction of duplication of information which means cleaner patient records and less time spent entering information
51	Patient information is more organised with the computer system compared to the paper system
	Fewer records are lost and record management has improved
52	I find it easy to work with electronic system than with paper records
53	Quality of care for patients has improved
54	There is improved systemic utilisation of evidence-based medicine
55	There is improved communication between healthcare professionals (Data sharing)
56	Information collected is accurate and reliable
57	Make clinical function better by proving computerised prescriptions, online lab results and digital radiological imaging
58	Information is readily available in the same hospital facilities
59	The new computer system plays a good role in academia
60	The referral process between hospital departments is improved
61	I believe patient discharge times from hospital is quicker
62	I have confidence that information is more secure and confidential in electronic compared to paper
63	I believe the computer systems will save the facility money
64	I believe it is easier to screen patients clinical research studies
65	Enhanced security around patient confidentiality

66	There is limited or no funds to run computer systems in this facility
67	High cost of IT equipment
68	Data is not accurate and there is missing data
69	Increased workload for staff
70	There is frequent down time or internet not available
	Overall
71	I would like to move to a paperless system as soon as possible
72	I find the computer system is faster to use compared to handwritten notes
73	I believe that it improves health care and stream lining operational effectiveness.
74	I believe the hospital will save money as a result of moving to the new system

Reference 2: Statement references from Admin Questionnaire

	The use of electronic system in your facility / centre
1	Our computer system captures only patient information and contact details
2	We follow the same standard when entering data in our computer system
3	I use computer system to communication medical information with other departments
4	I use computer system is only for billing and payment.
5	Patient database and health records are kept in both paper and computer
6	I use the same computer system for clinical trial patients
7	Patient data base is used for screening clinical trial patients
8	Information is readily available at any health care facility in the province
	Impact of automation: As result of the computer system
9	Patient waiting times for administration have decreased
10	Patient waiting times to be seen by a doctor or nurse have decreased
11	Patient overall satisfaction with care received is higher
12	I have superior access to patient record information when compared to paper based

13	There is increased satisfaction with the overall working conditions in the facility / centre
14	The facility has enjoyed improved service delivery
15	There is a reduction of duplication of information which means cleaner patient records and less time spent entering information
16	Patient information is more disorganised with the computer system compared to the paper system
17	Fewer records are lost and record management has improved
18	I find it easy to work with electronic system than with paper records
19	Quality of service for patients has improved
20	There is improved communication between healthcare and admin staff
21	Information is collected is accurate and reliable
22	Makes administration function better by providing information from other facility like pharmacy, other heath institute and laboratory.
23	Information is readily available
24	Plays a role in academia
25	The referral process between hospital departments is improved
26	I believe patient discharge times from hospital is quicker
27	I have confidence that information is more secure and confidential in electronic compared to paper
	Organisational Influence
28	Management encourages staff to use the computer system
29	Staff are eager to learn the new system
30	Initially I did not want to move to the new computer system
31	The is enough human resources to utilise the new computer system
32	Initially the staff did not want to move to the new computer system
33	As a result of the computer systems, I see improved morale in the workplace
34	As a result of the computer systems, my overall level of professionalism has increased

	Barriers and challenges encountered
35	Insufficient training was provided when I first had to use the system
36	There is no need for continuous training on the system as its easy and intuitive to use
37	I have a fear of having to use a computer instead of paper
38	I found the system difficult to use (Not user Friendly)
39	I find the system slow
40	Information on the computer is not secure or confidential
41	I prefer using a paper based system
42	I can get by without having to learn the computer system
43	The IT infrastructure is not well supported and maintained
44	There is restricted amount of data to entered in the system
45	Implementation of computed system is very slow
46	Historical issues of South Africa affect utilisation of the new computer system
47	Data privacy law in South Africa prevent proper utilisation of computer systems
48	Information in the system is limited to our facility / centre only
49	Data is not accurate and there is missing data
50	Computer system has increased Staff workload
51	There is frequent down time or internet not available
	Overall
52	I would like to move to a paperless system as soon as possible
53	I find the comprised system is faster to use compared to handwritten notes
54	I believe that it improves health care and seam lining operational effectiveness.
55	I believe the hospital will save money as a result of moving to the new system

