ADOPTION OF CLOUD COMPUTING BY THE SOUTH AFRICAN PUBLIC SECTOR

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DECLARATION

I, *Judian Govender, 211215503,* hereby declare that this treatise for Master in Business Administration (MBA) is my own work and that it has not previously been submitted for assessment or completion of any postgraduate qualification to another University or for another qualification (Refer to Appendix II for the signed declaration).

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Jai Guru Dev

ABSTRACT

Technology enables progress for individuals and organisations; however, adopting technology may not always be simple. Cloud computing technology has revolutionised how one consumes IT. Governments too can leverage the advantages of adopting cloud computing. A review of the literature reveals a gap in research on the adoption of cloud computing by the South African public sector. Limited research has been done on the topic of cloud computing and none of them are from a quantitative perspective. This study set out to answer the question, “What is the extent (current state, benefits, barriers and readiness levels) of the adoption of cloud computing by the South Africa public sector?” The study is of much value to the public sector of South Africa and other countries and organisations wanting to understand what to consider when adopting cloud computing.

The study used a survey research strategy that was exploratory in nature. The sample comprised government CIO’s and government Senior IT management. Questionnaires were sent via a web link and 51 responses were completed. The results revealed that more than half of the South African public sector has adopted cloud computing; however there is a lack of visibility of government initiatives that promote cloud computing. The study shows that public organisations that have adopted cloud computing significantly perceive more benefits of cloud computing than organisations that are yet to adopt. The Technology Organisation Environment (TOE) framework tested the barriers to adoption, revealing areas of concern that are limiting successful cloud computing adoption and adoption rates. The study uncovers a timeline for further cloud computing adoption in the South African public sector.

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LIST OF ACRONYMS AND ABBREVIATIONS

CIO	Chief Information Officer
DOI	Department of Information
G2B	Government to businesses
G2C	Government to citizens
G2G	Government to governments
GSA	General Service Administration
HHS	Health and Human Services
IaaS	Infrastructure as a Service
ICT	Information and Communication Technology
IDC	International Data Corporation
IoT	Internet of Things
IT	Information Technology
LE	Large-sized Enterprise
NASA	National Aeronautics and Space Administration
NIST	National Institute of Standards and Technology
NMMU	Nelson Mandela Metropolitan University
PaaS	Platform as a Service
SaaS	Software as a Service
SLA	Service Level Agreement
SME	Small and Medium-sized Enterprise
SOA	Service Orientated Architecture
TSC	Thusong Service Centers
UNESCO	United Nations Educational, Scientific and Cultural Organisation

CHAPTER 1

INTRODUCTION TO THE RESEARCH

1.1 BACKGROUND TO THE STUDY

Cloud computing has redefined the computing paradigm by providing dynamically scalable resources on demand over the internet (cloud). These resources are a combination of SOA (service oriented architecture) and virtualisation techniques (Papazoglou, 2003). Garrison, Kim and Wakefield (2012) argue that organisations can focus on their core business activities since they would not have to worry about maintaining the IT infrastructure (Garrison et al. 2012). Berman, Kesterson-Townes, Marshall and Srivathsa (2012) assert that by using cloud computing, the requirements for infrastructure investments are taken out of the picture so that it changes the competitive landscape by giving a chance for companies that have innovative ideas but no capital to invest, to deploy their software and succeed (Berman et al., 2012).

Marston, Li, Bandyopadhyay, Zhang and Ghalsasi (2011) claim that cloud computing is a disruptive way in which public sector enterprises can consume data, communicate and how they deploy and deliver services to their constituents. Governments are eager to adopt the cloud; however, (King, McKean and Lee, 2011) worldwide survey stated that the penetration of cloud computing in the public sector is at 23% compared to 42% in the private sector. A follow-up survey in 2012 found that only 12% of the respondents had spent more than 10% of the total IT resources on cloud services (Baldwin, 2012). According to a 2015 survey report, 93% of the respondents are using cloud

computing out of which only 11% is from the public sector (Weins, 2015). Feuerlicht and Margaris (2012), in their comparative study about cloud adoption in Australia and Czechoslovakia, reported that the primary reason for cloud adoption is the improved support for business processes rather than cost savings. Australia ranked second amongst the countries that support growth of cloud computing (Business Software Aliabce, 2012; Feuerlicht and Margaris, 2012).

Jangra and Bala (2011) argue that cloud computing is an enabler for many different services due to its dynamic scaling capability, pay-per-use business model, the virtualisation it offers and the various business models available. These models include infrastructure as a service (IaaS), Software as a service (SaaS), and Platform as a Service (PaaS). Cloud computing is best suited for disaster recovery and device and location independence. Business agility is more or less infinitely scalable with cloud computing and it results in less capital expenditure (Jangra and Bala, 2011). Adopting cloud computing reduces the chances for over-provisioning, under-provisioning and under-utilisation of resources (Sahu and Tiwari, 2012). Adam and Musah (2015) argue that the situation in the developed world is better than the developing world as far as the adoption of cloud computing by Small and Medium Enterprises (SMEs) is concerned. Sultan (2011) argues that the developing world is not yet taking full advantage of adopting cloud computing to catch up with the developed world. In Africa, India, China, and Taiwan innovations brought about by cloud adoption are the leading reasons for economical and societal changes. (Chang et al., 2012; Kshetri, 2012, 2013; Lee and Yen, 2012; Lian, Yen and Wang, 2014) Cloud adoption gives developing countries a level playing field with respect to

applications, IT infrastructure and data centres so that they can compete (Kshetri, 2010).

A study of adoption of cloud computing in the government in the United States (US), United Kingdom (UK), and Asia shows that the US has adopted cloud computing to some extent in several government divisions. These divisions are the general service administration (GSA) (Weigelt, 2009), the National Aeronautics and Space Administration (NASA) (Phillips, 2015), the Department of Information (DOI), the US department of health and human services (HHS) the census bureau and the white house (Metheny, 2013). The UK has embarked on Digital Britain (G-cloud) as a strategic priority (Suffolk, 2009). Cloud computing efforts are taking place in Sweden, France, and Spain (Petrov, 2009). Wyld (2010) specifies that Denmark has started a pilot effort, Japan is undertaking the "Kasumigaseki Cloud" effort, China has an IBM developed cloud computing initiative, Thailand is undertaking the establishment of private cloud and Vietnam is collaborating with IBM for its cloud computing services and New Zealand started consolidating all its cloud efforts since 2009. Kshetri (2010) reported on cloud adoption in sub-Saharan Africa and found that the University of Pretoria uses cloud computing for Medical research. The Higher Education Alliance for Leadership through Health imparts education with the help of the cloud in Kenya, the Democratic Republic of Congo, Uganda, Tanzania and Ethiopia. South Africa's Center for Higher Education Transformation uses a Google cloud platform. In South Africa, Mothers-2-Mothers (M2M) uses cloud for spreading HIV/AIDS awareness in nine African countries. Through the use of cloud computing Green Dreams' iCow tracks fertility cycles in the Agriculture area. MPesa was launched by Safaricom for

mobile money transfer and the United Nations Educational, Scientific and Cultural Organisation (UNESCO) has taken up a project for checking pollution that uses cloud computing (Kshetri, 2013).

The scenario in South Africa (SA), according to Schofield and Abrahams (2015) is that the adoption of cloud is extensive at the informational level. Departments such as basic education, health, science and technology, and government, which share information to the public, have shown interest in adopting cloud. There is still a need for further improvements in the area of e-education, e-health, and sharing business processes across governmental departments, which require extensive data sharing and hosting (Schofield and Abrahams, 2015).

A complicating factor that makes these studies confusing is that the definition of cloud varies with each study. Although all the authors seem to agree on the various models of cloud computing, their definition of cloud computing could vary from simple data storage in the cloud to very complicated SaaS applications and an architecture which serves multiple customers with a single instance of a software (multitenancy). There have not been many quantitative studies or qualitative studies done for cloud adoption in Africa and specifically in South Africa. There is a lack of research on the level of cloud adoption, what the public sector in South Africa perceives they will gain by migrating to cloud, and the obstacles, if any, that are holding up cloud adoption in South Africa. There are also no comprehensive studies on the readiness of the public sector in South Africa to adopt cloud computing.

1.2 PROBLEM STATEMENT

From the preliminary look at the literature, it is evident that a third world country can leapfrog traditional economic development cycles by successfully adopting a public sector cloud computing strategy. There is much South Africa can learn from other countries who have successfully adopted cloud computing in the public sector; however, there are challenges that may be unique to Africa and South Africa. The South African public sector was unsuccessful in their government wide open-source adoption strategy. All the reviewed research on public sector technology adoption in South Africa has been limited to interview based qualitative studies on a few public sector organisations within specific provincial regions. There is a gap in research that empirically investigates the adoption of cloud computing in the South African public sector.

1.3 RESEARCH AIMS AND OBJECTIVES

The primary objective (PRO) of this study is to determine the extent (current state, benefits, barriers and readiness levels) of the adoption of cloud computing by the South African public sector.

The primary research question (PRQ) of the study is “What is the extent (current state, benefits, barriers and readiness levels) of the adoption of cloud computing by the South African public sector?”

The secondary research objectives (SRO) and questions (SRQ) arising from the primary objective are shown in Table 1.1.

Table 1-1 Secondary research objectives and questions

Secondary Research Objectives	Secondary Research Questions
• To establish the extent of adoption of cloud computing by the South African public sector (SRO1).	• What is the extent of adoption of cloud computing by the South African public sector (SRQ1)?
• To establish the benefits of cloud computing as perceived by South African public sector agencies (SRO2).	• What are the benefits of cloud computing as perceived by South African public sector agencies (SRQ2)?
• To determine the technical, organisational and environmental (TOE) challenges faced by the South African public sector in adopting cloud computing (SRO3).	• What is the extent of technical, organisational and environment (TOE) barriers to cloud adoption faced by the South African public sector? (SRQ3)?
• To determine the readiness of the South African public sector to adopt cloud computing by assessing relevant readiness factors (SRO4).	• What is the level of readiness of the South African public sector to adopt cloud computing (SRQ4)?

1.4 RESEARCH METHODOLOGY

The aim of this study is to improve the knowledge and understanding of cloud computing to facilitate economic and social change. In this study, a mixed methodology will be utilised. Both qualitative and quantitative strategies will be

utilised. The study will perform a literature review and adopt a survey research strategy to answer some of the research questions. The scope of the survey will be limited to the public sector of South Africa. The data will be collected via an on-line questionnaire. The questionnaire will be a structured one with explanations to ensure all participants clearly understand the research.

1.4.1 Research Design Objectives

The research design objectives of this study are:

- To conduct a secondary literature review on cloud computing, cloud computing and innovation adoption in the public sector.
- Based on the literature review, to design a theoretical model;
- Based on the theoretical model, to create a questionnaire that will be used to answer the research questions;
- To submit the questionnaire to the statisticians to comment on its validity;
- To get ethics clearance for the questionnaire from Nelson Mandela Metropolitan University (NMMU) ethics committee;
- To collect data by sending a web link to the questionnaire to public sector line managers involved in IT;
- To capture and analyse the data on MS Excel software; SPSS; Statistica and Survey monkey
- To interpret the findings and make conclusions; and
- To highlight potential areas for further research.

1.4.2 The Sample

The research will evaluate the organisational cloud computing positioning of South African Government (public sector) agencies, on national, provincial and local levels. The research aims to achieve this by means of an online questionnaire administered to a minimum of 40 government senior IT leaders and decision makers of government departments or agencies. An initial email and a follow up with the research link will be sent through to the official government Chief Information Officer (CIO) contact list. In addition willing software vendors will invite their public sector customers to participate in the research by forwarding the research email and questionnaire link to their public sector customer contact list.

1.4.3 The Measuring Instrument and Data Analysis

The derived research instrument is an online questionnaire. The questionnaire will contain five sections and comprise of Section A: Demographic and organisational information; Section B: Adoption of cloud computing, Section C Benefits of cloud computing, Section D: Adoption challenges to cloud computing and Section E Readiness factors to adopting cloud computing. The questions will consist of a few open-ended and mostly closed-ended questions. The closed-ended questions include five point and three point Likert scale questions, along with true/false questions. The open-ended questions will supplement the closed-ended questions and will gather additional qualitative data to enhance the research. In order to understand the data, present the findings and resolve the posed research questions, the researcher will use academic theory.

1.5 OUTLINE OF THE STUDY

The study is divided into the following chapters.

- Chapter 1 will outline the scope of the study, the problem statement, the objective of the study, the research questions and methodology;
- In Chapter 2 a review of existing literature on the research objectives will be presented;
- In Chapter 3 the research methodology will be discussed;
- In Chapter 4 the data will be analysed; and
- In Chapter 5 the empirical results of the study will be interpreted, summarised and the managerial implications discussed. Recommendations for future research arising from these results will also be presented.

The link between chapters, research questions and objectives, and deliverables for each chapter are as shown in Table 1.2

Table 1-2 Summary of chapters, deliverables and link to research objectives

Chapter	Research Objectives	Chapter Deliverables
Chapter 1		Problem statement and definition
Chapter 2	SRO1	Understanding of cloud computing (general overview)
	SRO2	Benefits and challenges of cloud computing
	SRO3	Cloud computing in the public sector (globally)
	SRO4	Cloud computing in the South African public sector
Chapter 3		Research design and research strategies
		Sampling method and research instrument
Chapter 4	SRO1	Adoption of cloud computing
	SRO2	Perceived advantages of cloud computing by South African public
	SRO3	Technical, organisational and environmental challenges of cloud computing in South Africa PS
	SRO4	Readiness of the South African public sector to adopt cloud computing
Chapter 5		Research conclusions and recommendations

CHAPTER 2
LITERATURE REVIEW

2.1 INTRODUCTION

Cloud computing is large-scale delivery of services as a utility, using remote servers and shared resources to store and process data rather than local servers so as to obviate the necessity of owning and maintaining the computing infrastructure (Cai, Zhang, Wang, Li, Sun and Mao, 2009). Recent developments resulting in affordable pricing models in cloud computing such as pay-per-use have brought about the growth of the adoption of cloud computing in organisations and a reduction in the cost of IT adoption. Organisations can now buy services that they need to ensure best results. For government adoption of cloud computing, however, there are issues such as risk mitigation and security (Dhiman, 2011). Other issues that need to be resolved relate to the satisfaction of legal and regulatory obligations such as multi-tenancy and offshore data hosting. Multi-tenancy regulations disallow multiple organisations data hosted on the same server, which is accessed by multiple organisations, limiting gains in hardware efficiencies. Offshore data hosting regulations prevents any government data to be hosted outside the country of origin (Mvelase, Dlamini, Sithole and Dlodlo, 2013).

Now that cloud computing is defined and the context has been set, this study will review the published literature to establish the current state of cloud computing in the South African public sector (PRQ). This chapter will provide a theoretical review of cloud computing, the current state of cloud computing by the public sector, the level of adoption of cloud computing by the public sector,

the benefits, barriers and level of readiness to adopt cloud computing by the public sector.

2.2 CLOUD COMPUTING OVERVIEW

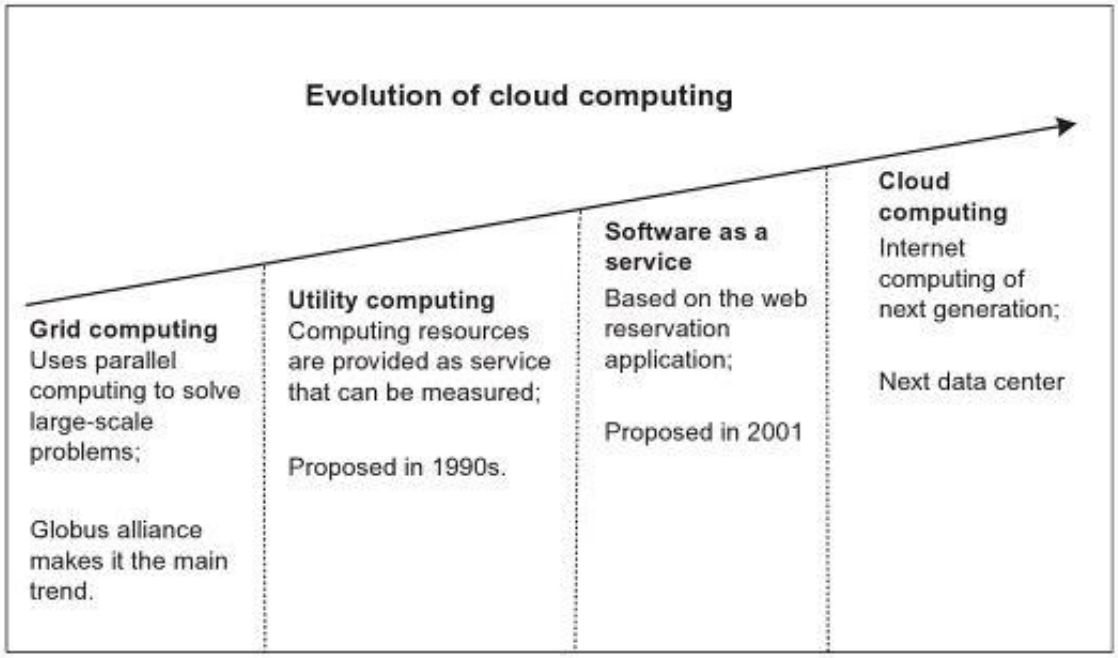
The motivation for this literature review is to investigate what contemporary literature has to offer about how cloud computing has proliferated in the public sector particularly in South Africa and to determine what the various barriers are, if any, to its adoption. The IEEE Computer Society defines cloud computing as: "A paradigm in which information is constantly stored in servers on the internet and cached temporarily on clients that include desktops, entertainment centres, computers, notebooks, handhelds and so forth". Mell (2011) defines the cloud as a large scale distributed computing paradigm where a pool of virtualised, scalable, and manageable storage, computing power, platforms and services can be provisioned on-demand to customers via the Internet. The common and widely accepted definition for cloud computing is provided by the US National Institute for Standards and Technology (NIST), who defines cloud computing as a model for providing ubiquitous, adequate and on-demand access to shared and configurable computing resources (for example servers, networks, storage, applications and services) with minimal effort and service provider interaction.

Historically, cloud computing has evolved from grid computing to utility computing and then to SaaS and finally cloud computing (Figure 2.1). Mohammed and Ibrahim (2014) in their study, try to differentiate between the terms cloud computing, grid computing and utility computing. In a grid computing environment, the workload is distributed or transferred to nodes with

needed computing resources. Usually chains of nodes, such as servers, are networked to form the grid. These nodes are typically clustered and are kept ready to handle the distributed workload. Grid computing enables parallel computing (a communication type where several calculations run simultaneously), although it's utility is best suited for large workloads. The emergence of virtualisation technology of storage, servers, and networks allows organisations to offer an on-demand, metered service similar to a public utility, hence the term utility computing. The main benefit of utility computing is capital and operational cost savings. Most datacentres have underutilised servers, storage networks and storage, due to over provisioning to handle peak workload, sudden spike and projected growth (Garfinkel and Abelson, 1999). Utility computing introduces '*pay only for what you use*' models, allowing organisations to hire computing resources when required.

Cloud computing has borrowed many concepts from grid computing; however, in cloud computing resources can be dynamically allocated or upgraded, even at a more granular level based on workload demand. Additionally, cloud computing can be developed with non-grid environments, such as a three-tier web architecture running traditional or Web 2.0 applications. The backbone of cloud computing is utility computing; however, it offers a wider picture. Utility computing can be applied internally to an organisation to build its own cloud infrastructure. It is the next generation of computing after the mainframe, personal computer, client-server computing and the web.