Reference 3: Statement references from IT Questionnaire

	The use electronic system in your facility / centre
1	Our computer system captures only patient information and contact details
2	It captures all patient information including health records.
3	We follow the same standard when entering data in our computer system
4	Computer system used to communication medical information with other departments
5	Computer system is only used for billing and payment.
6	Doctors receives online lab results
7	It is used for computerised prescription to the pharmacy
8	Ii is used to refer patient to radiology department and for digital imaging
9	Patient data base and health records are only kept in the computer
10	Patient data base and health records are only kept in the paper format
11	Patient database and health records are kept in both paper and computer
12	The same computer system is used for clinical trial patients
13	Patient data base is used for screening clinical trial patients
14	Computer system is used for evidence based medicine or clinical decision making
15	Information collected available to researchers and clinicians
16	Information collected is available for education and training
17	Same standards are used when entering data on the computer system or eHealth records
18	Data from this facility is sent to the central database regular
19	Data can be easily retrieved from the central database from any Hospital or clinic
20	Information is readily available at any health care facility in the province
	Impact of automation: As result of the computer system
21	Patient waiting times for administration have decreased
22	Patient waiting times to be seen by a doctor or nurse have decreased

23	Patient overall satisfaction with care received is higher (Improved access to care)
24	Users have superior access to patient record information when compared to paper based
25	Medical staff are treating more patients per shift in the outpatient/ward/where I work
26	There is increased satisfaction with the overall working conditions in the facility / centre
27	The facility has enjoyed improved service delivery
28	There is a reduction of duplication of information which means cleaner patient records and less time spent entering information
29	Patient information is more organised with the computer system compared to the paper system
30	Fewer records are lost and record management has improved
31	Staff it easy to work with electronic system than with paper records
32	Quality of care for patients has improved
33	There is improved systemic utilisation of evidence-based medicine
34	There is improved communication between healthcare professionals (Data sharing)
35	Information collected is accurate and reliable
36	Make clinical function better by proving computerised prescriptions, online lab results and digital radiological imaging
37	Information is readily available in the same hospital facilities
38	The computer system plays a good role in academia
39	The referral process between hospital departments is improved
40	I believe patient discharge times from hospital is quicker
41	I have confidence that information is more secure and confidential in electronic compared to paper
42	I believe the computer systems will save the facility money
43	I believe it is easier to screen patients clinical research studies
44	Enhanced security around patient confidentiality
	Organisational Influence and security

45	Management encourages staff to use the computer system
46	Staff are eager to learn the new system
47	Initially I did not want to move to the new computer system
48	There is enough human resources to utilise the new computer system
49	Initially the staff did not want to move to the new computer system
50	As a result of the computer systems, I see improved morale in the workplace
51	As a result of the computer systems, my overall level of professionalism has increased
52	South African government is supporting the implementation of e-health
53	Computer systems is secured with Username and password
	Challenges or Barriers encountered
54	Insufficient training was provided to staff
55	There are no standards of entering data or information
56	Staff has a fear of having to use a computer instead of paper
57	The computer system is difficult to use (Not user friendly)
58	I find the system slow
59	Information on the computer is not secure or confidential
60	Staff prefers to use a paper based system
61	Patient do not allow health personnel to share their information through e-health
62	The IT infrastructure is not well supported and maintained
63	There is restricted amount of data to entered in the system
64	Implementation of computed system is very slow
65	Historical issues of South Africa affect utilisation of the new computer system
66	Data privacy law in South Africa prevent proper utilisation of computer systems
67	Information in the system is limited to our facility / centre only
68	There is limited or no funds to run computer systems in this facility
69	High cost of IT equipment

70 Data is not accurate and there is missing data

71 Increase of workload for staff

72 There is frequent down time or internet not available

Overall

73 Staff would like to move to a paperless system as soon as possible

74 I find the computer system faster to use compared to handwritten notes

75 I believe that it improves health care and stream lining operational effectiveness.

76 I believe the hospital will save money as a result of moving to the new system

Reference 4: Statement references from Patients Questionnaire

Experience at the facility / centre

1 I wait less at registration counter

2 I wait less to see a doctor or nurse

3 I am more satisfaction with care received

4 My medical records are easily available when compared to paper based

5 I received my test results quickly

6 The facility has improved service delivery

7 The referral process between hospital departments is improved

8 I believe patient discharge times from hospital is quicker

9 I have confidence that information is more secure and confidential in electronic compared to paper

10 I will allow doctors to use my health information for educating other medical staff

11 I wait less at the hospital pharma cy to collect Medication.

12 If there any other import information related to computer systems in this facility that you would like to provide please provide it below:

Appendix V: Statistical results and methods used

Stats 01: Kruskal-Wallis Test (Nonparametric ANOVA) for Implementation of HIS in hospitals

The P value is 0.2265, considered not significant. Variation among column medians is not significantly greater than expected by chance.

The P value is approximate (from chi-square distribution) because at least one column has two or more identical values.

Calculation detail

Group	Number of Points	Sum of Ranks	Mean of Ranks
Admin	474	219152	462.34
Drs	102	44038	431.75
Nurses	245	102831	419.72
Pharma	42	19380	461.43
IT	27	11095	410.93

Kruskal-Wallis Statistic KW = 5.654 (corrected for ties)

Dunn's Multiple Comparisons Test

Comparison	Mean Rank Difference	P value
Admin vs. Drs	30.600	ns P>0.05
Admin vs. Nurses	42.629	ns P>0.05

Admin vs. Pharma	0.9164	ns P>0.05
Admin vs. IT	51.419	ns P>0.05
Drs vs. Nurses	12.029	ns P>0.05
Drs vs. Pharma	-29.683	ns P>0.05
Drs vs. IT	20.819	ns P>0.05
Nurses vs. Pharma	-41.712	ns P>0.05
Nurses vs. IT	8.790	ns P>0.05
Pharma vs. IT	50.503	ns P>0.05

Summary of Data

Group	Number of Points	Median	Minimum	Maximum
Admin	474	4.000	1.000	7.000
Drs	102	4.000	1.000	7.000
Nurses	245	4.000	1.000	7.000
Pharma	42	4.000	1.000	7.000
IT	27	3.000	1.000	7.000

Mann-Whitney Test of Admin and Doctors on implementation

The two-tailed P value is 0.2549, considered not significant. The P value is an estimate based on a normal approximation. The 'exact' method would not be exact, due to tied ranks.

Calculation details

Mann-Whitney U-statistic = 22467 and U' = 25881

Sum of ranks in Admin = 138456. Sum of ranks in Drs = 27720.

Summary of Data

Parameter:	Admin	Drs
Mean:	3.871	3.627
# of points:	474	102
Std deviation:	2.187	1.903
Std error:	0.1005	0.1884
Minimum:	1.000	1.000
Maximum:	7.000	7.000
Median:	4.000	4.000
Lower 95% CI:	3.674	3.253
Upper 95% CI:	4.068	4.002

Mann-Whitney Test of Admin and IT on implementation

The two-tailed P value is 0.3555, considered not significant. The P value is an estimate based on a normal approximation. The 'exact' method would not be exact, due to tied ranks.

Calculation details

Mann-Whitney U-statistic = 5734.0 and U' = 7064.0

Sum of ranks in Admin = 119639. Sum of ranks in IT = 6112.0.