Figure 2.1 Evolution of cloud computing



Some of the main characteristics of cloud computing are:

- *User-centric design* - a design framework whereby the end users wants, needs and limitation are given predominant attention (Mohammed and Ibrahim, 2015);
- *Quality of service* (QoS) - a guarantee of an overall service performance level by managing priorities of different users, applications and data flows (Wang et al., 2008);
- *Virtualisation* - creating a virtual rather than actual instance of a device or resource such as a network, server, storage device or operating system (Cwele, 2014);
- *High reliability* - improving system stability through active management and redundancy thereby ensuring the reliability of customer data and application platforms (Macias and Thomas, 2011);

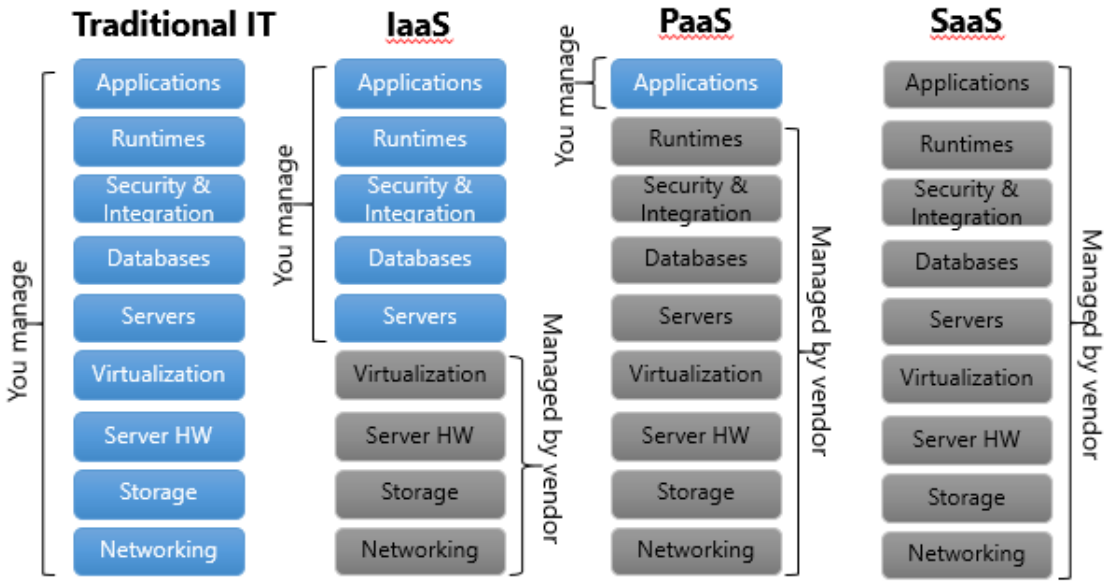
- *Extendibility* - a cloud computing systems design that incorporates mechanism for system expansion and enhancement without having to uproot the systems infrastructure (Zhang, Zhang, Chen and Huo, 2010);
- *Ease of implementation and ease of maintenance* - these are based on the design elegance and standardisation of code. It would be easier to write a patch for a modularised system with available source code that runs in isolation than it would be to patch spaghetti code – non standardised code with no clear modules (Keesookpun and Mitomo, 2012); and
- *Efficient use of resources* - maximising system resources utilisation through optimized cloud computing software and hardware architecture and management, for example smarter cluster management, smarter server management and smarter hardware management (Jadeja and Modi, 2012).

Mell (2011) mentions the following NIST standards as the five characteristics of cloud computing:

- Broad Network Access or ubiquitous availability;
- On-demand Self-service or as needed availability of services;
- Resource pooling or pooled resources are allocated as per need;
- Measured service or optimising resources by assigning them in measured quantities and
- Rapid elasticity or high scalability.

Busch et al. (2014) state that the three service delivery models for cloud computing are Infrastructure as a service (IaaS), Platform as a service (PaaS), and Software as a service (SaaS). IaaS, as the name suggests provides the infrastructure such as the virtual data centre and the customer is responsible for providing the software assets used PaaS is a superset of IaaS and provides the hardware as well as the operating systems, databases, storage, support and development environment. SaaS sits on top of IaaS and Paas, making the application easy to scale quickly without the customer having to expend too many resources. Figure 2.2 depicts the different service delivery models, the layers contained within each models' stack and indicates if that part of the stack is managed in-house by the adopting organisation or if that portion is managed by the outsourced cloud computing vendor.

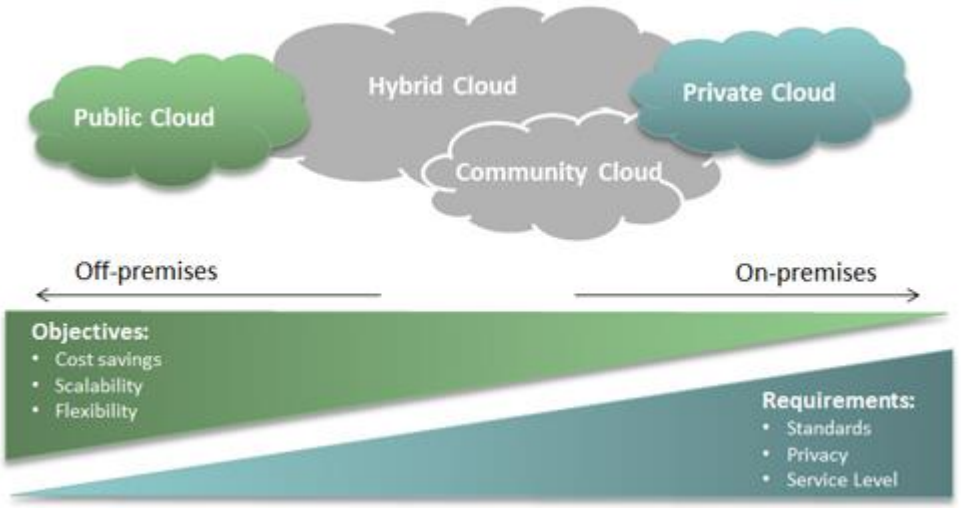
Figure 2.2 Service delivery models (Chou, 2010)



There are four possible deployment models in cloud computing (Figure 2.3), namely.:

- *Private cloud* - provisioned by an organisation for its exclusive use;
- *Community cloud* - provisioned for exclusive use of a community;
- *Public cloud* - provisioned for use by the public, and
- *Hybrid cloud* - an amalgamation of two or more of the earlier deployment models, bound together by standardised or proprietary technology.

Figure 2.3 Deployment models of cloud computing (Ubiry, 2013)



The problems with cloud computing faced by service providers are:

- Ensuring high data availability (Khajeh-Hosseini, Greenwood, Smith and Sommerville, 2012);
- Ensuring high standards of data privacy and security, similar to what the customer can provide for in-house data (Zhang, Cheng and Boutaba, 2010);

- Addressing the lack of standards for interfaces between different cloud service providers making it difficult to migrate from one provider to another (Marston et al., 2011);
- Resolving the issues in situations where different customers have data on the same servers due to multi-tenancy and segregating them when one customer faces cyber-attacks is a challenge (Cloud Security Aliance, 2011);
- Resolving the lack of control on the data as the data is hosted on third party servers (Leavitt, 2009; Miller, 2008).

Trivedi (2013) researched cloud computing in many industries and governments of India, USA and Singapore and proposed various models for cloud computing adoption in government or large enterprises. These models are based on factors such as the need for capabilities, how they are placed in the cloud adoption spectrum and how long it will take to go to cloud.

Goldsmith (2014), in his article about cloud computing trends (in Govtech.com), proposes an interesting theory about how cloud computing changes things for cities. This change is due to its ubiquitous proliferation and cost effective pay-per-use models, bringing parity between small and large cities. Both get equal, on-demand access to computing resources thus hastening their move to the cloud. He proposes that government should push itself as a platform rather than a vendor of solutions (Goldsmith, 2014). The move by government to be a platform may not be the right move, as most governments' bureaucracy will hinder the growth of this.

2.3 CURRENT STATE OF CLOUD COMPUTING IN THE SOUTH AFRICAN PUBLIC SECTOR

Maluleka and Ruxwana (2013) compare cloud adoption in South African government institutions with the adoption of Open Source Software (OSS). The adoption of OSS was hampered by user resistance, support and funding and as a result the expected cost savings were not realised. The study aimed to determineif cloud adoption in the South African government yielded cost savings or if there were any obstacles to that. The findings were that cloud computing was indeed cost effective and efficient and hence the study recommended cloud usage adoption for the South African public sector (Maluleka and Ruxwana, 2013). The Maluleka and Ruxwana (2013) study compared the adoption of cloud computing as an alternative to OSS adoption by considering the cost implications only and does not address other issues such as security, privacy, legal and regulatory issues.

Industry 4.0 is also referred to as the internet of things (IoT) and is where everything is digitised, sensors are everywhere and high-speed mobile connectivity as well cloud computing is harnessed. South Africa is not burdened by legacy software and therefore can move directly to Industry 4.0 (Gupta, 2015).

To compare the current state of cloud computing in other countries, this study investigates other literature, in order to set the baseline. Busch et al. (2014) performed a survey in Australia, and the findings revealed that most respondents (43%) were aware of cloud computing and only a few (7%) indicated non-familiarity. Only a few (10%) admitted to being subject matter

experts and 90% of them wanted to use cloud computing in their organisation and the majority (72%) of them do not see the adoption of cloud computing as a threat to their jobs. The majority of respondents (62%) preferred to use government cloud so that it mitigates the potential security risks by locally hosting a private cloud for exclusive use by the public sector. This survey carried out by (Busch et al., 2014) to determine the intent of the agencies of the government of Australia to adopt cloud computing, can help to determine a baseline for this study. However, the survey does not actually measure the adoption of cloud computing, the issues faced, the experiences (whether positive or negative), and any lessons learnt by the government agencies (Busch et al., 2014). Therefore, further research in this field is warranted.

Mutula and Mostert (2010) have researched the opportunities and challenges in implementing e-governance in South Africa. The study aims at the implementation of cloud computing in e-governance and poverty alleviation programs such as reconstruction and development programs (RDP), the Municipal Public-private Partnership pilot Program (MPPP), Black Economic Empowerment (BEE) and so on. The South African government has made rapid strides in formulating policy and regulatory frameworks for information handling. The study states that there has been an improvement in infrastructure such as undersea cabling (by SEACOM), proliferation of telecommunications (mobile), availability of internet and multipurpose community centres such as Internet centres and village knowledge centres are enabling factors for increased adoption of cloud computing. The study enumerates the problems and challenges facing South Africa in adopting cloud computing which are poverty, corruption, illiteracy and the skills shortage to name a few. There are still

infrastructure issues due to which reliable electricity supply is not guaranteed (Mbeki, 2008). The study lists a number of failures and successes of e-governance initiatives in South Africa. The introduction of IT into the National Welfare Agency (manages pension funds and worker's compensation) failed partially whilst the e-procurement systems developed by the Independent Electoral Commission was a success (Heeks, 2008). The study concludes that the investments made by the South African government in administering service delivery through e-governance using cloud computing were not successful due to lack of monitoring and evaluating systems in place (Mutula and Mostert 2010). The paper does not talk about the causes for the failure of the e-Governance applications, if they were due to failure of the policies or infrastructure or lack of intent.

2.4 LEVEL OF ADOPTION OF CLOUD COMPUTING BY THE SOUTH AFRICAN PUBLIC SECTOR

A Gigaom/North Bridge survey of 1,358 respondents (users and vendors) in 2014 revealed the following findings (Skok, 2014):

- Nearly half (49%) of the new businesses use cloud computing for revenue generation or product development;
- Thirty five percent (35%) felt cloud computing gave a competitive advantage to their business;
- Forty five (45%) are either already running their business in the cloud or want to

- SaaS had grown from 13% in 2011 to 72% in 2014; and
- Nearly three quarters (65 – 70%) of the respondents plan to move to cloud computing in the next year or two.

The significance of the survey findings are that respondents all showed an increased interest in moving to the cloud computing.

Schofield and Abrahams (2015) of the Johannesburg centre for software and the LINK centre at Wits University, did research to evaluate the enablers, constraints and other factors influencing the decisions to go for cloud computing. They state that those government departments planning to utilise cloud computing should be aware of the issues some of which are ownership of information, handling personal data (Hon, Millard and Walden, 2011), protecting the consumer (Reed, 2010), and government policy (Gillwald and Moyo, 2015). The government must remove unnecessary regulatory and legal barriers and encourage development of open standards to spur adoption of cloud computing. The public expects government information to be freely available at low or no cost (Dilmegani, Korkmaz and Lundqvist, 2014).

In South Africa, the national and provincial departments of basic education, health, municipalities, trade and industry are some of the departments that have their information available in the cloud for dissemination to the public, which does not require extensive hosting capabilities, as the data is not large. Thusong Service Centers (TSC) is a South African government programme that was initiated in 1999 as a primary vehicle for the implementation of development communication and information, to integrate government services into primarily-rural communities. The authors propose that services such as

TSC, its various interfacing agencies, and the State Information Technology Agency (SITA) could benefit by the establishment of a private government cloud environment. Schofield and Abrahams (2015) also note that South Africa has achieved success in implementing cloud services in the South African Revenue Services (SARS) and home affairs due to their implementation with little or no links to other departments. Fragmentation of departments and lack of oversight on budget spending for projects that span the different departments are preventing the government from building a private government cloud (Schofield and Abrahams, 2015). The new broadband policy, which formulates the new e-strategy for internet based applications for agriculture, rural development, health and other public services is in the formulation stage and is stated to be ready to achieve 70% of all such services to be e-enabled by 2019 (Department of Communications, 2013).

A green paper has been published which discusses innovation, applications utilising cloud computing, bring your own device (BYOD), and IT security (Department of Communications, 2014). The paper has invited comments, which is the next step in finalising the green paper (Cwele, 2014). This green paper does not preclude any government department in using cloud computing. The Gauteng education department already uses Dropbox and Moodle to deliver educational material to students (Millard, 2013).

The E-education green paper of South Africa 2004 promotes digitisation of education using Information and Communication Technology (ICT). This proposes provision of cheap internet to schools which has been given a stature of legal obligation so that broadband providers have to provide subsidised

broadband to educational institutions (Department of Communication, 2013). An E-Health policy has been formulated to ensure patient information protection and development of reusable information systems (Department of Health, 2012). According to the Department of Communication (2013) Minimum information security standards 1996, definition 4 are already available as the information security policy for the government of South Africa. The SITA act of 1988 provides the establishment of a centralised agency to provide ICT services for government departments. The Independent Communications Authority of South Africa (ICASA) Act 13 provides legislation for regulatory reforms for licensing telecom operators whilst ECTA 25 deals with issues of cybercrime. Various other acts, amendments and international treaties signed and ratified by South Africa help with the regulatory framework for implementation of ICT as a whole and cloud computing in particular. The Schofield and Abrahams (2015) paper is the most comprehensive study on cloud computing in South Africa that has been published to date.

2.5 BENEFITS OF CLOUD COMPUTING AS PERCIEVED BY THE SOUTH AFRICAN PUBLIC SECTOR

A study to find the impact of using cloud to deliver public services in South Africa was conducted (Mvelase et al., 2014). It focuses on a pay-as-you-go model and its application to the area of education, as it is the focus of the provincial and national governments of South Africa. The ICT4RED project was launched in the Eastern Cape Province as a proof of concept for adopting cloud computing to deliver government services. The ICT4Red project applied a

future-oriented, exploratory and qualitative action research methodology. The findings are that the cost of IT is reduced, no license costs are incurred, unlimited scalability, re-usable services are provided and e-governance applications can enforce security policies well. The Mvelase et al. (2014) study partially addressed the secondary question regarding the benefits of cloud computing as perceived by the South African public sector; however, this study was qualitative in nature with limited responses from a few public organisations. Mvelase et al. (2014) focus on interoperability between the various departments while developing a government-public cloud model. Three phases for this development are proposed:

- Phase 1 - Investigating countries that are using cloud for their government services and adapt the design for the South African perspective;
- Phase 2 - Present the design and implementation plan for the Government cloud model; and
- Phase 3 - Will present the plan for monitoring and assessing the impact of the plan implementation.

Mvelase et al. (2014) believe that that businesses and organisations in South Africa are interested in adopting this model due to the cost effectiveness in developing and maintaining applications. Data storage and IT infrastructure is maintained by third parties and near instant scalability is provided. Due to the pay-as-you-go model, this level of elasticity comes at a very affordable cost. Therefore, there is no necessity to spend money on IT infrastructure and not much capex planning is required. While Mvelase et al. (2014) wholeheartedly

agree that SMEs can definitely benefit by cloud computing, government agencies, list a number of reasons for and against the move to cloud:

- Reduce IT labour costs;
- Reduces license costs;
- Provides scalability;
- Architecture built on Service Oriented Architecture (SOA);
- Unlimited storage, CPU capacity, and bandwidth;
- Designers can focus on features and forget about hardware;
- E-governance projects may face data outburst, cloud computing handles this better while preserving QoS;
- Disaster recovery can be easily handled; and
- Integration between various applications of various departments is easy.

Nasr and Galal-Edeen (2012) propose 15 models of e-governance maturity models after studying the various implementations in the world. They use five countries as a reference for the implementation of a cloud infrastructure. Mvelase et al. (2013) propose a model for cloud computing in South Africa, which includes methods of managing the stakeholders. The stakeholders are:

- Cloud consumers (G2C, G2B, G2G);
- Cloud providers (National, Provincial, Local);

- Cloud management which governs the entire landscape; and
- Cloud auditors, which independently assess the cloud services, security and data privacy.

The effectiveness of the Nasr and Galal-Edeen (2012) model was not tested. There is also no evidence that this model is suited for a South African context as it has not been accepted by a South African governing body, or other renowned body. It is also not possible to know if this model is practical or efficient. Table 2.1 summarises the benefits of cloud computing as supported by various studies.

Table 2-1 Benefits of cloud computing

Benefits of cloud computing	Reference
Reduces upfront costs	Mvelase et al. (2013)
Helps the organisation to be more flexible	Mvelase et al. (2014)
Allows the organisation to better focus on its core business	Nasr and Galal-Edeen (2012)
Is easier to implement than traditional on-premise technology	Nasr and Galal-Edeen (2012)
Increases staff mobility through remote and mobile information access	Mvelase et al. (2013)
Provides improved scalability of hardware according to demand	Gupta (2015)
Provides improved scalability of software according to demand	Gupta (2015)
Helps the organisation to react more quickly to market conditions and competition	Skok (2014)
Facilitates access to the latest technologies	Gupta (2015)
Improves collaboration between different department, agencies, suppliers and citizens	Schofield and Abrahams (2015)
Improves sustainability by reducing carbon footprint through efficient economies of scale	Lin and Chen (2012)
Embracing cloud computing would make our organisation more effective and efficient ultimately leading to better service delivery	Lin and Chen (2012)

2.6 BARRIERS TO CLOUD ADOPTION FACED BY THE SOUTH AFRICAN PUBLIC SECTOR

Cruz (2012) reported that many companies that tried to establish datacentres in South Africa incurred heavy losses due to the perennial problem of electric grid outages. These electric grid outages is an opportunity for companies to pursue the cloud computing route, especially for delivering services through mobile applications, as there are five times as many mobile users as there are internet users. The cost of broadband internet is high in South Africa (Wyld, 2010) but coming down slowly from the exorbitant highs of 2001 and the electric grid is lacking in capacity as well as reliability resulting in companies wary of building datacentres in South Africa. This has spurred the success of mobile applications such as M-Pesa, which has very high usage statistics. The mobile internet bandwidth is not a problem for deploying as it is easier and since mobiles can be recharged through generator or solar cells, it is not necessary for them to be always connected to a power outlet (Cruz, 2012). Cruz (2012) feels that this is where Africa can excel in the use of cloud computing. While it is true that mobile applications may have better chance of success in Africa, not everything can be done with a mobile application and organisations need scalable resources available at a low cost to compete. (Cruz, 2012) study does not throw light on the status of availability of such resources in South Africa.

Cloud infrastructure (or specifically data storage) could reside in a different area when related to the area where the data is produced (Reed, 2010) which could mean that the data production, storage and consumption could all be in different jurisdictions. Questions arise as to who owns the data, how to enforce

intellectual property rights, how to maintain confidentiality, integrity and availability of data and who is responsible if there is a failure to do so. Legal rights pertaining to contractual obligations are also difficult to resolve.

The adoption barriers to cloud computing faced by the public sector and financial sector are somewhat different to that of other sectors due to imposed regulations (Abrahams, Ophoff and Mwalemba, 2015). Multitenancy is one such regulation as remotely sensitive data is not allowed to reside on shared environments (Tweneboah-Koduah, Endicott-Popovsky and Tsetse, 2014). Public sectors unsubstantiated dire perceptions of cloud computing which are contrary to other sectors serves as an impeding barrier (Chou, 2010). Lack of awareness of current progress in cloud computing creates fears which impede further cloud computing adoption (Yong and Zhao, 2015). All perception fears which negatively impact cloud adoption decisions are considered adoption barriers, these include fear of cyberattacks as there is a perception of easier access to data in public cloud environments (Chou, 2010), poor system performance due to increased demand by other clients on shared infrastructure as well as current bandwidth and infrastructure (Yong and Zhao, 2015). Another concern is integration and customisation abilities of cloud systems into on premise systems (Xi and Mitrovic, 2014). Reed (2010) further raises concern in bringing back an on premises system should cloud model not work, voicing concern over cloud lock-in. Vendor relationship concerns are also raised by Leavitt (2009) and Goldsmith (2015) whereby the direct relationship with the software vendor and implementer is diluted by cloud computing models implementation and support interaction.

Table 2.2 summarises the barriers to cloud computing adoption as supported by various studies.

Table 2-2 Barriers to cloud computing

Barriers to cloud computing	Reference
The availability of data	Tweneboah-Koduah, Endicott-Popovsky and Tsetse (2014)
The privacy of data	Abrahams, Ophoff and Mwalemba (2015)
Lack of control of data	Garfinkel and Abelson (1999)
Multitenancy (different organisations' data hosted on the same server)	Tweneboah-Koduah, Endicott-Popovsky and Tsetse (2014)
Cyber attacks	Chou (2010)
System performance	Yong and Zhao (2015)
Difficulty to integrate with in-house system	Xi and Mitrovic (2014)
Not enough ability to customise	Xi and Mitrovic (2014)
Difficult to bring back in-house	Reed (2010)
Lack of support from vendors	Leavitt (2009)
Lack of compatibility with proprietary software	Goldsmith (2014)
Poor IT infrastructure	Tian and Zhao (2015)

2.7 LEVEL OF READINESS OF THE SOUTH AFRICAN PUBLIC SECTOR TO ADOPT CLOUD COMPUTING

Xi and Mitrovic (2014) in the thesis “Readiness Assessment of cloud computing Adoption within a Provincial Government of South Africa” focused on readiness assessment of a provincial government, which includes parameters that are both technical and non-technical. The thesis proposes three types of readiness indicators: 1) Organisational indicators, 2) Infrastructural indicators and 3) Environmental indicators (Nelson, 2009). A model with these three indicators and twelve sub-indicators was proposed. The proposed model was evaluated using a qualitative case study methodology in a provincial government to assess its readiness for implementing cloud computing technologies and services. The sub-indicators for the Infrastructural indicators are:

- Availability and reliability supply; and
- Broadband connectivity indicator.

The sub-indicators for Organisational indicators are divided into strategic business considerations and operational business considerations. The strategic business considerations are:

- Strategy;
- Top management support;
- HR strategy; and
- Vendor Management/SLA agreement.

The Operational business considerations are:

- Security;
- Trust;
- Compatibility and interoperability; and
- Cost performance.

The sub-indicators for the Environmental indicator are:

- Regulatory environment; and
- Sustainability.

The Xi and Mitrovic (2014) study was limited to non-technological factors; it does not actually assess any province and no readiness indicators are provided. Only non-technological factors are considered and external factors are ignored because they could vary enormously. The study is thorough in establishing and explaining the factors underlying the indicators but there are no reasons explained as to why the study is only limited to those factors.

2.8 CONCLUSION

The Schofield and Abrahams (2015) research is the most comprehensive study which mentions all the factors that affect current cloud adoption in South Africa, the enablers, the barriers, the benefits and risks of adopting cloud computing, and the level of readiness of the public sector to adopt cloud computing. The study reports that the current cloud adoption in South Africa is all on the informational side and not the computing side. This situation can change once there is clarity of purpose, all regulations have been framed and a central authority is tasked with creating a private government cloud. It is true that, due to a lack of alternatives, some of the departments have been utilising commercial private or public cloud services currently; however if the South African government wants the usage of cloud to take off in a big way, it should create a private cloud platform. This platform will help integrate all the various departments' efforts and utilisation of data by all departments instead of duplication.

Building on internal cloud (run by the government) is fraught with risks such as capacity constraints and bureaucratic decision-making processes resulting in loss of agility to scale on demand, access to government data, and so on. Schofield and Abrahams (2015) argue that there has been no work done yet to achieve this readiness. Neither are the individual departments working on formulating a strategy to address the risks, nor are there any overarching guidelines being produced. Issues such as building security protocols and avoiding vendor lock-in are not yet addressed (Schofield and Abrahams, 2015).

Mvelase et al. (2014) propose a cloud model, which can be used by the South African government and is based on different models and implementations worldwide. Mohammed and Ibrahim (2015) try to differentiate between different types of computing. Busch et al. (2014) have defined different service delivery models for cloud computing. Trivedi (2013) propose models fit for governments and large enterprises to adopt cloud computing. Goldsmith (2014) proposes the concept of ‘government as a platform’. Maluleka and Ruxwana (2013) compare the adoption of cloud to the adoption of OSS and alert us about encountering the same pitfalls. Gupta (2015) hypothesises that the lack of development so far in Africa is a blessing in disguise as they directly leapfrog to Industry 4.0, which is a euphemism of cloud computing, as it has no legacy applications to hold back the implementation. The Busch et al. (2014) survey in Australia gives a general idea of the situation in Australia. Mutula and Mostert (2010) studied the implementation of e-governance in South Africa and identified projects that have succeeded and some that have not. A Gigaom /North Bridge survey gives a level of adoption of cloud by the industry. Cruz (2012) lists out the different barriers faced by entities trying to move their computing to the cloud, such as the lack of reliable electricity supply, and suggests mobile applications as an alternative.

The next chapter will discuss the research methodology and design which will enable the validation of the theory revealed in this chapter.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter discusses the adopted methodology for this research on the adoption of cloud computing in the South African public sector. This research process aims at answering the primary and secondary research questions of this study (Section 1.3). A survey research strategy is adopted in this study (Section 3.2). The research instrument used in this study is an online questionnaire (Section 3.3).

3.2 RESEARCH STRATEGY

Collis and Hussey (2003) advocate two research paradigms that are largely accepted. The positivist paradigm endeavours to uncover truth and present this by empirical means, maintaining that knowledge is quantifiable and objective. Quantitative research, which falls under a positivist paradigm, can be described as an objective (unbiased) method, which incorporates gathering and analysing statistical data by means of a statistical test. The phenomenological or interpretivist paradigm attempts to understand phenomena through meaning assigned by people. Qualitative research which falls under a phenomenological or interpretivist paradigm on the other hand is a subjective (biased) approach involving examining and reflecting on perceptions to further understand human and social activities (Collis, Hussy, 2003). Quantitative research is a data generating form of research that is customary to numeric presentation after

subjection to various statistical analysis; whereas the data produced by qualitative research is not readily formatted for statistical analysis (Clark & Dawson, 2000). This study adopts a mixed methodology, using both qualitative and quantitative paradigms. A mixed methodology allows for deeper insight into the studied subject matter (Caruth, 2013). Quantitative data is weak in that it struggles to explain the deeper meaning which is simpler done through qualitative data (Amaratunga et al., 2002). Qualitative data can be utilised to better understand and decipher quantitative data. The data collected in this study was both quantitative and qualitative.

Collis and Hussey (2003) state that research design can be descriptive, explanatory (analytical), exploratory or predictive. This study employs an exploratory research design. The study will allow for insight into the adoption of cloud computing by the South African public sector (Chapter 2). The literature allowed for the creation of a theoretical framework, which is empirically validated through means of a survey research strategy (Goulding, 2005). The theoretical framework incorporates opinions and perception about the use and adoption of cloud computing.

The study takes place across the South African public sector including all government local, provincial and national departments and agencies. The study population comprised of the entire South African public sector. The research endeavoured to attain a minimum of sixty (60) respondents comprising of government CIO, government senior IT management and IT decision makers.

3.3 SAMPLING METHOD AND RESEARCH INSTRUMENT

The study adopted a research questionnaire as the research instrument to measure the respondents' perceptions of certain statements related to the research questions. The questionnaire comprised of statements measured on a Likert scale and opened-ended questions that allow respondents the opportunity to express their views. The questionnaire follows a logical sequence, is clear, unambiguous and of comfortable length to complete within 15 minutes (Clark & Dawson, 2000). The questionnaire is prefixed by a cover letter (Appendix A) explaining the purpose of the research.

The questionnaire consists of the following sections:

- Section A is used to gather data about the demographic and organisational profile of the respondents;
- Section B is used to gather data about the adoption of cloud computing (SRQ1);
- Section C is used to gather data about the benefits of cloud computing (SRQ2);
- Section D is used to gather data about the technical, organisational and environmental barriers to cloud adoption (SRQ3); and
- Section E is used to gather data about the readiness factors to adopting cloud computing (SRQ4).

Responses will be analysed by means of statistical tools using methods of central tendency and inferential statistics. The link to the research questionnaire and a personalised introductory email were sent to the government CIO mailing

list as well as to contacts provided by the software vendors. The questionnaire was set up as an online form ensuring anonymity and was accessible to any smart device with an internet connection. The questionnaire's mobility was set up for the respondent's convenience so as to encourage participation. Those respondents without a listed email address were faxed or called up personally. Two reminder emails were sent out at two weeks and one week before the survey-closing deadline. The survey was also administered physically via iPads at the GovTec 2015 conference held in Kwa-Zulu Natal on 28 October. Non-probability and viral sampling were used whereby respondents and industry personnel were asked to recommend other respondents that could participate in the survey (Plowright, 2011).

3.4 VALIDITY OF THE MEASURING INSTRUMENT

The measuring instrument's validity was evaluated by means of face validity. Collis and Hussey (2003) describe face validity as when the measuring instrument is deemed to measure and capture the phenomena that the research intends to capture. The research ensured validity by fully evaluating the objectives and literature reviewed and relaying this in the questionnaire. To test the structure and validity of the questionnaire, an industry expert, statistician and subject matter academic iteratively reviewed the questionnaire before finalisation. The questionnaire was piloted with sample participants before full distribution. The survey was granted ethics clearance (Appendix B).

3.5 CONCLUSION

This chapter presented the research methodology used in the study. The research paradigm adopted is a mixed methodology (qualitative and quantitative). The research design is exploratory and the research strategy used is a survey. The sampling technique used is non-probability viral sampling. The validity of the measuring instrument was measured for face and content validity and deemed valid. The data collected from the questionnaires will be analysed in the following chapter (Chapter 4).

CHAPTER 4
DATA ANALYSIS

4.1 INTRODUCTION

Chapter 3 presented the research design utilised for the survey. The data collected from this survey will be analysed and graphically presented in this chapter. In total 51 completed responses were received (Section 4.2). The response rate cannot be measured as it is undetermined how many persons actually received the survey questionnaire. The results revealed the extent of adoption of cloud computing of respondents (Section 4.3), the respondent's perceptions of the benefits of cloud computing (Section 4.4), the levels of TOE barriers to adoption of cloud computing experienced by the respondents organisations (Section 4.5) and the readiness of respondents organisations to adopt cloud computing (Section 4.5).

4.2 DEMOGRAPHIC AND ORGANISATIONAL INFORMATION

The analysis initially reviews and presents the demographic information of the respondents which corresponds to Section A of the surveyed questionnaire. This section aims to provide a clearer profile of the respondents, such as age, gender, highest qualification, employer, region, managerial level, and other demographic information. This information is important to the study to understand the spread and verify the validity of the results.

Less than a third (31%) of the respondents were female, with 69 percent being male (Figure 4.1). Nearly half (47 %) of the respondents were between the ages

of 40 to 49 years old (Figure 4.2). Thirty three percent were between 50 to 59 years and 4 percent were older than 60 years. Sixteen percent were between 30 and 39 years old and none were below 30 years old.

Figure 4.1 Gender Profile of Respondents

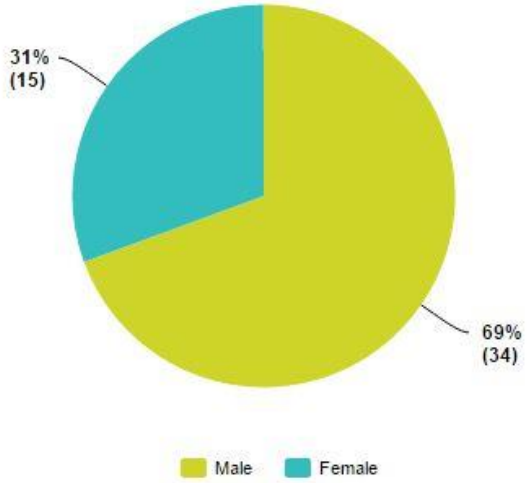
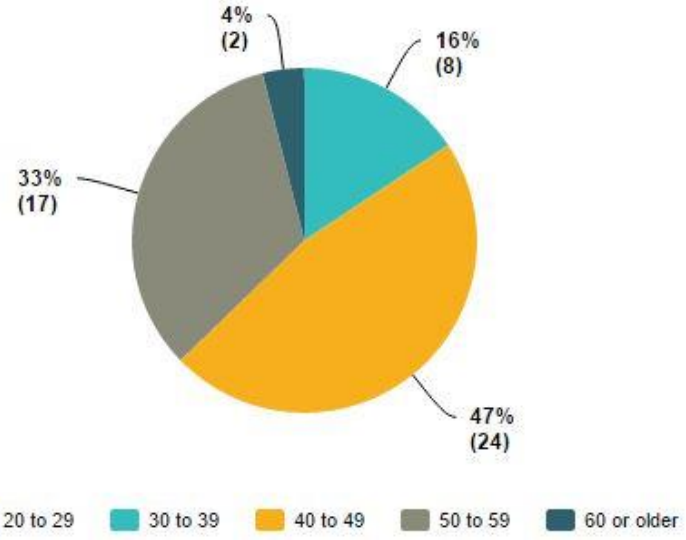
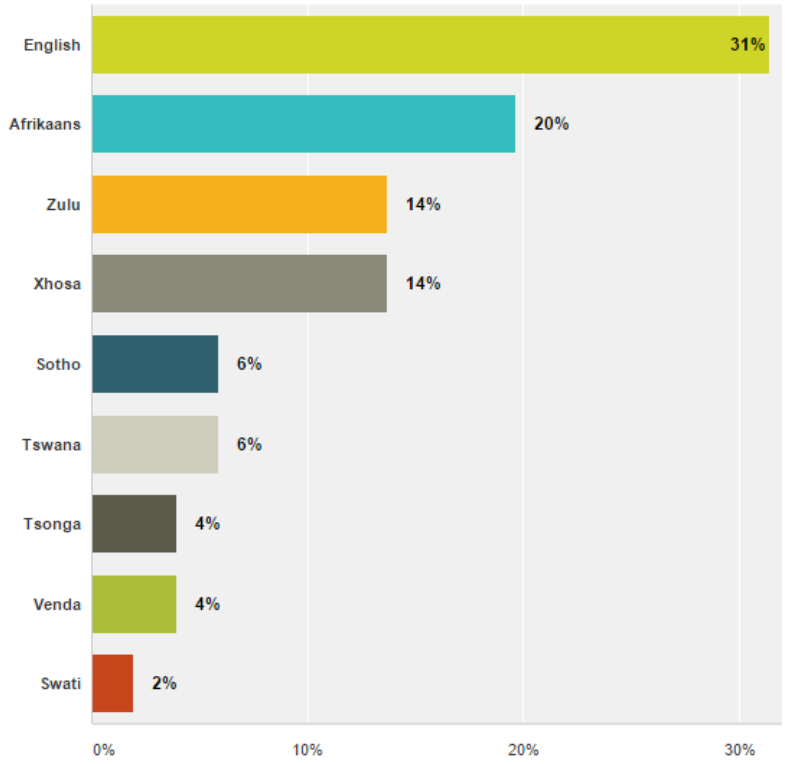


Figure 4.2 Age Profile of Respondents



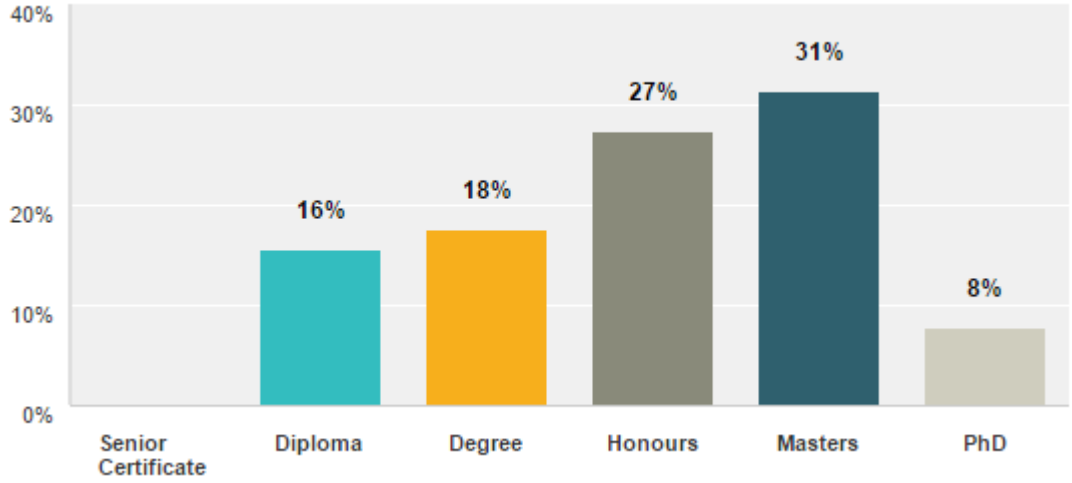
The majority of respondents (31%) had English as their first language followed with Afrikaans (20%) then Zulu and Xhosa (14% each) and Other African languages (22%). It is notable that 69% of respondents' first language was not the dominant business language, which is English in South Africa (Figure 4.3).

Figure 4.3 Language Profile



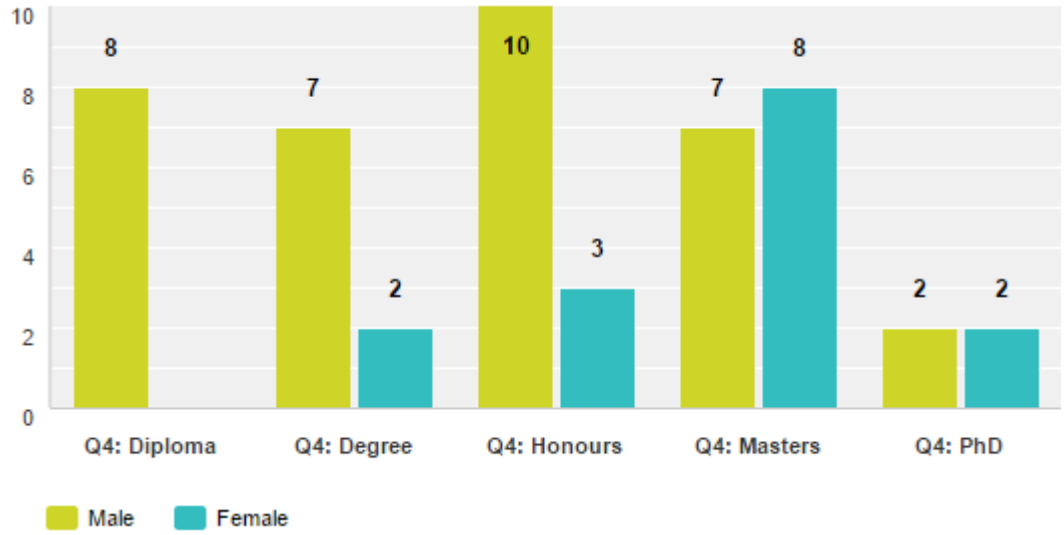
All respondents had some form of formal educational qualification, with 16 percent having diplomas as their highest qualification, 18 percent university degrees, and 27 percent honours degrees. Nearly a third (31%) held master's degrees and 8 percent held PhD's, refer to Figure 4.4.

Figure 4.4 Highest Qualifications



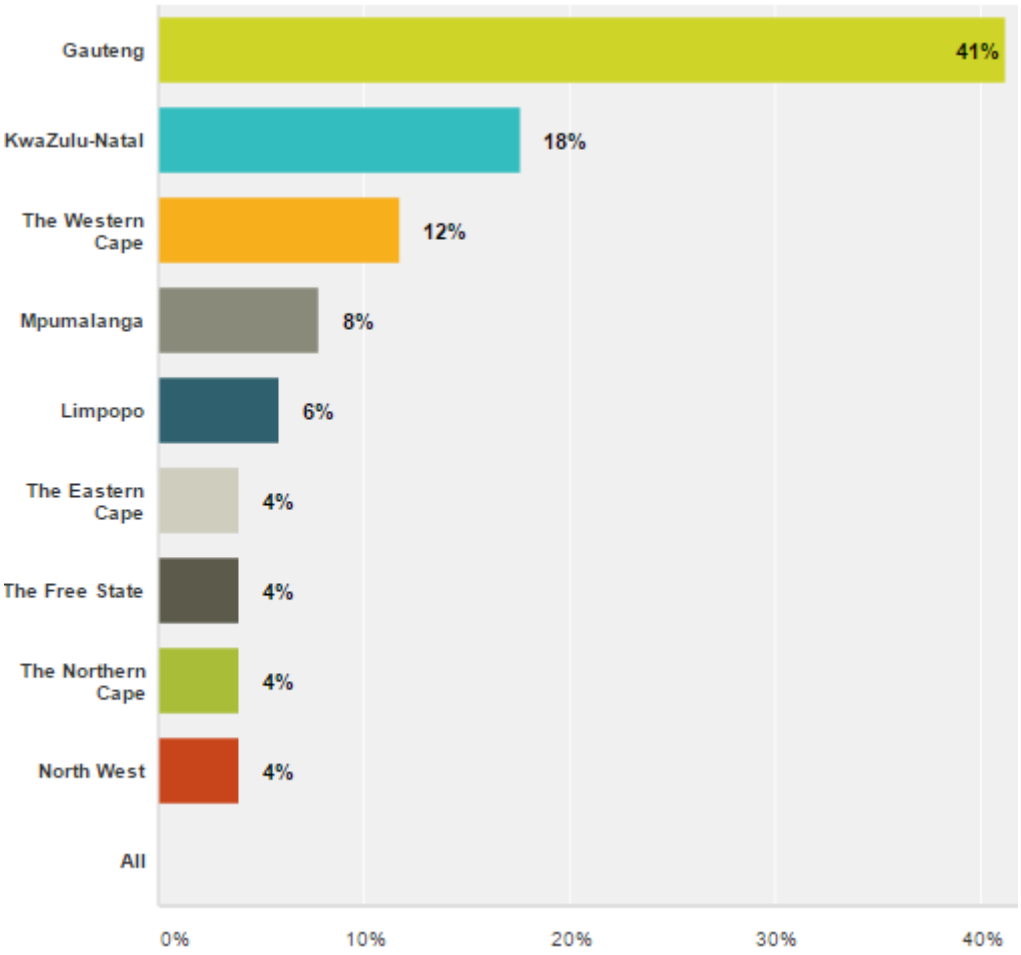
On a weighted average comparison, female respondents held a higher qualification than males, with 13 percent of females holding PhDs compared with six percent in males (Figure 4.5). Fifty three percent of females held masters degrees compared with 21 percent of males. Twenty percent of females held Honours degrees compared with 29 percent of males. Thirteen percent of females held degrees compared with 21 percent in males.