Summary of Data

Parameter:	Admin	IT
Mean:	3.871	3.444
# of points:	474	27

Std deviation:	2.187	2.375
Std error:	0.1005	0.4571
Minimum:	1.000	1.000
Maximum:	7.000	7.000
Median:	4.000	3.000
Lower 95% CI:	3.674	2.505
Upper 95% CI:	4.068	4.384

Mann-Whitney Test of Admin and Pharma on implementation

The two-tailed P value is 0.9685, considered not significant. The P value is an estimate based on a normal approximation. The 'exact' method would not be exact, due to tied ranks.

Calculation details

Mann-Whitney U-statistic = 9917.5 and U' = 9990.5

Sum of ranks in Admin = 122566. Sum of ranks in Pharma = 10821.

Summary of Data

Parameter:	Admin	Pharma
Mean:	3.871	3.929
# of points:	474	42
Std deviation:	2.187	1.918
Std error:	0.1005	0.2959
Minimum:	1.000	1.000
Maximum:	7.000	7.000
Median:	4.000	4.000

Lower 95% CI:	3.674	3.331
Upper 95% CI:	4.068	4.526

Mann-Whitney Test of Admin and Nurses on implementation

The two-tailed P value is 0.0314, considered significant. The P value is an estimate based on a normal approximation. The 'exact' method would not be exact, due to tied ranks.

Calculation details

Mann-Whitney U-statistic = 52489 and U' = 63641

Sum of ranks in Admin = 176216. Sum of ranks in Nurses = 82624.

Summary of Data

Parameter:	Admin	Nurses
Mean:	3.871	3.535
# of points:	474	245
Std deviation:	2.187	1.978
Std error:	0.1005	0.1264
Minimum:	1.000	1.000
Maximum:	7.000	7.000
Median:	4.000	4.000
Lower 95% CI:	3.674	3.287
Upper 95% CI:	4.068	3.782

Stats 02: Kruskal-Wallis Test (Nonparametric ANOVA) for hospitals using both paper and computer to keep patients records

The P value is 0.6206, considered not significant. Variation among column medians is not significantly greater than expected by chance. The P value is approximate (from chi-square distribution) because at least one column has two or more identical values.

Calculation detail

Group	Number of Points	Sum of Ranks	Mean of Ranks
Admin	475	202229	425.75
Doctors	102	45174	442.88
Nurses	245	106369	434.16
Pharmacy	42	19908	474.00

Kruskal-Wallis Statistic KW = 1.774 (corrected for ties). Post tests were not calculated because the P value was greater than 0.05.

Summary of Data

Group	Number of Points	Median	Minimum	Maximum
Admin	475	4.000	1.000	7.000
Doctors	102	4.000	1.000	7.000
Nurses	245	4.000	1.000	8.000
Pharmacy	42	4.000	1.000	7.000

Unpaired t test with Welch correction of the means of **Admin and Doctors**

P value

The two-tailed P value is 0.5320, considered not significant. Welch correction applied. This test does not assume equal variances.

Welch's approximate t = 0.6262 with 160 degrees of freedom.

95% confidence interval

Mean difference = 0.1321 (Mean of Doctors minus mean of Admin)

The 95% confidence interval of the difference: -0.2844 to 0.5485

Assumption test: Are the data sampled from Gaussian distributions? The t test assumes that the data are sampled from populations that follow Gaussian distributions. This assumption is tested using the method Kolmogorov and Smirnov:

Group	KS	P Value	Passed normality test?
Admin	0.1919	<0.0001	No
Doctors	0.2195	<0.0001	No

At least one column failed the normality test with P<0.05. Consider using a nonparametric test or transforming the data (i.e. converting to logarithms or reciprocals).