Figure 4.5 Gender Vs Qualifications



Respondents were surveyed from all nine South African provinces (Figure 4.6), with the majority of responses coming from Gauteng (41%) followed by KwaZulu-Natal (18%) and Western Cape (12%).

Figure 4.6 Regional distribution of respondents



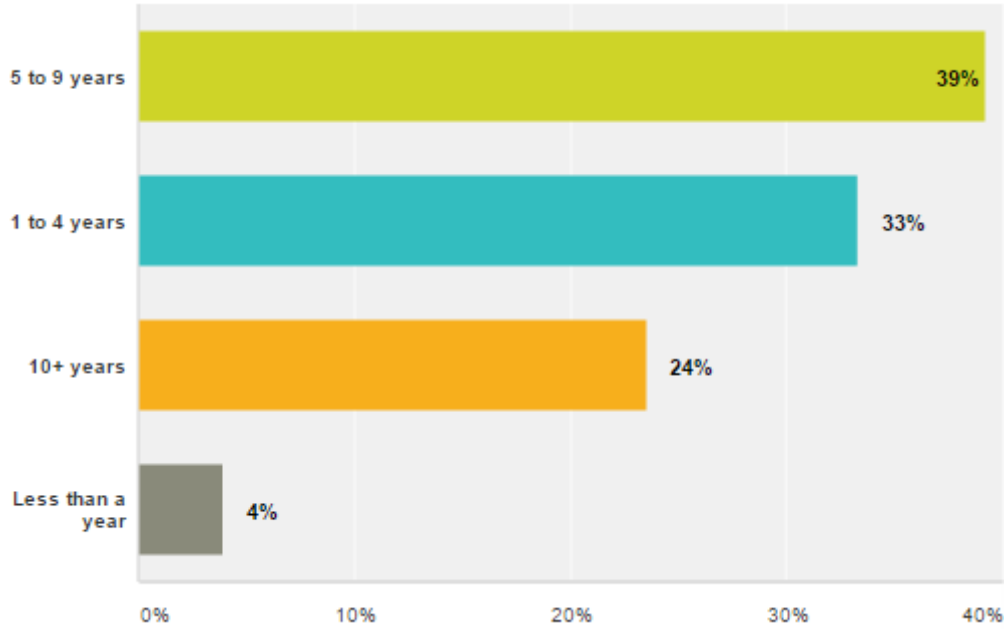
The respondents were given an option to revel the public sector department or agency they were employed at. Of the 51 completed responses, 40 identified their organisation. The list below (Table 4.1) shows the names of their organisation. Of these 21 were South African local municipalities and 19 were South African national departments.

Table 4-1 Departments and municipalities that responded to the study

Department of Social Development	Human Settlements
eThekwini Metropolitan Municipality	Human Settlements
Lesedi Local Municipality	Information Technology
Msunduzi Local Municipality	Knysna Local Municipality
Abaqulusi Local Municipality	Labour
Agriculture, Forestry and Fisheries	Lejweleputswa District Municipality
Arts and Culture	Merafong City Local Municipality
Basic Education	Midvaal Local Municipality
City of Cape Town	Mkhambathini Local Municipality
City of Cape Town Metropolitan Municipality	National Research Foundation of South Africa
City of Tshwane Metropolitan Municipality	Provincial Legislature
Department of Science and Technology	Sedibeng District Municipality
Department of Water Affairs	Sisonke District Municipality
Ekurhuleni Metropolitan Municipality	Statistics South Africa
Energy / Power Generation	Umdoni Local Municipality
eThekwini Metropolitan Municipality	uMhlathuze Local Municipality
Finance	Water and Sanitation
Frances Baard District Municipality	West Rand District Municipality
Gert Sibande District Municipality	West Rand District Municipality
Home Affairs	Women

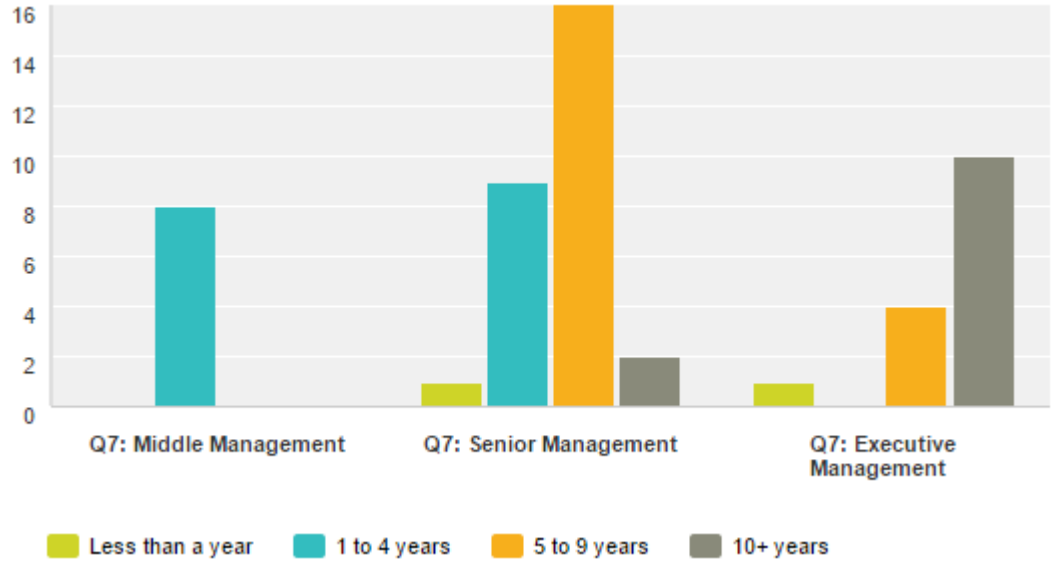
The majority (39 %) of respondents were in their organisation for 5 to 9 years (Figure 4.7). Thirty three percent were there for one to four years, 23 percent were there for greater than 10 years and only four percent were there for less than a year.

Figure 4.7 Period of service to employer



The respondents' company status ranged from middle management to senior management to executive management (Figure 4.8). None of the respondents were junior or senior employees. All respondents that were in middle management were also in their organisation for one to four years. The majority of respondents in senior management (57%) were in their organisation for 5 to 9 years and the majority of respondents in executive management (67%) were in their organisation for over 10 years.

Figure 4.8 Company status vs tenure

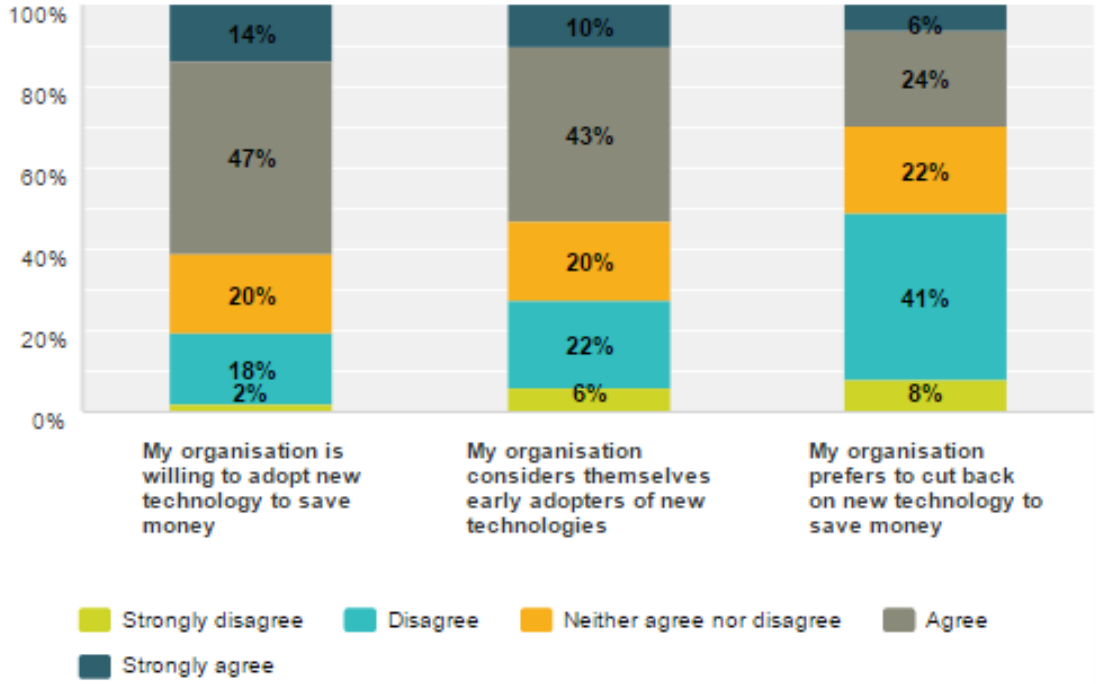


4.3 ADOPTION OF CLOUD COMPUTING

This section was designed to address the research question (RQ1) and gather an understanding of the organisations' adoption of cloud computing. By understanding this adoption one can gather an idea of the public sector's current positioning in cloud computing adoption. This section also attempts to understand what types of cloud environments have been adopted and timelines for future adoption.

Forty seven percent of respondents agree that their organisations are willing to adopt new technology to save money (Figure 4.9). Conversely, 41 percent of respondents disagreed that their organisations prefer to cut back on new technology to save money. Forty three percent of the respondents considered their organisations as early adopters of new technology.

Figure 4.9 Adoption of technology



Of the organisations surveyed, 54 % (n=27) uses some form of cloud computing compared to 46 % (n = 23) who do not (Figure 4.10). A one sampled t test of these two groups show that the t-statistic was not significant at the 0.5 critical alpha level, T (51) = 0.573, p = 0.569.

Figure 4.10 Use of cloud computing

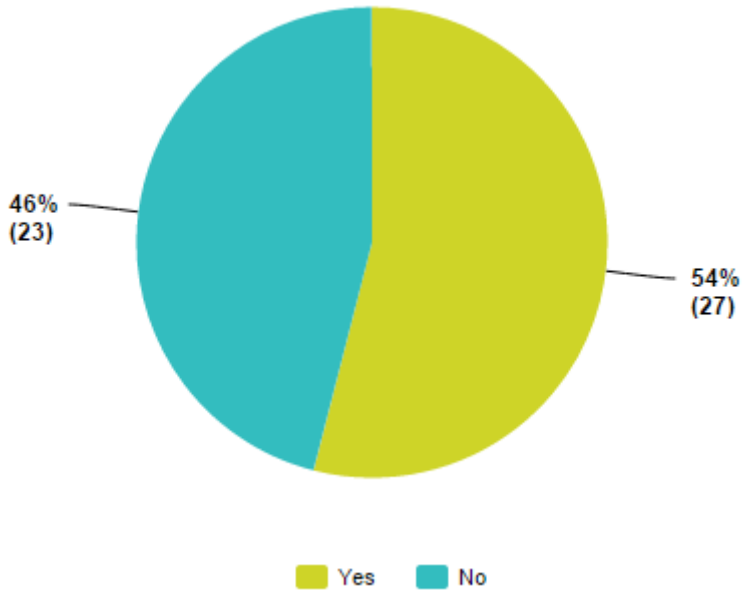
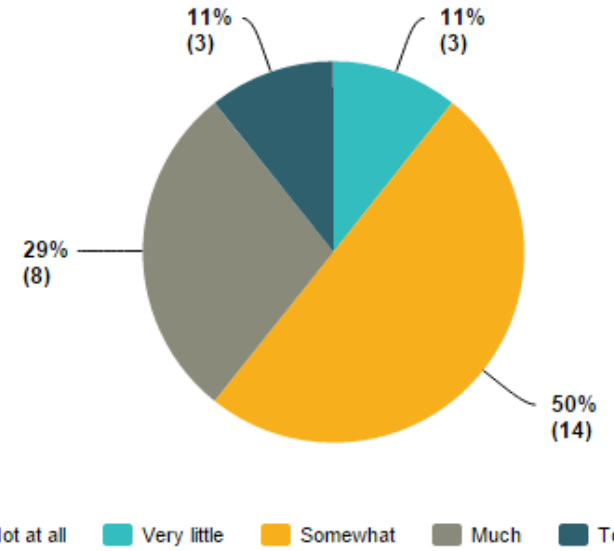


Figure 4.11 shows that from the 54 percent of respondents who said their organisations use cloud computing, 50 percent stated that their cloud computing project was somewhat successful, whilst 29 percent said it had much success and 11 percent said it was greatly successful. Eleven percent said that their cloud computing project had very little success.

Figure 4.11 Success of cloud project



Answer Choices	Responses	
Not at all (1)	0%	0
Very little (2)	11%	3
Somewhat (3)	50%	14
Much (4)	29%	8
To a great extent (5)	11%	3
Total		28

Basic Statistics				
Minimum	Maximum	Median	Mean	Standard Deviation
2.00	5.00	3.00	3.39	0.82

Of the organisations that utilise cloud computing the extent of use of certain major cloud technologies was measured. IaaS and Paas appear as the most

extensively used cloud computing models with μ= 4 (Figure 4.12 and Table 4.2). SaaS was the next most utilised followed by cloud analytics then human resources modules in the cloud. Customer resource management (CRM) in the cloud was the second least utilised with a μ =2 and cloud ERP the least utilised.

Figure 4.12 Utilisation of cloud technologies

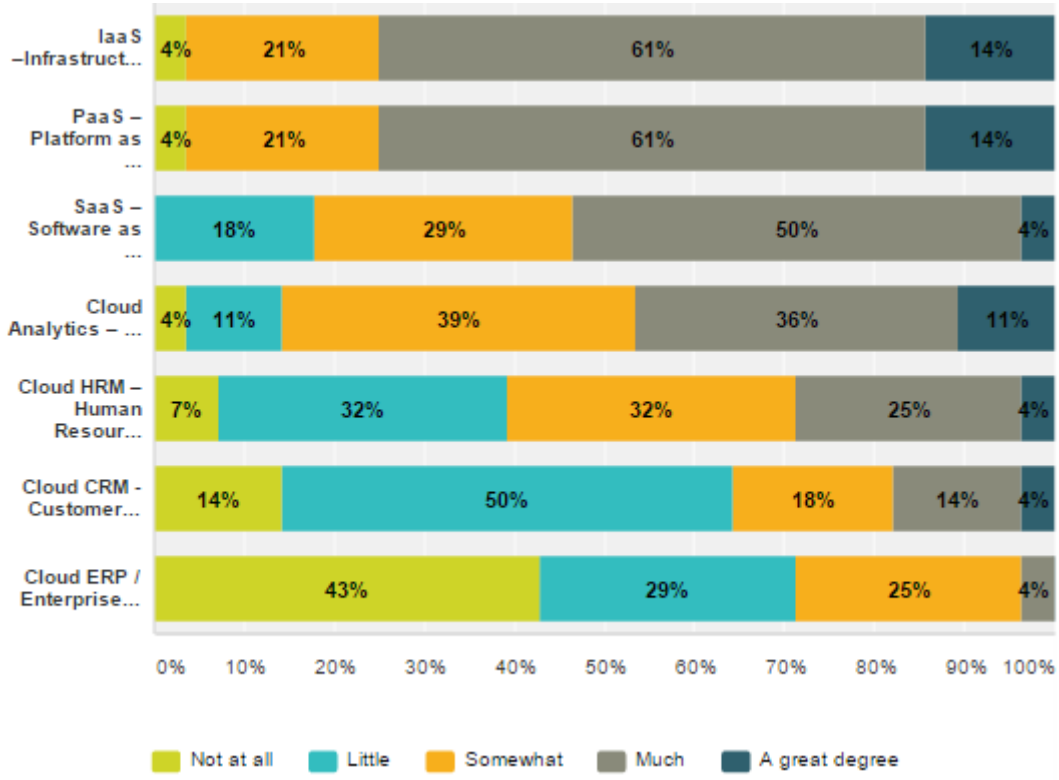


Table 4-2 Utilisation of cloud computing technologies

	Minimum	Maximum	Median	Mean	Standard Deviation
IaaS –Infrastructure as a Service	1.00	5.00	4.00	3.82	0.80
PaaS – Platform as a Service	1.00	5.00	4.00	3.82	0.80
SaaS – Software as a Service	2.00	5.00	4.00	3.39	0.82
Cloud Analytics – On demand Business Intelligence solutions	1.00	5.00	3.00	3.39	0.94
Cloud HRM – Human Resource Management	1.00	5.00	3.00	2.86	0.99
Cloud CRM - Customer relationship management	1.00	5.00	2.00	2.43	1.02
Cloud ERP / Enterprise resource planning	1.00	4.00	2.00	1.89	0.90

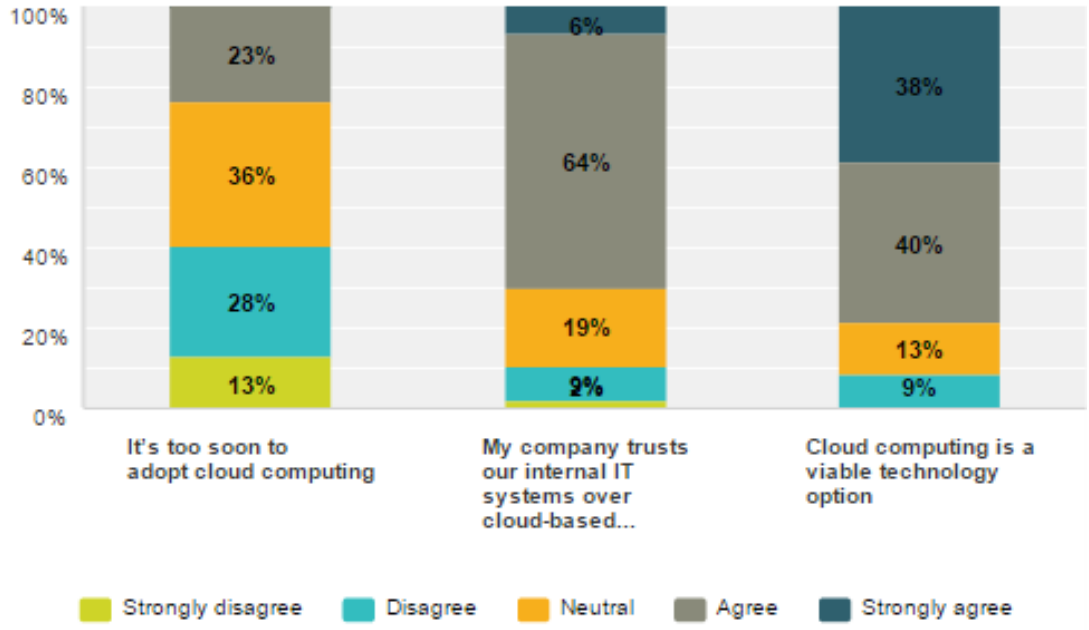
The questionnaire measured the respondents' activities and intentions towards adopting cloud computing (Figure 4.13). Fourteen percent of the respondents rely solely on cloud computing for their systems' activities, 93 percent utilise a combination of cloud computing and internally owned IT systems. Seventy one percent of respondent organisations are currently assessing the cloud, while 75 percent is currently developing a cloud strategy. Finally 57 percent of respondents stated that their organisations are testing a proof of concept, 68 percent are currently implementing and 93 percent plans to increase their use of cloud computing.

Figure 4.13 Move towards cloud adoption, activities

A - Rely solely on cloud computing technologies for their ICT needs
B - Testing a proof of concept
C - Currently implementing
D - Currently assessing the cloud
E - Developing a cloud strategy
F - Utilise a combination of cloud computing and internally owned IT systems
G - Plans to increase your use of cloud

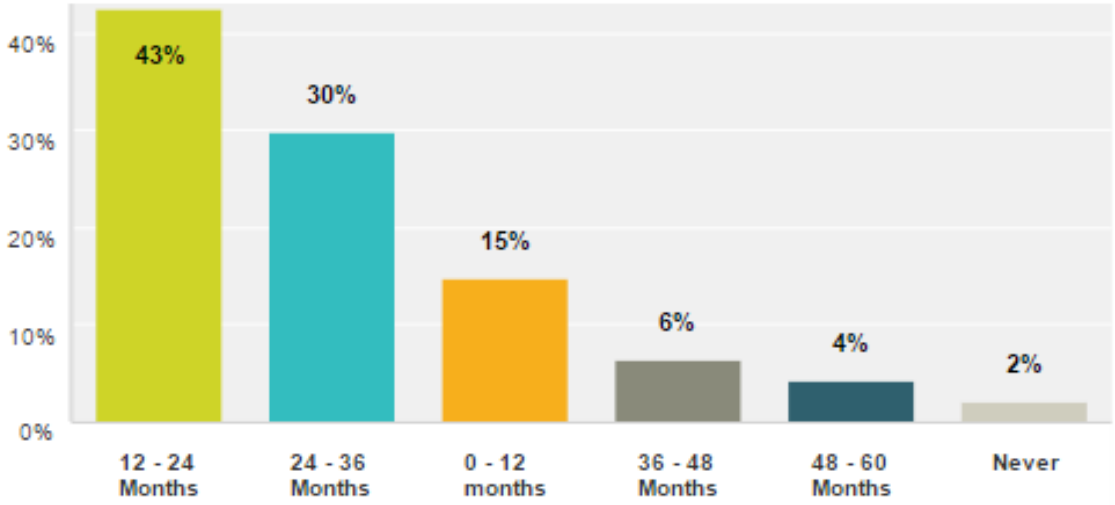
Of the companies that have not adopted any cloud computing, seventy percent says that their company trust their internal IT systems over cloud based technologies (Figure 4.14). For the statement “It’s too soon to adopt cloud computing”, the largest percentage (36%) of responses were neutral. The majority (78%) agree and strongly agree that cloud computing is a viable technology option.

Figure 4.14 Intention for cloud computing



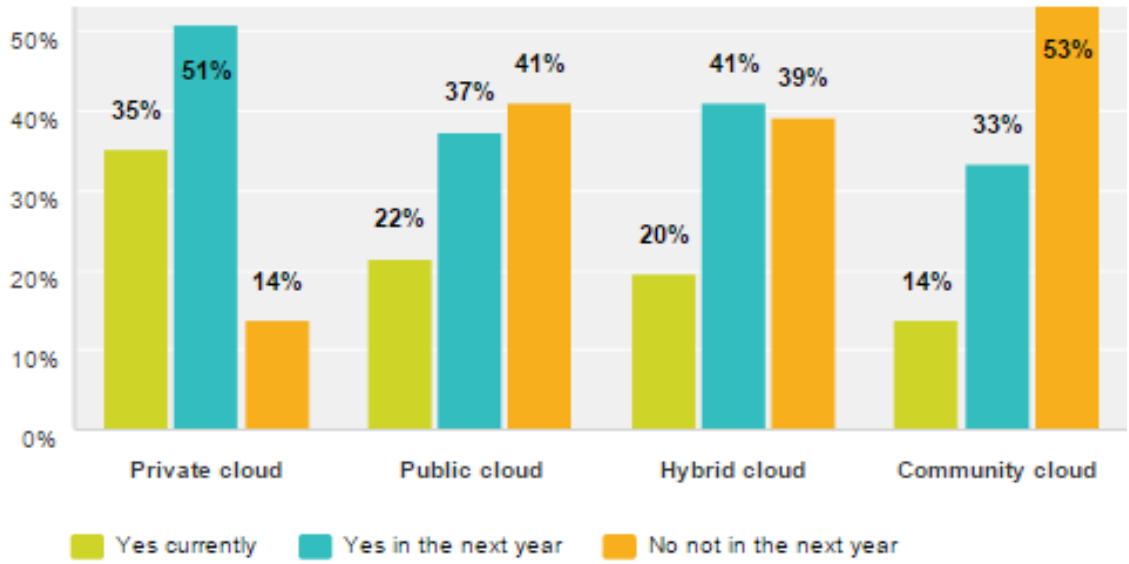
To establish a timeline to cloud adoption for those organisations surveyed who don't have any form of cloud computing, they were asked when they plan to integrate some form of cloud computing (Figure 4.15). The majority of the respondents (43%) said that they planned to do so in the next 12 to 24 months. On the other hand, 30 percent said they planned to do so in the next 24 to 36 months, whilst 15 percent said in the next 12 months. Six percent of respondents stated that they planned to integrate cloud computing in the next 36 to 49 months, four percent planned to do so in the next 48 to 60 months whilst two percent said they will not implement cloud computing at all.

Figure 4.15 Cloud computing adoption timeline



To further derive some details regarding actual and planned cloud computing adoption environments/models all respondents were asked when will they adopt a specific cloud computing environment (Figure 4.16). The cloud computing environments included private cloud, public cloud, hybrid cloud and community cloud. Over a third (35%) of respondents said that they already use a private cloud, with 51 percent saying they will adopt a private cloud in the next year, 14 percent said they would not adopt in the next year. Twenty two percent of respondents already have public clouds in place, with 37 percent saying they will adopt public clouds in the next year and 41 percent will not adopt in the next year. Twenty percent of respondents already have a hybrid cloud in place, 41 percent say they will in the next year and 39 percent stated they would not in the next year. Fourteen percent of respondents already have a community cloud in place with 33 percent adopting in the next year and 53 percent stated that they would not in the next year.

Figure 4.16 Short term adoption of different cloud environments



4.4 BENEFITS OF CLOUD COMPUTING

Twelve benefits of adopting cloud computing was derived from the literature reviewed (Table 2.1). The third set of questions (SQ3) were based on this theory and were included to understand the respondents' perceptions of the benefits of adopting cloud computing. Respondents were asked to validate these benefits by indicating how strongly they agree or disagree with these benefits as these were perceived by them.

From the responses, there is a general acceptance and understanding of the benefits of adopting cloud computing by the majority of respondents as indicated by the mean and median's across the 12 statements posed (Table 4.3).

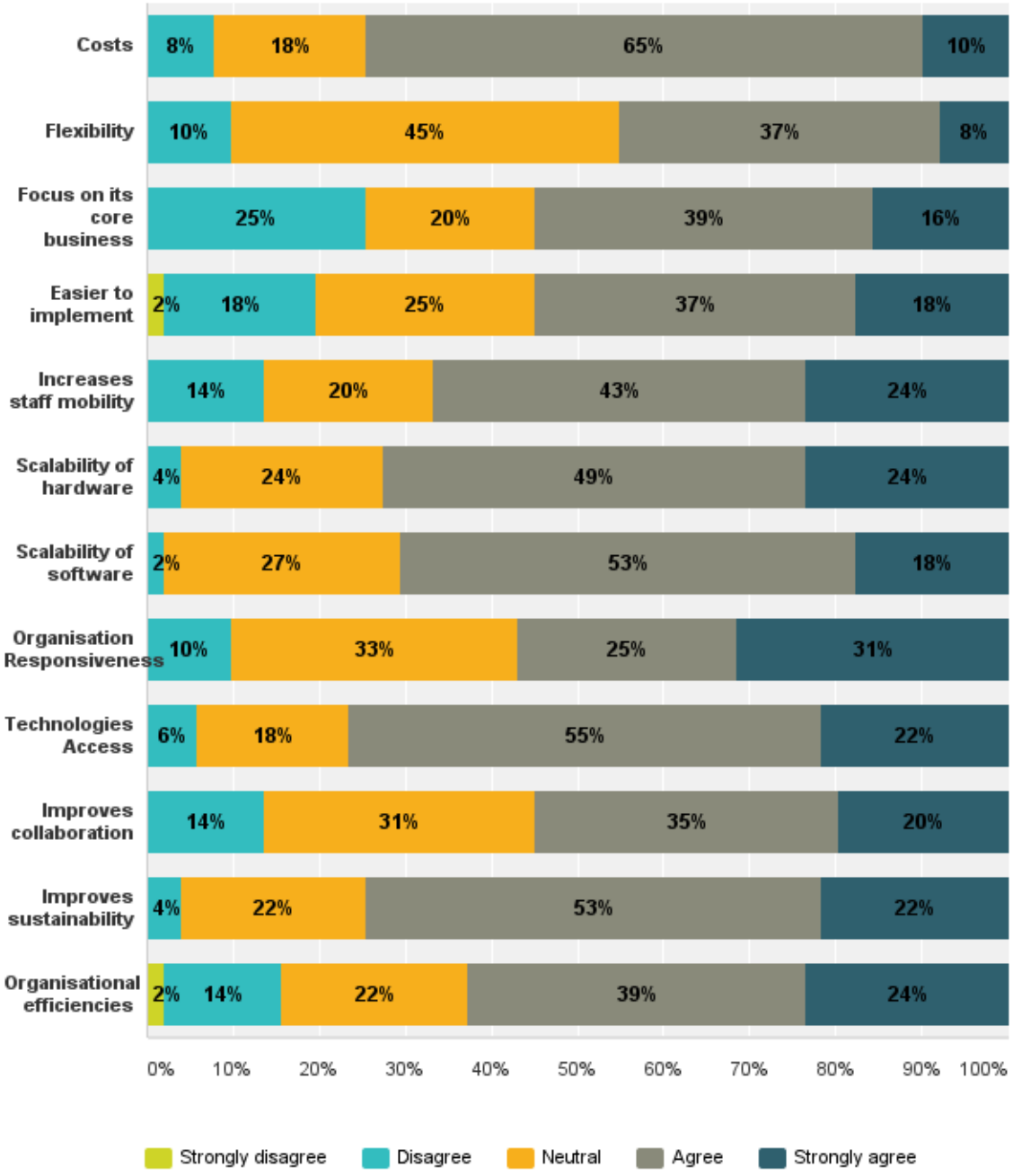
Table 4-3: Benefits of cloud computing adoption

	Minimum	Maximum	Median	Mean	Standard Deviation
Costs	2.00	5.00	4.00	3.76	0.73
Flexibility	2.00	5.00	3.00	3.43	0.77
Focus on its core business	2.00	5.00	4.00	3.45	1.03
Easier to implement	1.00	5.00	4.00	3.51	1.04
Increases staff mobility	2.00	5.00	4.00	3.76	0.96
Scalability of hardware	2.00	5.00	4.00	3.92	0.79
Scalability of software	2.00	5.00	4.00	3.86	0.71
Organisation Responsiveness	2.00	5.00	4.00	3.78	1.00
Technologies Access	2.00	5.00	4.00	3.92	0.79
Improves collaboration	2.00	5.00	4.00	3.61	0.95
Improves sustainability	2.00	5.00	4.00	3.92	0.76
Organisational efficiencies	1.00	5.00	4.00	3.69	1.04

Seventy five percent of all respondents agreed and strongly agreed that adopting cloud computing reduces upfront processing systems cost, 18 percent were neutral and eight percent disagreed that the adoption of cloud computing reduces upfront cost. Fifty five percent of respondents were neutral or disagreed that adoption of cloud computing helps organisation be more flexible.

Fifty five percent agreed and strongly agreed that adoption of cloud computing allows organisation to better focus on its core business (Figure 4.17). One-fifth (20%) of respondents believes that cloud computing is more difficult to implement that traditional on premise technologies. Sixteen percent of respondents disagree that embracing cloud computing would make organisations more effective and efficient and ultimately lead to better service delivery in the public sector. However 63 percent did agree to this.

Figure 4.17 Benefits of cloud computing



A single factor Anova test was performed to determine if there was a significant difference of the perceived benefits of cloud computing between those organisations that adopted cloud computing and those that did not. The null hypothesis is as follows:

H0: μ1 = μ2;

There is no significant difference in the perceived benefits between organisations with cloud computing and those with no cloud computing.

The test used the means of all the tested benefits (Table 4.3) grouped by organisations that adopted cloud computing and compared it to organisations that did not adopt cloud computing. An Anova test was performed, and the results (P < critical α; F > F crit) revealed that there was a significant difference and therefore H0 was rejected (Figure 4.18). The test revealed that there was a significant difference in the level of perceived benefit by organisations at the $p < 0.05$ level for [$F(1, 22) = 18.89$, $p = 0.000276$]. Given the confirmation from the Turnkey-Kramer procedure, higher sum, higher critical means and lower variance of organisations that adopted cloud computing, it can be stated with confidence that organisations that have adopted cloud computing significantly perceive greater benefits from cloud computing than organisations that have not adopted cloud computing.

Figure 4.18 Anova test for benefits of cloud computing

SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Cloud	12	46.71	3.8925	0.030239		
No Cloud	12	42.07	3.505833333	0.065917		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.897067	1	0.897066667	18.65856	0.000276	4.30095
Within Groups	1.057717	22	0.04807803			
Total	1.954783	23				
Turnkey-Kramer Procedure		**Num Dd**	2	**Den df**	20	2.95
ccomparisions	**Absolute**	**difference**	**Critical Range**	**Results**		
Cloud to no Cloud	0.386667		0.204548053	Means significantly different		

4.5 BARRIERS TO CLOUD ADOPTION

Section D of the questionnaire considers the barriers to the adoption of cloud computing, which addresses sub research question four (SRQ4). This section considers the adoption barriers from three different views, that of technical, organisational, and environmental. Tornatzky and Fleischer (1990) TOE framework was adopted because of its sound philosophical constructs and its frequent use in studying the adoption of various IT innovations.

4.5.1 Technical barriers

Respondents were asked, on behalf of their organisation, to assess the importance of technical concerns to their organisations current technological

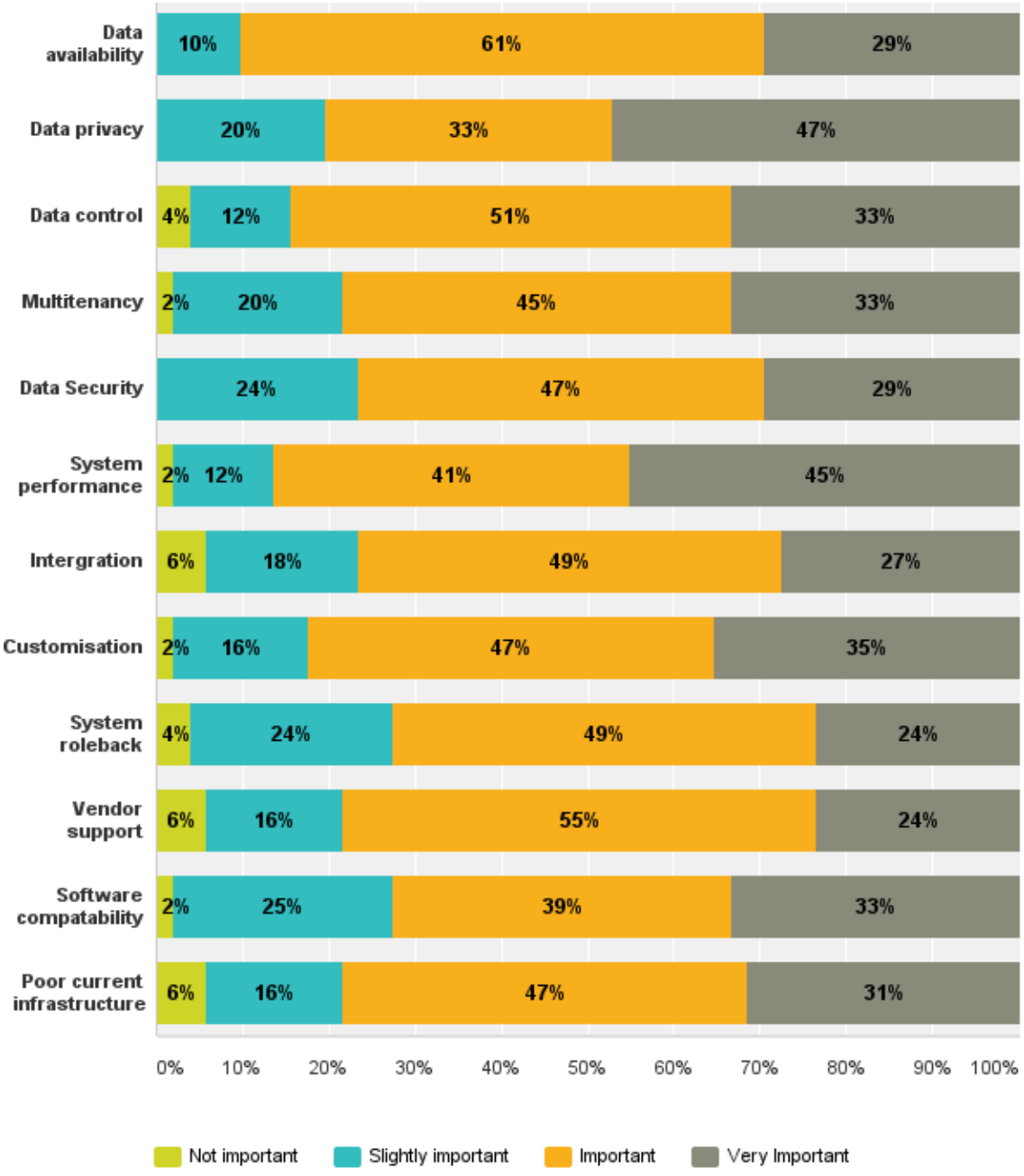
standing. Being strong or having ample resources in a particular area meant that that aspect was a low concern (not important) whereas having weakness or little recourse in an area meant that is an area of high concern (very important). A scale of 1 to 4 was used with 1 meaning not important and 4 very important. The 12 technical concern questions all scored on average a mean and median of 3 reflecting that in general all respondents have a high concern for technical barriers (Table 4.4).

Table 4-4 Technical barriers to cloud adoption

	Minimum	Maximum	Median	Mean	Standard Deviation
The availability of data	2.00	4.00	3.00	3.20	0.59
The privacy of data	2.00	4.00	3.00	3.27	0.77
Lack of control of data	1.00	4.00	3.00	3.14	0.77
Multitenancy	1.00	4.00	3.00	3.10	0.77
Cyber attacks	2.00	4.00	3.00	3.06	0.73
System performance	1.00	4.00	3.00	3.29	0.75
Difficulty to integrate with in-house system	1.00	4.00	3.00	2.98	0.83
Not enough ability to customise	1.00	4.00	3.00	3.16	0.75
Difficult to bring back in-house	1.00	4.00	3.00	2.92	0.79
Lack of support from vendors	1.00	4.00	3.00	2.96	0.79
Lack of compatibility with proprietary software	1.00	4.00	3.00	3.04	0.82
Poor IT infrastructure currently in place	1.00	4.00	3.00	3.04	0.84

Ninety percent of respondents expressed that the availability of data is either important or very important to their organisation (Figure 4-19). Eighty percent stated that the privacy of data is important or very important. Eighty four percent of respondents indicated that the lack of control of data is either an important or very important concern to their organisations. Multitenancy is an important important concern to 78 percent of respondents. More than three quarters of respondents (76%) acknowledge cyber-attacks as an important to very important concern. System performance is a major concern as indicated by 86 percent of respondent who rate it as either important or very important. Seventy six percent (76%) noted that the difficulty to integrate cloud systems with in-house systems as an important to very important concern. Lack of support from vendors proves to be a concern as indicated by 79 percent of respondents who rated this as either an important or a very important concern. Seventy eight percent of respondents voiced concern over the current poor IT infrastructure in place, rating it as either an important or very important technical barrier to the adoption of cloud computing.

Figure 4.19 Technical barriers to the adoption of cloud computing



4.5.2 Organisational Barriers

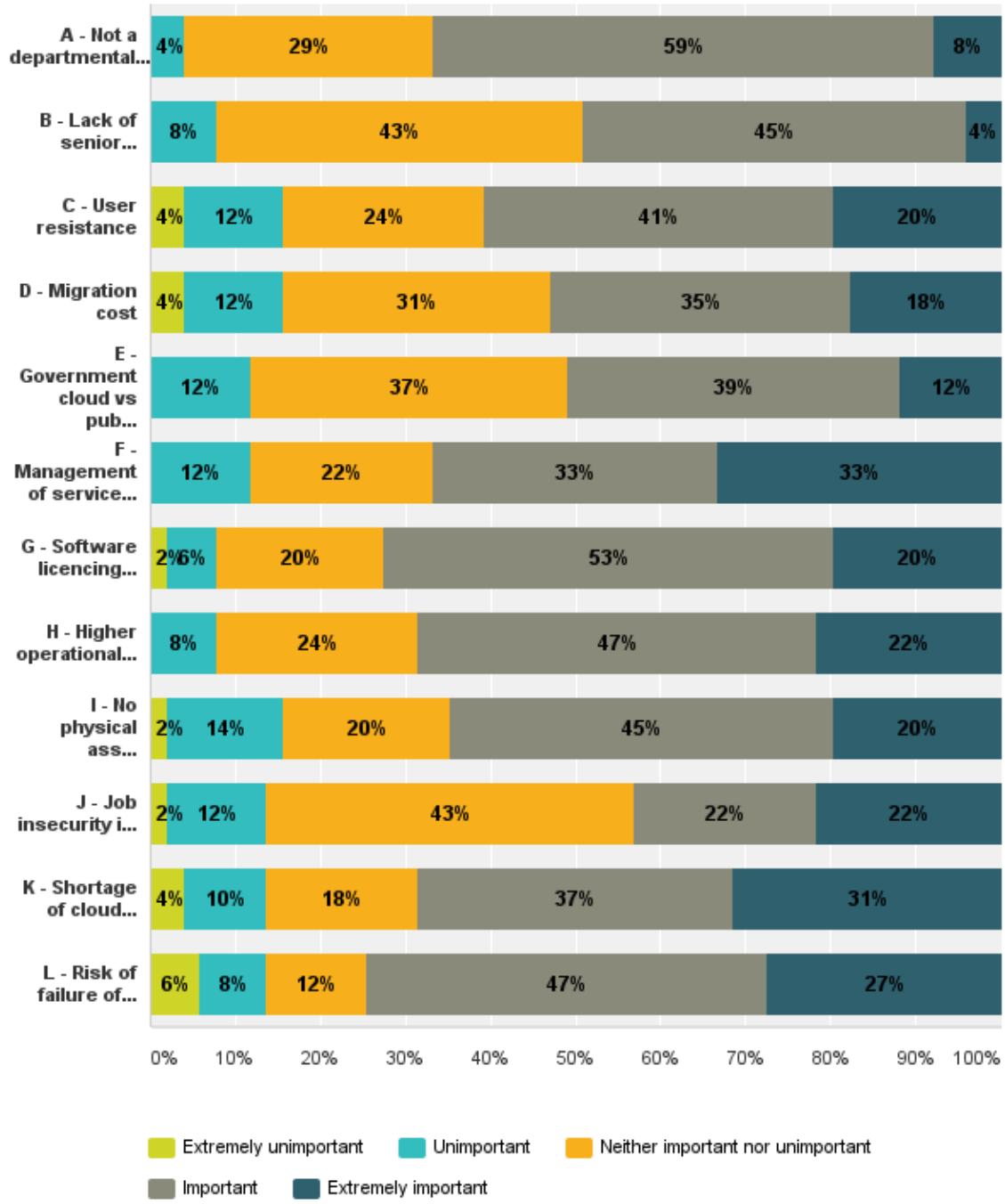
Similar to technical barriers, the organisational barriers were tested as part of the TOE framework adopted. Twelve questions tested the significance of the organisational barriers on a five-point scale, with 1 being extremely unimportant and 5 extremely important. The average mean is 3.68 and the average median was 3.8 with an average standard deviation of 0.94 (Table 4.5). The results indicate that on average managerial barriers are of important concern to the respondents' organisations.