Summary of Data

Parameter:	Admin	Doctors
Mean:	3.476	3.608
# of points:	475	102
Std deviation:	2.123	1.889
Std error:	0.09741	0.1870
Minimum:	1.000	1.000
Maximum:	7.000	7.000
Median:	4.000	4.000
Lower 95% CI:	3.285	3.236
Upper 95% CI:	3.667	3.979

Unpaired t test with Welch correction for **Admin and Nurses**

P value

The two-tailed P value is 0.6397, considered not significant. Welch correction applied. This test does not assume equal variances. Welch's approximate t = 0.4684 with 520 degrees of freedom.

95% confidence interval

Mean difference = 0.07523 (Mean of Nurses minus mean of Admin)

The 95% confidence interval of the difference: -0.2403 to 0.3907

Assumption test: Are the data sampled from Gaussian distributions? The t test assumes that the data are sampled from populations that follow Gaussian distributions. This assumption is tested using the method Kolmogorov and Smirnov:

Group	KS	P Value	Passed normality test?
Admin	0.1919	<0.0001	No
Nurses	0.1848	<0.0001	No

At least one column failed the normality test with P<0.05. Consider using a nonparametric test or transforming the data (i.e. converting to logarithms or reciprocals).

Summary of Data

Parameter:	Admin	Nurses
Mean:	3.476	3.551
# of points:	475	245
Std deviation:	2.123	1.999
Std error:	0.09741	0.1277
Minimum:	1.000	1.000
Maximum:	7.000	8.000
Median:	4.000	4.000
Lower 95% CI:	3.285	3.301
Upper 95% CI:	3.667	3.801

Unpaired t test with Welch correction of means of **Admin and Pharmacy.**

P value

The two-tailed P value is 0.1524, considered not significant. Welch correction applied. This test does not assume equal variances. Welch's approximate t = 1.453 with 50 degrees of freedom.

95% confidence interval

Mean difference = 0.4528 (Mean of Pharmacy minus mean of Admin) The 95% confidence interval of the difference: -0.1729 to 1.078. Assumption test: Are the data sampled from Gaussian distributions? The t test assumes that the data are sampled from populations that follow Gaussian distributions. This assumption is tested using the method Kolmogorov and Smirnov:

Group	KS	P Value	Passed normality test?
Admin	0.1919	<0.0001	No
Pharmacy	0.1815	0.0013	No

At least one column failed the normality test with P<0.05. Consider using a nonparametric test or transforming the data (i.e. converting to logarithms or reciprocals).

Summary of Data

Parameter:	Admin	Pharmacy
Mean:	3.476	3.929
# of points:	475	42
Std deviation:	2.123	1.918
Std error:	0.09741	0.2959
Minimum:	1.000	1.000
Maximum:	7.000	7.000
Median:	4.000	4.000
Lower 95% CI:	3.285	3.331
Upper 95% CI:	3.667	4.526

Unpaired t test with Welch correction of **Doctors and Nurses.**

P value

The two-tailed P value is 0.8021, considered not significant. Welch correction applied. This test does not assume equal variances. Welch's approximate t = 0.2509 with 199 degrees of freedom.

95% confidence interval

Mean difference = -0.05682 (Mean of Nurses minus mean of Doctors) The 95% confidence interval of the difference: -0.5034 to 0.3897

Assumption test: Are the data sampled from Gaussian distributions? The t test assumes that the data are sampled from populations that follow Gaussian distributions. This assumption is tested using the method Kolmogorov and Smirnov:

Group	KS	P Value	Passed normality test?
Doctors	0.2195	<0.0001	No
Nurses	0.1848	<0.0001	No

At least one column failed the normality test with P<0.05. Consider using a nonparametric test or transforming the data (i.e. converting to logarithms or reciprocals).