Table 4-5: Organisational barriers to cloud adoption

	Minimum	Maximum	Median	Mean	Standard Deviation
Not a departmental or agency strategic initiative	2.00	5.00	4.00	3.71	0.67
Lack of senior management /executive support	2.00	5.00	3.00	3.45	0.69
User resistance	1.00	5.00	4.00	3.61	1.05
Migration cost	1.00	5.00	4.00	3.51	1.04
Government cloud vs public cloud	2.00	5.00	4.00	3.51	0.85
Management of service provides	2.00	5.00	4.00	3.88	1.00
Software licencing agreements	1.00	5.00	4.00	3.82	0.88
Higher operational expense for cloud	2.00	5.00	4.00	3.82	0.86
No physical assets purchased with budget	1.00	5.00	4.00	3.67	1.00
Job insecurity i.e. IT department downsizing	1.00	5.00	3.00	3.49	1.02
Shortage of cloud computing skills	1.00	5.00	4.00	3.82	1.10
Risk of failure of adopting cloud computing to be greater than the benefits of a success	1.00	5.00	4.00	3.82	1.10

More than half (59%) of the respondents indicated that that adoption of cloud computing if not a department or agency strategic initiative is of important concern (Figure 4.20). Forty nine percent of respondents indicated that a lack of senior management or executive management is a managerial barrier, which raises concern. User resistance to adopting the new cloud technology could also pose much concern as indicated by 61 percent of respondents who nominated it to be important or extremely important. Migration cost to move from the old system to a clouded environment scored a weighted average of 3.51 indicating that this is a concern of importance. There is important to very important (51%) concern over a government cloud environment versus a public cloud environment adopted by a government entity. The management of cloud computing service providers and software licence agreements had a weighted average of 3.88 and 3.82 respectively, indicating these are an important concern. Sixty nine percent of respondents surveyed indicated that they were concerned about a higher overall operational expense for cloud computing; however the literature review and benefits of cloud computing analysis shows that cloud computing is less expensive that on premise operational systems. Sixty five percent of respondents were concerned that no physical assets are purchased with the allocated IT budget. Perceived job insecurity caused by the adoption of cloud computing was predominantly neither important nor unimportant. Cloud computing skills shortage was of important to extremely important concern to 68 percent surveyed. Seventy four percent (74%) of respondents indicated concern over the risk of failure of adopting cloud computing to outweigh the benefits of cloud success.

Figure 4.20 Organisational barriers to cloud adoption



A - Not a departmental or agency strategic initiative

B - Lack of senior management /executive support

C - User resistance

D - Migration cost

E - Government cloud vs public cloud

F - Management of service provides

G - Software licencing agreements

H - Higher operational expense for cloud

I - No physical assets purchased with budget

J - Job insecurity i.e. IT department downsizing

K - Shortage of cloud computing skills

L - Risk of failure of adopting cloud computing to be greater than the benefits of a success

4.5.3 Environmental barriers

The last pillar of the TOE framework the environmental barriers considers how the external business environment factors influence the adoption of cloud computing by the South African public sector. The environment context includes elements such as market structure, the external support available for adopting new technologies and government regulations. These elements interact with each other to influence technology adoption decisions. From the literature reviewed, nine environmental factors were derived. The significance of the nine environmental factors was tested on a five-point scale with 1 being extremely unimportant and 5 extremely important (Table 4.6). The average mean was 3.84 and the average median was 4 with an average standard deviation of 0.86, which indicates that on average that the identified environmental barriers are of important concern to the respondents' organisations.

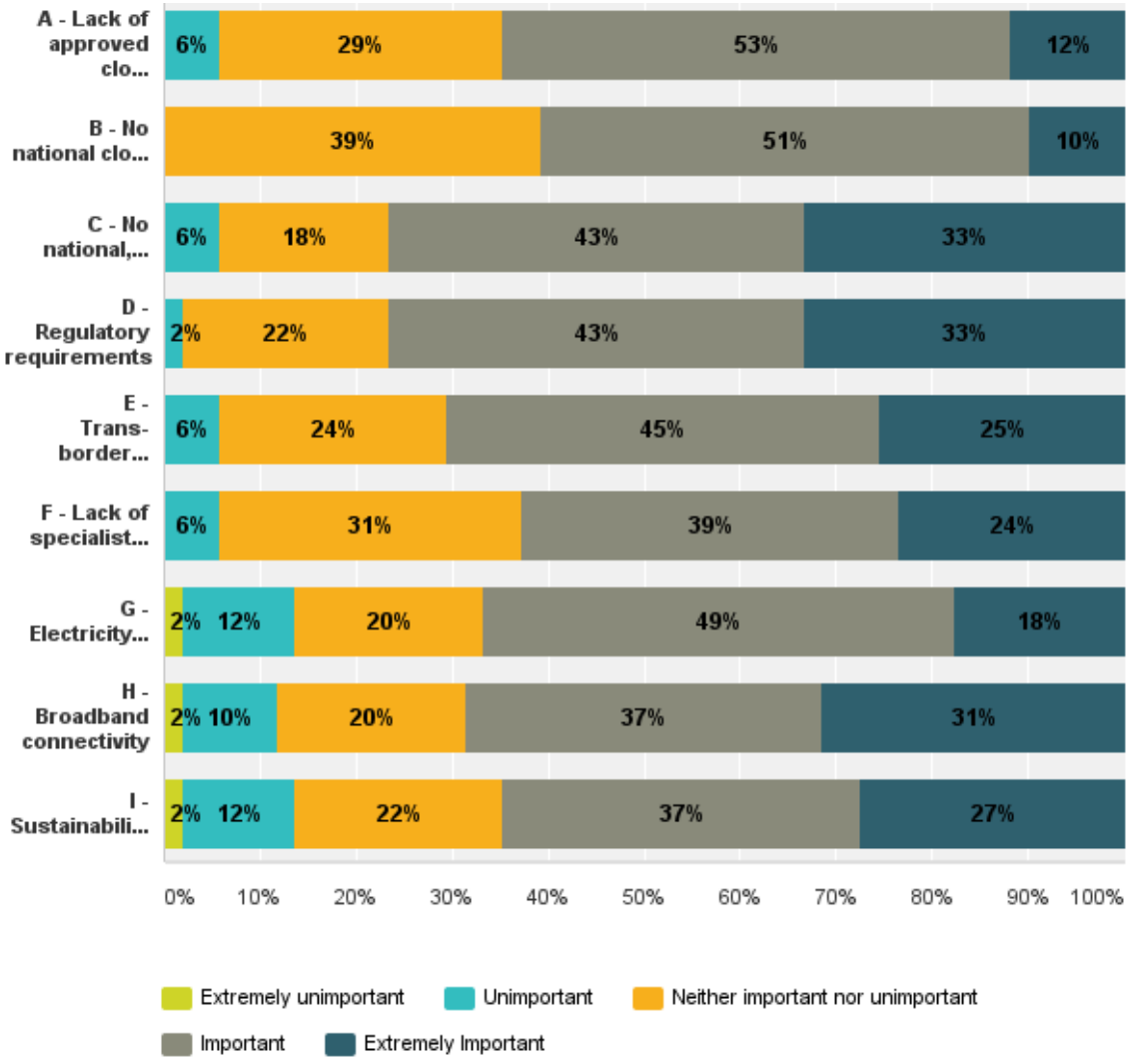
Table 4-6: Environmental barriers to cloud computing

	Minimum	Maximum	Median	Mean	Standard Deviation
Lack of approved cloud standards	2.00	5.00	4.00	3.71	0.75
No national cloud computing policy in place	3.00	5.00	4.00	3.71	0.64
No national, local, departmental or agency cloud adoption strategy or guidelines in place	2.00	5.00	4.00	4.04	0.86
Regulatory requirements	2.00	5.00	4.00	4.08	0.79
Trans-border information flow	2.00	5.00	4.00	3.90	0.85
Lack of specialist public sector local vendors	2.00	5.00	4.00	3.80	0.86
Electricity availability	1.00	5.00	4.00	3.69	0.96
Broadband connectivity	1.00	5.00	4.00	3.86	1.03
Sustainability and carbon efficiency	1.00	5.00	4.00	3.76	1.04

Figure 4.21 shows that to sixty-five percent of respondents the lack of approved cloud standards is of important to extremely important concern. Sixty one percent of respondents believed that no national cloud computing policy in place was of important to extremely important concern. More than three quarters of respondents (76%) voiced concern over no national, local, departmental or agency, cloud adoption strategy, or cloud adoption guidelines currently being in place. Regulatory requirements were an issue of concern by 76 percent of respondents. Trans-border information flow was indicated as an important to extremely important concern by 70 percent of respondents. Sixty three percent of respondents indicated that there is a lack of local vendors who specialise in the public sector. Electricity availability and broadband connectivity

was of concern to 67 percent and 68 percent of respondents respectively. Sixty four percent of respondents showed concern over sustainability and carbon efficiency.

Figure 4.21 Environmental barriers to cloud computing



A - Lack of approved cloud standards

B - No national cloud computing policy in place

C - No national, local, departmental or agency cloud adoption strategy or guidelines in place

D - Regulatory requirements

E - Trans-border information flow

F - Lack of specialist public sector local vendors

G - Electricity availability

H - Broadband connectivity

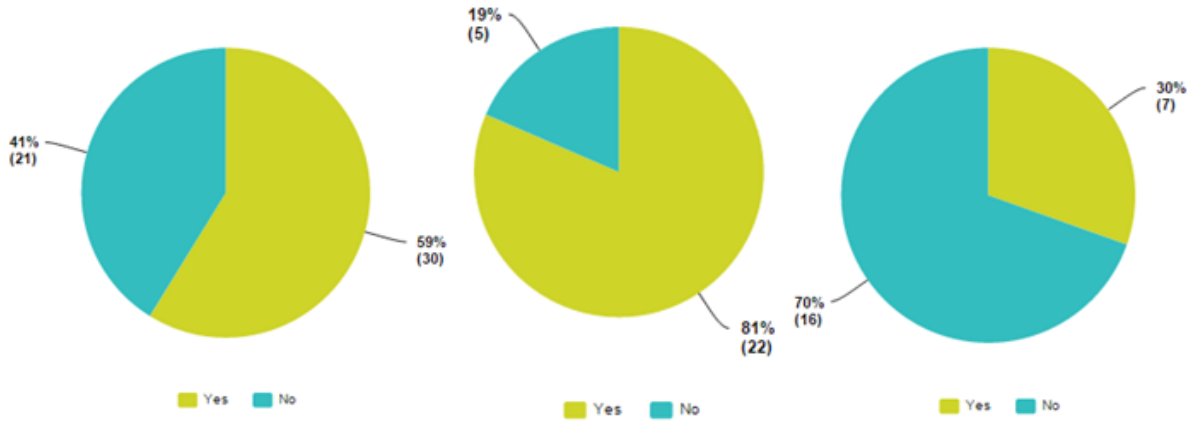
I - Sustainability and carbon efficiency

4.6 READINESS FACTORS TO ADOPTING CLOUD COMPUTING

The final section of the questionnaire tested the readiness factors to adopting cloud computing. Three questions tested the respondent awareness of government drives to cloud computing, external pressure to move to cloud computing and the respondent organisations readiness to move to cloud computing.

Fifty nine cent of respondents were aware of government mandates towards cloud computing, whilst 41 percent of respondents were unaware. Comments elicited where “government strategic plan 7.1” and “SITA have been talking about it, but no major capability has been established yet”. In Figure 4.22, the data is analysed firstly by all respondents giving 59 percent awareness to government cloud initiatives. The data was then analysed according to those respondents whose organisations have adopted some form of cloud computing, and the results revealed that 81 percent of these were aware of government drives to cloud computing. The final analysis was by organisations who have no cloud computing currently in place, and of these 30 percent are aware of cloud computing initiatives.

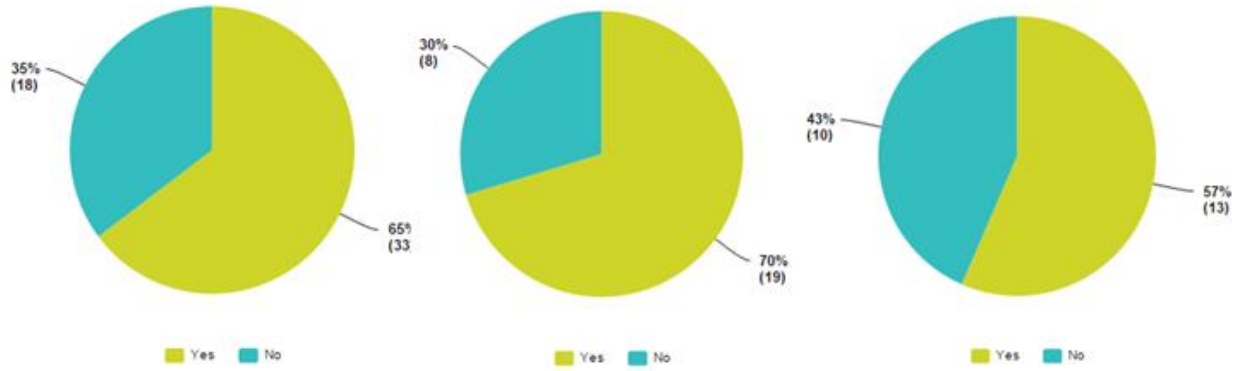
Figure 4.22 Awareness of government drivers towards cloud computing



A = all respondents B = currently using cloud C = no cloud computing

Sixty five percent of respondents said that they were impacted or influenced to move to cloud computing by forces that were external to their organisation. Comments from respondents were *"Government strategic plan 7.1"* and *"SITA – South Africa State information technology association".* In Figure 4.23, the data was filtered to test whether respondent's organisations were externally influenced to move to cloud computing, This was tested against three scenarios: a – all organisations; b - organisations that use cloud computing and c – organisation that has no cloud computing. Scenario a, 65 percent said they were influenced; scenario b – 70 percent and scenario c 57 percent

Figure 4.23 Externally influenced to move to cloud computing

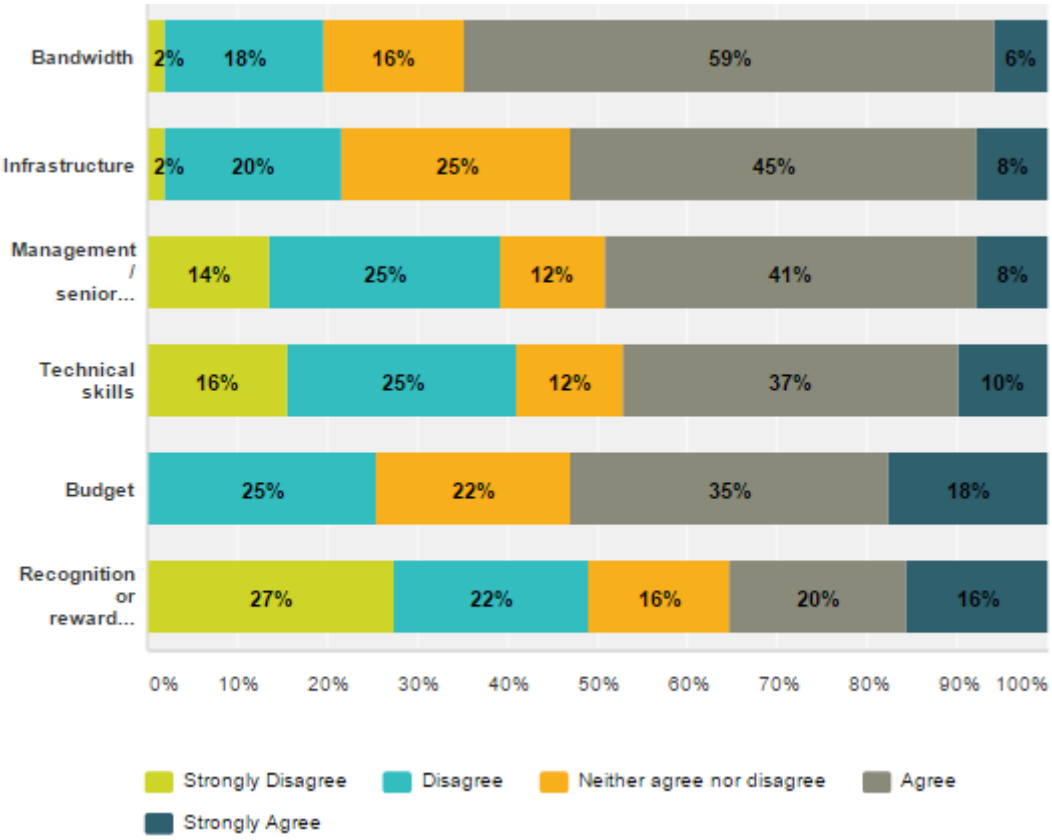


A = all respondents B = currently using cloud C = no cloud computing

The final question required respondents to indicate their perception of their organisations TOE readiness level for adopting cloud computing (Figure 4.24). Sixty five percent of respondents indicated that their organisations have adequate bandwidth to support a cloud computing model. Twenty percent indicated that they have sufficient bandwidth to adopt cloud computing and 16 percent was uncertain if they did. Fifty three percent of respondents indicated that their current IT infrastructure was adequate to support a cloud computing model; Twenty two percent stated that it was not adequate, twenty five percent was uncertain. Forty nine percent of respondents indicated that management and senior leadership support levels was sufficient to support the adoption of cloud computing, 39 percent disagreed. Forty seven percent of respondents agreed that their organisation currently had adequate technical skills to adopt cloud computing, 41 percent of respondents said that they did not have adequate levels of technical skill currently to adopt cloud computing. Fifty three percent of respondents indicated that their organisation had sufficient allocation of budget to adopt cloud computing model, 25 percent indicated that their organisation did not have adequate budget for a cloud computing initiative, 25

percent of respondents were unaware of the adequacy of their budgets. Thirty six percent of respondents indicated that their organisations had adequate recognition and reward incentives for individuals to drive cloud and innovation initiatives. The majority of 47 percent indicated the there was a lack of such incentives.

Figure 4.24 TOE resources level for cloud readiness all - respondents



Comparing the same data filtered by respondents whose organisation already uses cloud computing (Figure 4.25) versus organisation who have not yet adopted cloud computing (Figure 4.26). A clear pattern emerges, those who have adopted cloud computing have adequate resources for cloud adoption as indicated by a mean of 3.54, median of 3.83 and standard deviation of 0.99. Those who have not yet adopted cloud computing don't have adequate resources (mean = 2.79, median =2.5, standard deviation = 1.14).

Figure 4.25 TOE resources level for cloud readiness – using cloud computing

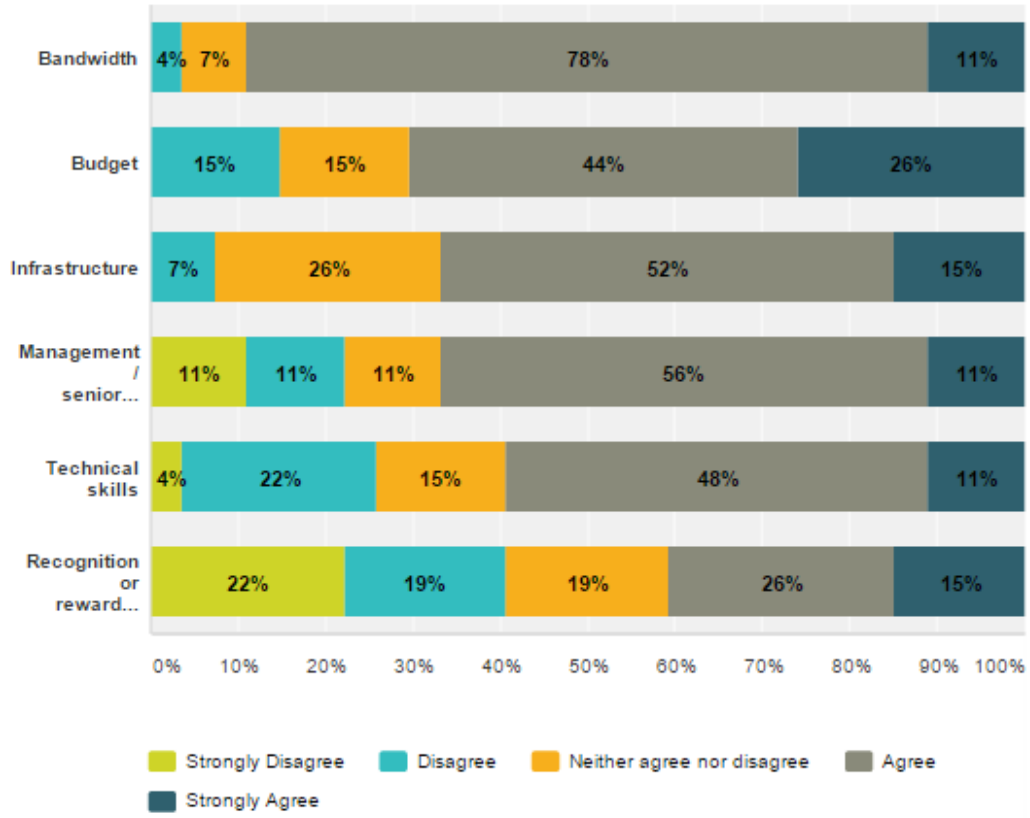
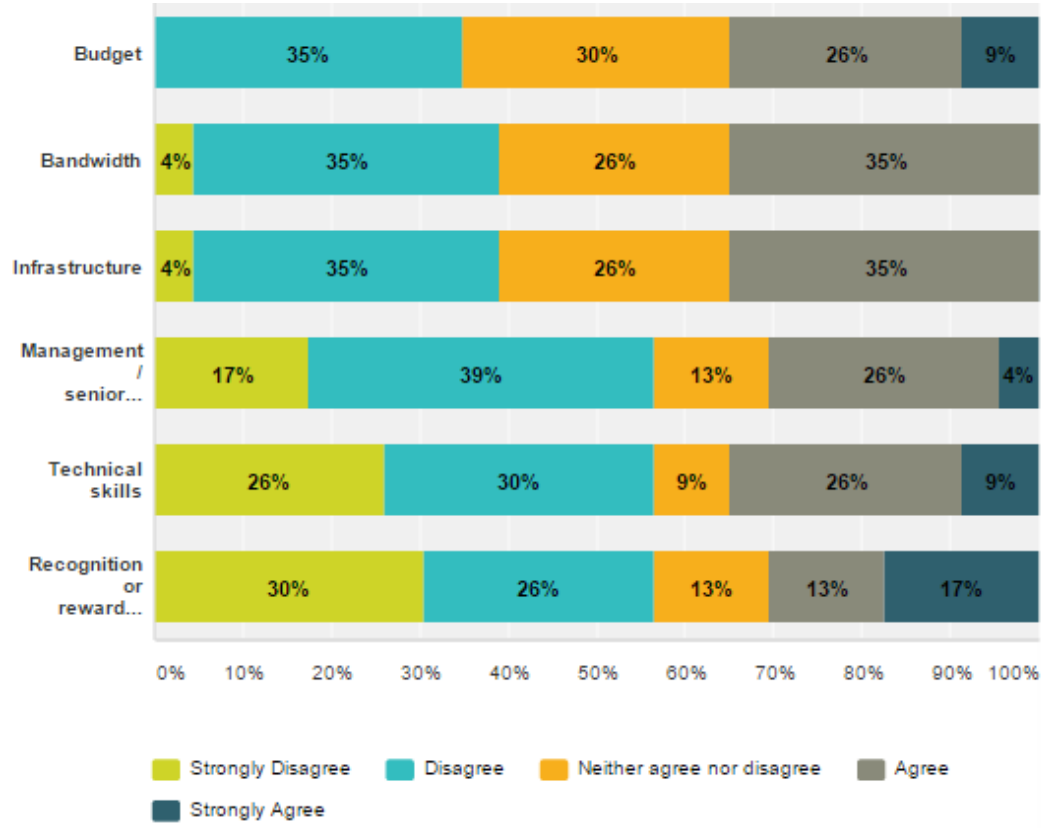


Figure 4.26 TOE resources level for cloud readiness – no cloud computing



4.7 CONCLUSION

Chapter 4 presented the descriptive statistics for the survey. The majority of the respondents (69%) were men between the ages 40 to 45 years and 31 percent spoke English as a first language. More than a third of respondents had worked at their organisations for between five and nine years. All respondents had a formal tertiary education and responses were gathered from all nine South African provinces.

More than half (54%) the respondents had adopted cloud computing in their organisations and the majority of these adoption projects (79%) were successful. The majority (93%) of these respondents plan to increase their use of cloud computing. Seventy percent of organisations that have not adopted cloud computing trust their internal IT systems above cloud technologies; however 78 percent of these respondents believe that cloud computing is a viable technology option. The most used cloud computing models were IaaS (61%) and PaaS (61%). Forty three percent of respondents plan to adopt cloud computing in the next 12 to 24 months. More than half (51%) of these respondents will adopt a private cloud environment in the next year whilst 41 percent will adopt hybrid cloud computing environments.

Although there was a consensus of the benefits of cloud computing (Table 2.1) as shown by the average positive rating ($\mu = 3.72$), there was a significant difference in the level of perceived benefit among those that have adopted cloud computing and those that are still to adopt (Figure 4.18). TOE barriers to adoption were tested. The overall rating for technical barriers was neutral ($\mu = 3.1$), whereas organisational barriers ($\mu = 3.7$) and environmental barriers ($\mu = 3.8$) were rated positively overall.

There is a distinct difference in the awareness of government initiative by those organisations that have adopted cloud computing (81%) to those that have not (30%). Sixty one percent of respondents stated that they are externally influenced to move to cloud computing. The average mean ($\mu = 3.2$) across all the TOE resources indicate a general readiness to move to cloud computing by all respondents.

CHAPTER 5
CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

In this chapter, the results from the data analysis will be summarised and linked to academic theory and to the research questions (Section 5.2). Several managerial implications and recommendations for future studies were identified (Section 5.3). Finally, several limitations of the research (Section 5.4) and suggestions for future research are provided (Section 5.5).

5.2 REVIEW OF RESEARCH QUESTIONS

5.2.1 Review of Secondary Research Question 1 (SRQ1)

What is the extent of adoption of cloud computing by the South African public sector?

The survey attracted respondents from all nine provinces in South Africa. Majority of responses came from the major economic provinces, Gauteng (41%), Kwa-Zulu-Natal (18%) and the Western Cape (12%). The majority (84%) of respondents held senior to executive public sector positions and majority (63%) was in that organisation for over five years. This demographic gives much validity to the accuracy of the results.

More than half of the public sector, 54% of the resopndents have already adopted some form of cloud computing in their organisations of these 90

percent had some success. The most widely adopted forms of cloud computing in the public sector currently are IaaS and PaaS, this contradicts the findings of Skok (2014) study which found that SaaS was the highest consumed cloud computing platform. The study confirms the findings of Atukwase (2014) showing that Cloud ERP is the least adopted form of cloud computing by the South Africa public sector.

The results show that there have been some success in the adoption of cloud by the South Africa public sector however there is still some way to go as almost half the sector by inference has not adopted any form of cloud computing. As per the literature review Skok (2014) proposes that the real value of cloud computing comes in the software, however this is not the most consumed pillar of cloud computing according to this study. Cloud ERP, which has lots to offer, likely the most to offer in terms of benefits is consumed the least. It is possible that these may be unique to the developing world public sector or the South African public sector.

The results shows that the majority of respondents' organisations (61%) are willing to adopt new technology to lower cost, however at the same time they (55%) will not shy away from new technology because of cost. More than half of the respondents' organisations consider themselves early adopters of technology. From this there is an understanding that there is an appetite for technology such as cloud computing by the South African public sector and the real value add which comes from SaaS should be promoted as the next step.

Respondents whose organisations have already adopted cloud computing were asked a few different questions than those organisations that are yet to adopt.

Of those that have cloud computing technology in place, 93 percent plan to increase their use of cloud computing; however, they prefer to use a combination of cloud and on premise systems. Seventy five percent of those who already have cloud computing are currently developing an organisational cloud strategy, (57%) testing a proof of concept, (68%) implementing and (71%) are currently assessing further use of cloud computing.

Those organisations who are still to adopt cloud computing (70%) trust their current IT systems over cloud based systems; however of these 78% believe that cloud computing is a viable technology option. Nearly half (43%) of those respondents who are yet to adopt cloud computing plan to do so in the next 12 to 24 months. This timeline somewhat confirms the Skok (2014) proposed timeline that showed that 65 to 70 percent will move to cloud in the next 24 months.

5.2.2 Review of Secondary Research Question 2 (SRQ2)

What are the benefits of cloud computing as perceived by South African public sector?

This section intended to gather an understanding of the benefits of cloud computing as perceived by the South African Public sector. From the literature reviewed 12 most prominent benefits (Table 1.2) was Identified and tested. The highest scoring benefit which 77 percent of respondents agreed and strongly agreed to, was that cloud computing facilitates access to the latest technology, this benefit was closely followed by a reduction in upfront cost and that cloud computing improves sustainability by reducing the carbon footprint through

efficient economies of scale. The average mean and average median distribution of the results indicate that generally respondents accepted all 12 benefits proposed as benefits their organisation already experienced or would accept as benefits and possibly experience if they adopted cloud computing. These findings confirm the Maluleka and Ruxwana (2013) study reporting that cloud computing improves cost effectiveness and efficiency of governments. From the results, one could conclude that there is a common acceptance and understanding across the South African public sector of the benefits of the adoption of cloud computing. An Anova test of the perceived benefits of organisations adopting cloud computing compared to those that are yet to adopt revelled a significant difference in the perception of benefits of cloud computing by the two groups. This lack of perceived benefit by organisations that are yet to adopt cloud computing could result in complacency and a delay in adoption.

5.2.3 Review of Secondary Research Question 3 (SRQ3)

What is the extent of technical, organisational and environment (TOE) barriers to cloud adoption faced by the South African public sector?

This question was intended to gather a full understanding of the perceived barriers to cloud adoption as experienced by the South African public sector. The TOE framework was adopted to get a full view of the understanding of the barriers to adoption of cloud computing.

Technical barriers

Upon analysing the literature, the twelve most important perceived technical barriers were identified. Availability of data stood out as the number one

perceived barrier to cloud adoption as reflected by 90 percent of responses. System performance and the lack of control of data closely followed as selected by 86 and 84 percent of respondents respectively. All 12 technical barriers proposed were of concern to the respondents in their consideration of cloud computing adoption as reflected by the average positive (μ=3.1) , with an average standard deviation below one. These findings confirm the validity of the identified technical barriers as summarised in Table 2.2 and it affirms the referred studies for each of these identified barriers.

Organisational barriers

Twelve perceived organisational barriers were tested on a five-point Likert scale. “Risk of failure of adoption of cloud computing to be greater that the benefits of success” was the highest perceived barrier as indicated by 74 percent of respondents. Concerns with “Software licencing agreements” was the second highest perceived barrier by 74 percent of respondents followed by higher operational expense selected by 69% of respondents. Lack of senior management or executive support (49%) and job insecurity due to possible IT downsizing (44%) scored as the lowest concerns with standard deviations of 0.69 and 1.02 respectfully. The results showing a lack of senior management support could be biased, since the respondents were the senior management and executives responsible. All 12 of the organisational barriers tested scored an average positive rating (μ = 3.83) with an average standard deviation of 0.94 indicating that organisational barriers are of important concern in improving the rate of adoption of cloud computing. From the TOE barriers, the organisational barriers scored the highest mean indicating that organisational barriers are the

highest barrier of concern. This confirms the Abrahams, Ophoff and Mwalemba (2015) study also showing that organisational concerns are the highest category of concern of the TOE framework.

Environmental barriers

Nine perceived environmental barriers were tested. Two barriers had the same rating and were the highest rated of the environmental barriers, and these were, no national cloud computing policy in place and regulatory requirement (73% each). Trans-border information flow was the second highest rated environmental barrier with 70 percent. The most concerning perceived environmental barriers selected, are all government policy factors and awareness campaigns. There are government cloud initiatives currently in place as identified by respondents in the comments section, namely “Government strategic plan 7.1” and “SITA” initiatives. Trans-border information flow – public and financial sector information is not allowed to pass the borders of South Africa. However, the reputable large software vendors host their cloud data offshore. The Abrahams, Ophoff and Mwalemba (2015) study also identifies the South African environmental factors as preventative to the rapid adoption of technology.

5.2.4 Review of Secondary Research Question 4 (SRQ4)

What is the level of readiness of South Africa public sector to adopt cloud computing technologies?

Major readiness differences emerged between organisations that already have cloud computing in place verses those organisations that are yet to adopt. From

an awareness perspective those organisation that adopted cloud computing are 51 percent more aware of government initiative that those organisation that are yet to adopt cloud.

The essential TOE resources availability was tested, this included bandwidth, budget, Infrastructure, senior leadership support, technical skill and recognition and reward incentives for individual to drive cloud or innovation initiatives. Those public sector organisations that already adopted cloud computing possess greater resource availability to further increase adoption of cloud technologies as compared to those organisation that are yet to adopt. This is reflected by direct comparisons of each readiness factor tested as well as the overall average (μ=3.55) for having adopted cloud compared with still to adopt (μ=2.79). Therefore it can be deduced that the lack of these readiness factors are delaying the move to cloud computing by these organisation. This reaffirms the findings of the study (Mutula and Mostert, 2010) reporting that the investments made by the South African government in administering service delivery through e-governance using cloud computing were not successful due to lack of monitoring and evaluating systems in place.

5.2.5 Review of Primary Question (PRQ)

What is the extent (current state, benefits, barriers, and readiness levels) of Adoption of Cloud computing by the South Africa Public sector?

The primary objective (PRO) of this study was to determine the extent (benefits, barriers, current state and readiness levels) of adoption of cloud computing by

the South African Public sector. This objective has been met, thereby answering the primary research question, by the analysis of data presented in Chapter 4. In summary, the South African Public sector has a moderate inclination for new technology as reflected by their wiliness to adopt new technology and the successful current adoption levels and mix of cloud computing technologies by more than half of the sector's organisations. Public sector organisations that have already adopted cloud computing also reflect greater technical and managerial maturity compared to those that are yet to adopt. There is good agreement and general understanding of the benefits of cloud computing. Organisations yet to implement cloud technologies plan to do so in the next 12 to 36 months; however, the TOE barriers especially organisational barriers may limit adoption levels.

5.3 CONTRIBUTIONS AND RECOMMENDATIONS

This research contributes to the theory of cloud computing, adoption of technology studies, and the progress of public sector through technology adoption. The findings presented allows for the understanding of what encourages and what prevents the adoption of cloud technology. The TOE framework used to elicit the barriers to adoption is of substantial benefit to the public sector in assessing not just technological progress but government progress in general as government can influence or control all the barriers tested as compared to other sectors that are limited to work within their area of influence. Organisations can use the study to assess their readiness to adopt and chances of success.

There is work to be done by the sector especially the local municipalities to prepare them for further technology adoption. Organisations in this sector need to be prepared managerially for acquiring the appropriate structures, technical skill and incentives to drive technology adoption. Cloud technology adoption campaigns should intensify to ensure an increase in awareness by those organisations who are yet to adopt cloud technologies. Sector organisations wanting to adopt cloud computing should learn from fellow sector organisations that have already successfully implemented such technologies in order to ensure higher implementation success rates. Offshore data hosting policies is of concern and should be reviewed since most major vendors host offshore to allow economies of scale; whilst private cloud may address this concern to some degree, the economies of cloud technologies are lost.

5.4 LIMITATIONS OF THE RESEARCH

The sample size of 51 is relatively small compared the extent of the public sector. The spread of respondents from the countries various provinces was skewed to the major economic cities. Majority of respondents where local municipalities, more provincial and national department can be included. The research was mostly quantitative, thus a more detailed understanding may surface in a qualitative approach.

5.5 FURTHER RESEARCH

Future research in adoption of cloud computing should consider.

- Focus on a specific area within the public sector such as healthcare, transport, security, financial and so forth.
- Achieving a larger sample size, which will increase the spread of responses and reliability of the results.
- Change the research model hypothesis to prove the relationship between TOE factors and adoption rates.
- Research both vendors, sector views of cloud adoption, and understand the perception gaps.

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APPENDIX A:
QUESTIONNAIRE

A.1 Initial participant invite email

Dear $%Executive Name%,

The Nelson Mandela Metropolitan University Business School request your participation in a Cloud Computing survey of the South Africa Public sector.
As an integral Government Information Officer you have been specifically selected to participate as you are an important contributor to the development of your organisation and South Africa through you ICT involvement.

This study will enable us to gather a clearer view of our Public sectors technology adoption and the challenges thereof. In doing so we may be able to propose a more effective and efficient technology adoption guideline which learns from your organisations challenges strengths and synergies to in return enable you and the public sector at large to move forward with technology.

This online survey should take less than 15 minutes to complete and can be accessed by clicking the link below or coping and pasting the url into your web browser. For your convenience this link can also be accessed from any connected device such as a smart phone or tablet.

Survey Link: https://www.surveymonkey.com/s/Cloud_Survey_2015

Please note that your participation in this study is entirely voluntary and you have the right to withdraw from the study at any stage.
All information will be treated as STRICTLY CONFIDENTIAL and will only be used for academic purposes. The survey has been structured to ensure your anonymity.
Should you wish to verify the authenticity of the study, please contact Dr. Brenda Scholtz from NMMU at +27 41 504 2079 or Brenda.Scholtz@nmmu.ac.za

Please complete the questionnaire by 30 July 2015.

Thank you, your contribution is highly appreciated.

Sincerest Regards

Judian Govender
Independent Management Consultant | Technology & Innovation
T +27-11-656-6718, M +27-73-919-8076, mailto: Judian.Govender@gmail.com

A.2 Initial reviewed questionnaire

SECTION A: DEMOGRAPHIC AND ORGANISATIONAL INFORMATION

A1. What is your age?

20 - 29 years	30 – 39 years	40 – 49 years	50 – 59 years	60 + years

A2. What is your gender?

Male	Female

A3. What is your first official language?

English	Afrikaans	Zulu	Xhosa	North Sotho
Tswana	Tsonga	Venda	Swati	South Sotho
Ndebele	Other			

A4. What is the highest education level you have completed?

Senior Certificate	Diploma	Degree	Honours	Masters	PHD

A5. For which department or agency are you currently working?

A6. In which province do you work?

The Eastern Cape	The Free State	Gauteng	KwaZulu-Natal	Limpopo
The Western Cape	The Northern Cape	Mpumalanga	North West	All

A7. What is your status in your company?

Executive Management	Senior Management	Middle Management	Senior Employee	Junior Employee

A8. Please indicate the number of employees in your organisation?

1 -49	50 -99	100- 199	200-499	500+

A9. How many years are you in your current organisation?

Less than a year	1 to 4 years	5 to 9 years	10+ years

A10. How many years are you in your current role?

Less than a year	1 to 4 years	5 to 9 years	10+ years

SECTION B: ADOPTION OF CLOUD COMPUTING

B1. Please indicate whether or not you agree or disagree with the following statements regarding your organisation.

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
B1.1	My organisation is willing to adopt new technology to save money					
B1.2	My organisation prefers to cut back on new technology to save money					
B1.3	My organisation considers themselves early adopters of new technologies					

B2. Does your company use cloud computing?

Yes	No

If Yes to B2 please complete B3 to B5 else complete B6 to B9

B3. Was the Cloud Computing project that you undertook successful?

Not at all	Very little	Somewhat	Much	To a great extent

B4. To what extent does your organisation utilise the following technologies?		Not at all	Little	Somewhat	Much	A great degree
B4.1	SaaS – Software as a Service	1	2	3	4	5
B4.2	Cloud ERP / Enterprise resource planning	1	2	3	4	5
B4.3	Cloud CRM - Customer relationship management	1	2	3	4	5
B4.4	Cloud HRM – Human Resource Management	1	2	3	4	5
B4.5	Cloud Analytics – On demand Business Intelligence solutions	1	2	3	4	5
B4.6	IaaS –Infrastructure as a Service	1	2	3	4	5
B4.7	PaaS – Platform as a Service	1	2	3	4	5
B4.8	Other:			3	4	5

If you answered Yes to B2 proceed to section C.