Summary of Data

Parameter:	Doctors	Nurses
Mean:	3.608	3.551
# of points:	102	245
Std deviation:	1.889	1.999
Std error:	0.1870	0.1277
Minimum:	1.000	1.000

Maximum:	7.000	8.000
Median:	4.000	4.000
Lower 95% CI:	3.236	3.301
Upper 95% CI:	3.979	3.801

Stats 03: Kruskal-Wallis Test (Nonparametric ANOVA) on Infrastructure maintenance

The P value is < 0.0001, considered extremely significant. Variation among column medians is significantly greater than expected by chance. The P value is approximate (from chi-square distribution) because at least one column has two or more identical values.

Calculation detail

Group	Number of Points	Sum of Ranks	Mean of Ranks
Admin	205	47035	229.44
Doctors	102	41704	408.86
Nurses	243	81602	335.81
Pharmacists	42	14614	347.94
IT	27	6936.5	256.91

Kruskal-Wallis Statistic KW = 84.973 (corrected for ties)

Dunn's Multiple Comparisons Test

Mean Rank

Comparison	Difference	P value
Admin vs. Doctors	-179.42	*** P<0.001
Admin vs. Nurses	-106.37	*** P<0.001
Admin vs. Pharmacists	-118.50	*** P<0.001
Admin vs. IT	-27.471	ns P>0.05
Doctors vs. Nurses	73.047	** P<0.01
Doctors vs. Pharmacists	60.917	ns P>0.05
Doctors vs. IT	151.95	*** P<0.001
Nurses vs. Pharmacists	-12.130	ns P>0.05
Nurses vs. IT	78.903	ns P>0.05
Pharmacists vs. IT	91.033	ns P>0.05

Summary of Data

Group	Number of Points	Median	Minimum	Maximum
Admin	205	2.000	1.000	7.000
Doctors	102	5.000	1.000	7.000
Nurses	243	4.000	1.000	7.000
Pharmacists	42	4.000	1.000	7.000
IT	27	2.000	1.000	7.000

Mann-Whitney Test of Admin and Doctors on IT infrastructure

The two-tailed P value is < 0.0001, considered extremely significant. The P value is an estimate based on a normal approximation. The 'exact' method would not be exact, due to tied ranks.

Calculation details

Mann-Whitney U-statistic = 4408.0 and U' = 16502

Sum of ranks in Admin = 25523. Sum of ranks in Doctors = 21755.

Summary of Data

Parameter:	Admin	Doctors
Mean:	2.590	4.598
# of points:	205	102
Std deviation:	1.839	1.478
Std error:	0.1284	0.1463
Minimum:	1.000	1.000
Maximum:	7.000	7.000
Median:	2.000	5.000
Lower 95% CI:	2.339	4.307
Upper 95% CI:	2.842	4.889

Mann-Whitney Test of Admin and Nurses on IT infrastructure

The two-tailed P value is < 0.0001, considered extremely significant. The P value is an estimate based on a normal approximation. The 'exact' method would not be exact, due to tied ranks.

Calculation details

Mann-Whitney U-statistic = 16121 and U' = 33694

Sum of ranks in Admin = 37236. Sum of ranks in Nurses = 63340.

Summary of Data

Parameter:	Admin	Nurses
Mean:	2.590	3.782
# of points:	205	243
Std deviation:	1.839	1.776
Std error:	0.1284	0.1139
Minimum:	1.000	1.000
Maximum:	7.000	7.000
Median:	2.000	4.000
Lower 95% CI:	2.339	3.559
Upper 95% CI:	2.842	4.005

Mann-Whitney Test of Admin and Pharmacists on IT infrastructure

The two-tailed P value is < 0.0001, considered extremely significant. The P value is an estimate based on a normal approximation. The 'exact' method would not be exact, due to tied ranks.

Calculation details

Mann-Whitney U-statistic = 2679.5 and U' = 5930.5

Sum of ranks in Admin = 23795. Sum of ranks in Pharmacists = 6833.5.