B5. Which of the following activities has your organisation undertaken as part of its move towards adopting / implementing a cloud environment?		Yes	No
B5.1	Rely solely on cloud computing technologies for their ICT needs	1	2
B5.2	Utilise a combination of cloud computing and internally owned IT systems	1	2
B5.3	Currently assessing the cloud	1	2
B5.4	Developing a cloud strategy	1	2
B5.5	Testing a proof of concept	1	2
B5.6	Currently implementing	1	2
B5.7	Plans to increase your use of cloud	1	2

B.6 To what extent do you agree with the following statements		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
B6.1	My company trusts our internal IT systems over cloud-based technologies	1	2	3	4	5
B6.2	It's too soon to adopt cloud computing	1	2	3	4	5
B6.3	Cloud computing is a viable technology option	1	2	3	4	5
B.7	My organisation plans to integrate some form of cloud computing in the next 12 months	Yes	No			

B8. What types of cloud computing environments does your organisation use / intend to use?

	Yes currently	Yes in the next year	No not in the next year
B8.1 Private cloud	1	2	3
B8.2 Public cloud	1	2	3
B8.3 Hybrid cloud	1	2	3
B8.4 Community cloud	1	2	3

SECTION C: BENEFITS OF CLOUD COMPUTING

C1. To what extent do you agree that adopting cloud computing technology has the following benefits?

Cloud Computing:		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
C1.1	Reduces upfront costs	1	2	3	4	5
C1.2	Helps the organisation to be more flexible	1	2	3	4	5
C1.3	Allows the organisation to better focus on its core business	1	2	3	4	5
C1.4	Is easier to implement than traditional on-premise technology	1	2	3	4	5
C1.5	Increases staff mobility through remote and mobile information access	1	2	3	4	5
C1.6	Provides improved scalability of hardware according to demand	1	2	3	4	5
C1.7	Provides improved scalability of software according to demand	1	2	3	4	5
C1.8	Helps the organisation to react more quickly to market conditions and competition	1	2	3	4	5
C1.9	Facilitates access to the latest technologies	1	2	3	4	5
C1.10	Improves collaboration between different department, agencies, suppliers and citizens	1	2	3	4	5
C1.11	Improves sustainability by reducing carbon footprint through efficient economies of scale	1	2	3	4	5
C1.12	Embracing cloud computing would make our organisation more effective and efficient ultimately leading to better service delivery	1	2	3	4	5
C1.13	Has other benefits (specify):				4	5

SECTION D: BARRIERS TO CLOUD ADOPTION

D1. Based on your organisation's current awareness of cloud computing, how important are the following **technical** concerns in adopting a cloud environment?		Not important	Slightly important	Important	Very Important
D1.1	The availability of data	1	2	3	4
D1.2	The privacy of data	1	2	3	4
D1.3	Lack of control of data	1	2	3	4
D1.4	Multitenancy, i.e. different organisation data hosted on the same server	1	2	3	4
D1.5	Cyber attacks	1	2	3	4
D1.6	System performance	1	2	3	4
D1.7	Difficulty to integrate with in-house system	1	2	3	4
D1.8	Not enough ability to customise	1	2	3	4
D1.9	Difficult to bring back in-house	1	2	3	4
D1.10	Lack of support from vendors	1	2	3	4
D1.11	Lack of compatibility with proprietary software	1	2	3	4
D1.12	Poor IT infrastructure currently in place	1	2	3	4

D2. Based on your organisation's current awareness /experience of cloud computing, how important are the following **organisational** concerns in adopting a cloud environment?		Extremely unimportant	Unimportant	Neither important nor unimportant	Important	Extremely Important
D2.1	Not a departmental or agency strategic initiative	1	2	3	4	5
D2.2	Lack of senior management /executive support	1	2	3	4	5
D2.3	User resistance	1	2	3	4	5
D2.4	Migration cost	1	2	3	4	5
D2.5	Government cloud vs public cloud	1	2	3	4	5
D2.6	Management of service provides	1	2	3	4	5
D2.7	Software licencing agreements	1	2	3	4	5
D2.8	Higher operational expense for cloud	1	2	3	4	5
D2.9	No physical assets purchased with budget	1	2	3	4	5
D2.10	Job insecurity i.e. IT department downsizing	1	2	3	4	5
D2.11	Shortage of cloud computing skills	1	2	3	4	5
D2.12	Risk of failure of adopting cloud computing to be greater than the benefits of a success	1	2	3	4	5

D3. Based on your organisation's current awareness of cloud computing, how important are the following **environmental** concerns in adopting a cloud environment?		Extremely unimportant	Unimportant	Neither important nor unimportant	Important	Extremely Important
D3.1	Lack of approved cloud standards	1	2	3	4	5
D3.2	No national cloud computing policy in place	1	2	3	4	5
D3.3	No national, local, departmental or agency cloud adoption strategy or guidelines in place	1	2	3	4	5
D3.4	Regulatory requirements	1	2	3	4	5
D3.5	Trans-border information flow	1	2	3	4	5
D3.6	Lack of specialist public sector local vendors	1	2	3	4	5
D3.7	Electricity availability	1	2	3	4	5
D3.8	Broadband connectivity	1	2	3	4	5
D2.9	Sustainability and carbon efficiency	1	2	3	4	5

SECTION E: READINESS FACTORS TO ADOPTING CLOUD COMPUTING

E1. Are you aware of any Government drives / mandates towards cloud computing?

Yes	no
Please Describe:	

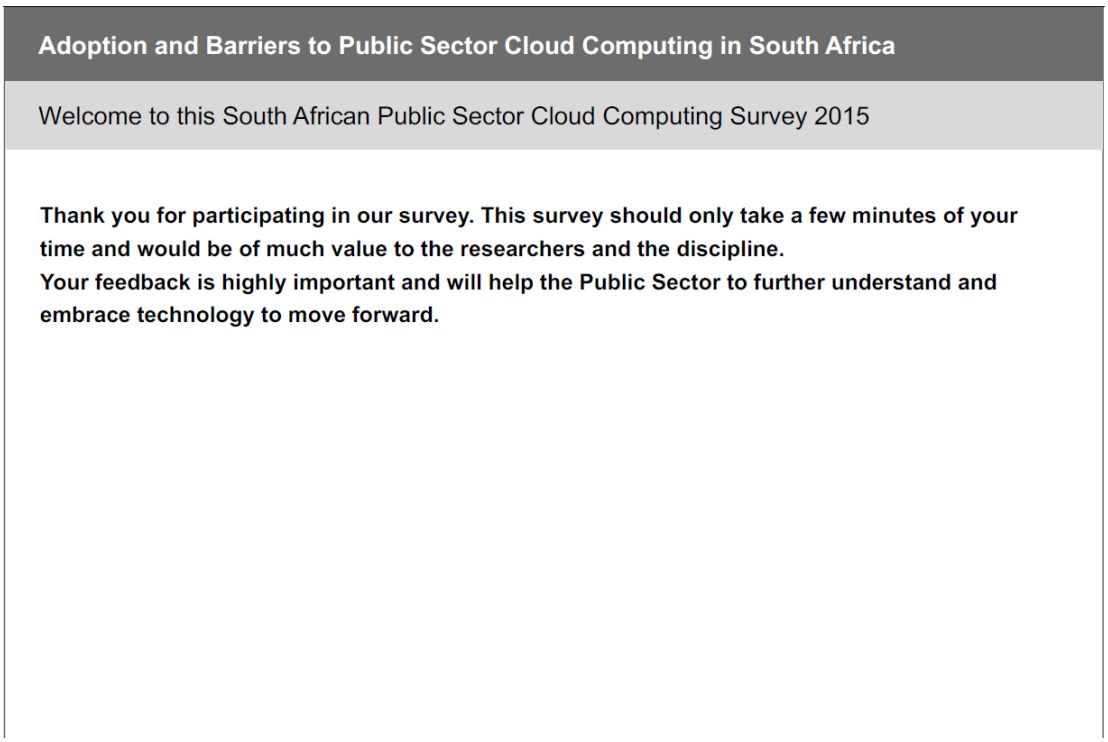
E2. Are you impacted or influenced to move to cloud by any forces external to your organisation?

Yes	no
Please Describe:	

E3.Does you organisation have adequate levels of the resources listed below to adopt and support a cloud computing model?		Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
E3.1	Bandwidth	1	2	3	4	5
E3.2	Infrastructure					
E3.3	Management / senior leadership support	1	2	3	4	5
E3.4	Technical skills	1	2	3	4	5
E3.5	Budget	1	2	3	4	5
E3.6	Recognition or reward incentives for individuals to drive cloud or innovation initiatives	1	2	3	4	5

Conclude with “Thank you for …”

A.3 Online survey



Adoption and Barriers to Public Sector Cloud Computing in South Africa

Welcome to this South African Public Sector Cloud Computing Survey 2015

Thank you for participating in our survey. This survey should only take a few minutes of your time and would be of much value to the researchers and the discipline.
Your feedback is highly important and will help the Public Sector to further understand and embrace technology to move forward.

Adoption and Barriers to Public Sector Cloud Computing in South Africa

Demographics

What is your age?

- ◯ 20 to 29
- ◯ 30 to 39
- ◯ 40 to 49
- ◯ 50 to 59
- ◯ 60 or older

What is your gender?

- ◯ Male
- ◯ Female

What is your first official language?

What is the highest level of education you have completed?

Other (please specify)

Adoption and Barriers to Public Sector Cloud Computing in South Africa

Organisational Information

For which department or agency are you currently working?

In which provinces do you work?

- [ ] The Eastern Cape
- [ ] The Free State
- [ ] Gauteng
- [ ] KwaZulu-Natal
- [ ] Limpopo
- [ ] The Western Cape
- [ ] The Northern Cape
- [ ] Mpumalanga
- [ ] North West
- [ ] All

What is your status in your company?

- ( ) Junior Employee
- ( ) Senior Employee
- ( ) Middle Management
- ( ) Senior Management
- ( ) Executive Management

How many years are you in your current role?

- ( ) Less than a year
- ( ) 1 to 4 years
- ( ) 5 to 9 years
- ( ) 10+ years

Adoption and Barriers to Public Sector Cloud Computing in South Africa

Adoption of Cloud Computing

Please indicate whether or not you agree or disagree with the following statements regarding your organisation

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
My organisation is willing to adopt new technology to save money	◯	◯	◯	◯	◯
My organisation prefers to cut back on new technology to save money	◯	◯	◯	◯	◯
My organisation considers themselves early adopters of new technologies	◯	◯	◯	◯	◯

Does your company use cloud computing?

◯ Yes

◯ No

Adoption and Barriers to Public Sector Cloud Computing in South Africa

Adoption of Cloud Computing

Was the Cloud Computing project that you undertook successful?

- ◯ Not at all
- ◯ Very little
- ◯ Somewhat
- ◯ Much
- ◯ To a great extent

To what extent does your organisation utilise the following technologies?

	Not at all	Little	Somewhat	Much	A great degree
SaaS – Software as a Service	◯	◯	◯	◯	◯
Cloud ERP / Enterprise resource planning	◯	◯	◯	◯	◯
Cloud CRM - Customer relationship management	◯	◯	◯	◯	◯
Cloud HRM – Human Resource Management	◯	◯	◯	◯	◯
Cloud Analytics – On demand Business Intelligence solutions	◯	◯	◯	◯	◯
IaaS –Infrastructure as a Service	◯	◯	◯	◯	◯
PaaS – Platform as a Service	◯	◯	◯	◯	◯

Other (please specify)

Adoption and Barriers to Public Sector Cloud Computing in South Africa

Adoption of Cloud Computing

Which of the following activities has your organisation undertaken as part of its move towards adopting / implementing a cloud environment?

	Yes	No
Rely solely on cloud computing technologies for their ICT needs	◯	◯
Utilise a combination of cloud computing and internally owned IT systems	◯	◯
Currently assessing the cloud	◯	◯
Developing a cloud strategy	◯	◯
Testing a proof of concept	◯	◯
Currently implementing	◯	◯
Plans to increase your use of cloud	◯	◯

Adoption and Barriers to Public Sector Cloud Computing in South Africa

Adoption of Cloud Computing

To what extent do you agree with the following statements

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
My company trusts our internal IT systems over cloud-based technologies	◯	◯	◯	◯	◯
It's too soon to adopt cloud computing	◯	◯	◯	◯	◯
Cloud computing is a viable technology option	◯	◯	◯	◯	◯

My organisation plans to integrate some form of cloud computing in the next

- ◯ 0 - 12 months
- ◯ 12 - 24 Months
- ◯ 24 - 36 Months
- ◯ 36 - 48 Months
- ◯ 48 - 60 Months
- ◯ Never

Adoption and Barriers to Public Sector Cloud Computing in South Africa

Adoption of Cloud Computing

What types of cloud computing environments does your organisation use / intend to use?

	Yes currently	Yes in the next year	No not in the next year
Private cloud	◯	◯	◯
Public cloud	◯	◯	◯
Hybrid cloud	◯	◯	◯
Community cloud	◯	◯	◯

Adoption and Barriers to Public Sector Cloud Computing in South Africa

Benefits of Cloud Computing

To what extent do you agree that adopting cloud computing technology has the following benefits?

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Reduces upfront costs	◯	◯	◯	◯	◯
Helps the organisation to be more flexible	◯	◯	◯	◯	◯
Allows the organisation to better focus on its core business	◯	◯	◯	◯	◯
Is easier to implement than traditional on-premise technology	◯	◯	◯	◯	◯
Increases staff mobility through remote and mobile information access	◯	◯	◯	◯	◯
Provides improved scalability of hardware according to demand	◯	◯	◯	◯	◯
Provides improved scalability of software according to demand	◯	◯	◯	◯	◯
Helps the organisation to react more quickly to market conditions and competition	◯	◯	◯	◯	◯
Facilitates access to the latest technologies	◯	◯	◯	◯	◯
Improves collaboration between different department, agencies, suppliers and citizens	◯	◯	◯	◯	◯
Improves sustainability by reducing carbon footprint through efficient economies of scale	◯	◯	◯	◯	◯
Embracing cloud computing would make our organisation more effective and efficient ultimately leading to better service delivery	◯	◯	◯	◯	◯

Has other benefits (please specify)

Barriers to Cloud Adoption

Based on your organisation's current awareness of cloud computing, how important are the following *technical* concerns in adopting a cloud environment?

	Not important	Slightly important	Important	Very Important
The availability of data	◯	◯	◯	◯
The privacy of data	◯	◯	◯	◯
Lack of control of data	◯	◯	◯	◯
Multitenancy, i.e. different organisation data hosted on the same server	◯	◯	◯	◯
Cyber attacks	◯	◯	◯	◯
System performance	◯	◯	◯	◯
Difficulty to integrate with in-house system	◯	◯	◯	◯
Not enough ability to customise	◯	◯	◯	◯
Difficult to bring back in-house	◯	◯	◯	◯
Lack of support from vendors	◯	◯	◯	◯
Lack of compatibility with proprietary software	◯	◯	◯	◯
Poor IT infrastructure currently in place	◯	◯	◯	◯

Based on your organisation's current awareness /experience of cloud computing, how important are the following *organisational* concerns in adopting a cloud environment?

	Extremely unimportant	Unimportant	Neither important nor unimportant	Important	Extremely important
Not a departmental or agency strategic initiative	○	○	○	○	○
Lack of senior management /executive support	○	○	○	○	○
User resistance	○	○	○	○	○
Migration cost	○	○	○	○	○
Government cloud vs public cloud	○	○	○	○	○
Management of service provides	○	○	○	○	○
Software licencing agreements	○	○	○	○	○
Higher operational expense for cloud	○	○	○	○	○
No physical assets purchased with budget	○	○	○	○	○
Job insecurity i.e. IT department downsizing	○	○	○	○	○
Shortage of cloud computing skills	○	○	○	○	○
Risk of failure of adopting cloud computing to be greater than the benefits of a success	○	○	○	○	○

Based on your organisation's current awareness of cloud computing, how important are the following *environmental* concerns in adopting a cloud environment?

	Extremely unimportant	Unimportant	Neither important nor unimportant	Important	Extremely Important
Lack of approved cloud standards	○	○	○	○	○
No national cloud computing policy in place	○	○	○	○	○
No national, local, departmental or agency cloud adoption strategy or guidelines in place	○	○	○	○	○
Regulatory requirements	○	○	○	○	○
Trans-border information flow	○	○	○	○	○
Lack of specialist public sector local vendors	○	○	○	○	○
Electricity availability	○	○	○	○	○
Broadband connectivity	○	○	○	○	○
Sustainability and carbon efficiency	○	○	○	○	○

Adoption and Barriers to Public Sector Cloud Computing in South Africa

Readiness Factors to Adopting Cloud Computing

Are you aware of any Government drives / mandates towards cloud computing?

- ◯ Yes
- ◯ No

Please Describe

Are you impacted or influenced to move to cloud by any forces external to your organisation?

- ◯ Yes
- ◯ No

Please describe:

Does you organisation have adequate levels of the resources listed below to adopt and support a cloud computing model?

	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
Bandwidth	◯	◯	◯	◯	◯
Infrastructure	◯	◯	◯	◯	◯
Management / senior leadership support	◯	◯	◯	◯	◯
Technical skills	◯	◯	◯	◯	◯
Budget	◯	◯	◯	◯	◯
Recognition or reward incentives for individuals to drive cloud or innovation initiatives	◯	◯	◯	◯	◯

APPENDIX B: Ethical clearance

Nelson Mandela Metropolitan University
for tomorrow

FORM E

ETHICS CLEARANCE FOR TREATISES/DISSERTATIONS/THESES

Please type or complete in black ink

FACULTY: **Business and Economic Sciences**

SCHOOL/DEPARTMENT: **Business School**

I, (surname and initials of supervisor) **Scholtz B**

the supervisor for (surname and initials of candidate) **Govender J**

(student number) **211215503**

a candidate for the degree of **Masters of Business Administration**

with a treatise/dissertation/thesis entitled (full title of treatise/dissertation/thesis):

Adoption and Challenges of Cloud Computing in South Africa Public Sector

considered the following ethics criteria *(please tick the appropriate block):*

	YES	NO
1. Is there any risk of harm, embarrassment of offence, however slight or temporary, to the participant, third parties or to the communities at large?		✓
2. Is the study based on a research population defined as 'vulnerable' in terms of age, physical characteristics and/or disease status?		✓
2.1 Are subjects/participants/respondents of your study:		✓
(a) Children under the age of 18?		✓
(b) NMMU staff?		✓
(c) NMMU students?		✓
(d) The elderly/persons over the age of 60?		✓
(e) A sample from an institution (e.g. hospital/school)?		✓
(f) Handicapped (e.g. mentally or physically)?		✓

3. Does the data that will be collected require consent of an institutional authority for this study? (An institutional authority refers to an organisation that is established by government to protect vulnerable people)		✓
3.1 Are you intending to access participant data from an existing, stored repository (e.g. school, institutional or university records)?		✓
4. Will the participant's privacy, anonymity or confidentiality be compromised?		✓
4.1 Are you administering a questionnaire/survey that:		✓
(a) Collects sensitive/identifiable data from participants?		✓
(b) Does not guarantee the anonymity of the participant?		✓
(c) Does not guarantee the confidentiality of the participant and the data?		✓
(d) Will offer an incentive to respondents to participate, i.e. a lucky draw or any other prize?		✓
(e) Will create doubt whether sample control measures are in place?		✓
(f) Will be distributed electronically via email (and requesting an email response)? Note: • If your questionnaire **DOES NOT** request respondents' identification, is distributed electronically and you request respondents to return it *manually* (print out and deliver/mail); **AND** respondent anonymity can be guaranteed, your answer will be NO. • If your questionnaire **DOES NOT** request respondents' identification, is *distributed via an email link and works through a web response system (e.g. the university survey system);* ***AND*** respondent anonymity can be guaranteed, your answer will be NO.		✓

*Please note that if **ANY** of the questions above have been answered in the affirmative **(YES)** the student will need to complete the full ethics clearance form (REC-H application) and submit it with the relevant documentation to the Faculty RECH (Ethics) representative.*

and hereby certify that the student has given his/her research ethical consideration and full ethics approval is not required.

SUPERVISOR(S) — **DATE** 31/05/2015

p.p. **HEAD OF DEPARTMENT** — **DATE** 1/6/2015

STUDENT(S) — **DATE** 25/05/2015

Please ensure that the research methodology section from the proposal is attached to this form.

Please note that by following this Proforma ethics route, the study will NOT be allocated an ethics clearance number.

APPENDIX C: Declaration form

DEPARTMENT OF ACADEMIC ADMINISTRATION
EXAMINATION SECTION
SUMMERSTARND NORTH CAMPUS
PO Box 77000
Nelson Mandela Metropolitan University
Port Elizabeth
6013

Enquiries: Postgraduate Examination Officer

Nelson Mandela Metropolitan University
for tomorrow

DECLARATION BY CANDIDATE

NAME: JUDIAN GOVENDER

STUDENT NUMBER: 21121503

QUALIFICATION: MASTERS IN BUSINESS ADMINISTRATION

TITLE OF PROJECT: ADOPTION OF CLOUD COMPUTING BY THE SOUTH AFRICAN PUBLIC SECTOR

DECLARATION:

In accordance with Rule G5.6.3, I hereby declare that the above-mentioned treatise/ dissertation/ thesis is my own work and that it has not previously been submitted for assessment to another University or for another qualification.

SIGNATURE: 

DATE: 17/11/2015