Summary of Data

Parameter:	Admin	Pharmacists
Mean:	2.590	3.952
# of points:	205	42
Std deviation:	1.839	2.048
Std error:	0.1284	0.3160
Minimum:	1.000	1.000
Maximum:	7.000	7.000
Median:	2.000	4.000
Lower 95% CI:	2.339	3.314
Upper 95% CI:	2.842	4.591

Mann-Whitney Test of Admin and IT on IT infrastructure.

The two-tailed P value is 0.8587, considered not significant. The P value is an estimate based on a normal approximation. The 'exact' method would not be exact, due to tied ranks.

Calculation details

Mann-Whitney U-statistic = 2711.0 and U' = 2824.0

Sum of ranks in Admin = 23826. Sum of ranks in IT = 3202.0.

Summary of Data

Parameter:	Admin	IT

Mean:	2.590	2.963
# of points:	205	27
Std deviation:	1.839	2.328
Std error:	0.1284	0.4481
Minimum:	1.000	1.000
Maximum:	7.000	7.000
Median:	2.000	2.000
Lower 95% CI:	2.339	2.042
Upper 95% CI:	2.842	3.884

Mann-Whitney Test of Doctors and IT on IT infrastructure

The two-tailed P value is 0.0007, considered extremely significant. The P value is an estimate based on a normal approximation. The 'exact' method would not be exact, due to tied ranks.

Calculation details

Mann-Whitney U-statistic = 806.00 and U' = 1948.0

Sum of ranks in Doctors = 7201.0. Sum of ranks in IT = 1184.0.

Summary of Data

Parameter:	Doctors	IT
Mean:	4.598	2.963
# of points:	102	27
Std deviation:	1.478	2.328
Std error:	0.1463	0.4481
Minimum:	1.000	1.000

Maximum:	7.000	7.000
Median:	5.000	2.000
Lower 95% CI:	4.307	2.042
Upper 95% CI:	4.889	3.884

Mann-Whitney Test of Nurses and IT on IT infrastructure

The two-tailed P value is 0.0434, considered significant. The P value is an estimate based on a normal approximation. The 'exact' method would not be exact, due to tied ranks.

Calculation details

Mann-Whitney U-statistic = 2518.5 and U' = 4042.5

Sum of ranks in Nurses = 33689. Sum of ranks in IT = 2896.5.

Summary of Data

Parameter:	Nurses	IT
Mean:	3.782	2.963
# of points:	243	27
Std deviation:	1.776	2.328
Std error:	0.1139	0.4481
Minimum:	1.000	1.000
Maximum:	7.000	7.000
Median:	4.000	2.000
Lower 95% CI:	3.559	2.042
Upper 95% CI:	4.005	3.884

Mann-Whitney Test of Pharmacists and IT on IT infrastructure

The two-tailed P value is 0.0499, considered significant. The P value is an estimate based on a normal approximation. The 'exact' method would not be exact, due to tied ranks.

Calculation details

Mann-Whitney U-statistic = 410.00 and U' = 724.00

Sum of ranks in Pharmacists = 1627.0. Sum of ranks in IT = 788.00.

Summary of Data

Parameter:	Pharmacists	IT
Mean:	3.952	2.963
# of points:	42	27
Std deviation:	2.048	2.328
Std error:	0.3160	0.4481
Minimum:	1.000	1.000
Maximum:	7.000	7.000
Median:	4.000	2.000
Lower 95% CI:	3.314	2.042
Upper 95% CI:	4.591	3.884

CHAPTER 11

11. LIST OF PUBLICATIONS BASED ON THE THESIS

Seahloli, MS. (2015) Challenges encountered when applying for the ethics and permission to conduct the non-clinical trial study in the hospitals and clinic. South American Journal of Clinical Research. 2(1): 1-14. http://www.eijasr.com/index.php/Clinical-Research/article/viewFile/215/198

Seahloli MS, S Kannan, Demana P. (2015). Current status and potential of South African hospitals to implement research to overcome health challenges, archive international health goals and increase capacity of clinicians and nurses. South American Journal of Clinical Research 2(2): 1-11