



PERCEPTIONS OF CLOUD COMPUTING IN THE SOUTH AFRICAN GOVERNMENT

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Declaration

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Abstract

The South African government is unable to provide efficient Information Technology (IT) services to the citizens because of the fragmented approach in government where each department procures their own IT services and equipment. This leads to a silo approach and no sharing across the departments. The rapid technology advancements are creating new opportunities and a new way of working. Government is unable to respond to the demand and the rigid procurement makes getting a new service or equipment a laborious task. The departments do not have buying power because of the silo approach. There are no economies of scale, integration and interoperability that will make technology less expensive and shared across government. The diverse environments that have different technologies are growing and becoming increasingly more complex and unmanageable. The suppliers are going directly to the departments by bypassing the government mandate. Cloud computing is an option to assist government but the adoption of cloud computing is slow.

If the situation remains the same or if nothing is done to improve the government ICT services, the service delivery for efficient ICT services to citizens will decline. An example is: People will need to take time off from their jobs in order to go to a government department and then wait in the long queues to get a basic service - this will create frustration and dissatisfaction towards the SA government. This is time consuming as each time that a person will need a service then they will have to go to the government department for a service that could have been offered as an ICT service.

A survey was conducted for the government users and the primary objectives was to determine the awareness of government IT employees about cloud computing and government IT employee readiness to implement cloud computing solutions.

The results show that government users are in favour of using cloud computing and understand the many benefits and challenges. Poor security is the number one disadvantage; and the government department must ensure that the data in cloud computing is kept secure. E-Mail, ECM and ERP software are the most used software in government that must move to cloud computing. A government cloud and community cloud must be used in order to keep data secure. For a successful adoption of cloud computing, the important drivers that must be considered includes: scalability of infrastructure, reduce cost as it is pay for what is used, skills training and ensure business continuity.

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Chapter 1. Introduction

1.1 What is Cloud Computing?

The SA government wants to use new technology to provide better services to its citizens and IT has drastically improved over the last few years with new functionality and lower cost. The government's IT landscape has been slowly transforming to meet the needs of the citizens. The introduction of cloud computing will require government to make decisions for investments into the government IT landscape in order to provide better services.

The traditional thinking about IT is where infrastructure is bought upfront and the platforms are installed on the infrastructure and services are installed that use the platform and infrastructure. This upfront investment is made without really knowing if the service will work. Cloud computing has changed this paradigm whereby the consumer does not need to buy the infrastructure, platform or services but rather rent it for a specific time and pay for what is used. This can be compared to the water that we get in our homes; we don't know how it reached our homes or where it is stored but if we want water we open the tap and we pay only for what is used. Similarly, if there is a requirement for an IT service such as an email service, the cloud provider will provide access to an email service over the Internet - this is known as Software-as-a-Service (SaaS) - without having to buy servers, software or network equipment.

With rapid development of processing and storage technologies and the success of the Internet, the computer resources have become cheaper and more powerful. Cloud computing provides many benefits such as no upfront investment, lowering of operating costs and high scalability, where the cloud resources can be increased or decreased based on the demand (Zhang, Cheng & Boutaba, 2010).

The people of South Africa are exposed to high quality IT services that are available in the private sector and with this knowledge they are demanding similar services in government. The trend is that many of the services are being made available over the Internet instead of the old approach of being in extranets. Cloud computing is changing the way that IT is being provided and managed where, traditionally hardware and software were bought and managed through its life-cycle. The limitation was on the capacity as it was not scalable and if a new service is required then additional hardware and software needs to be procured, installed and provisioned.

However, with cloud computing the paradigm has changed from ownership to rental where the asset is not bought but rented for a specific time and only pay for the usage. Cloud computing can fill a need that makes the user more empowered and they can control what they want and how they want it.

Cloud computing fits into an integrated hardware and software provisioning where the hardware and software is now scalable, elastic and easily provisioned. If a new service is required it can be provisioned in a few minutes with a few configuration settings to setup the new environment. Some of the benefits include (Varia, 2010):

- Just-in-time Infrastructure: It is not limited by capacity and services can be quickly provisioned as it is managed centrally.
- Usage based costing: The user only pays for what they use. This is a new way of thinking by giving the user more choice and allowing them to control their usage.
- Virtual Administration: The administrators will move up the technology stack and learn how to manage abstract cloud resources using scripts.
- Multi-tenancy: Multiple users can share physical resources.
- Disaster Recovery and Business Continuity: The way the cloud is architected, it will have disaster recovery and business continuity in place.
- Security: There will be security in the way the cloud is designed by ensuring the data is protected while in transit and while at rest.

There are different definitions of cloud computing and, according to the National Institute of Standards and Technology (NIST), after sixteen updates to the definition, the final definition of cloud computing is:

“Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.”

Source: (<http://csrc.nist.gov/publications/nistpubs/800-145/SP800-145.pdf>)

1.2 Why focus on the SA Government

According to Jansen & Grance (2011) from NIST, the public cloud providers’ default offerings generally do not have specific government department’s security and privacy requirements for

cloud computing - the standard cloud offering may not be well suited for the government if it is not customised.

The South African State Information Technology Agency (SITA) has been established to consolidate the IT requirements for government and this includes being a service provider to government and also to assist government to get services from industry (State IT Agency, 2006). Due to the dynamics of the government-specific requirements, SITA made a strategic decision that it will become a cloud service provider to government. The cloud computing strategy was approved by the SITA Executive team and the management board. SITA will assist government by providing these cloud services within the government network so the data does not leave the government network.

1.3 Contribution and Limitation

The contribution of this study will provide a view on cloud computing in government that includes awareness about the understanding of cloud computing, the opportunities that are available with cloud computing, the transition of old technology to the adoption of cloud computing, the challenges with adopting cloud computing and the administrator perspectives.

The limitations of the study: There may be a lack of knowledge from some of the respondents about cloud computing and equal representation of respondents from all spheres of government departments.

1.4 Research Goals

There has been much interest in cloud computing and whether it does offer any real value as compared to mainframe and traditional computing. The purpose of this dissertation is to determine the perceptions of the SA government towards cloud computing that would determine whether the SA government users understand cloud computing, cloud computing adoption, issues about cloud computing and factors to be considered in the South African government context.

1.5 Summary of Dissertation

The dissertation research was approached by first reviewing the current literature on cloud computing and the SA government. The primary research method used was a quantitative methodology (survey) to determine the perceptions of cloud computing within the SA government. The survey included respondents only from the SA government and the findings from both the literature review and the survey were used to develop the key findings on the perceptions.

Chapter 2. Literature Review

2.1 Introduction

Cloud computing means entrusting data to information systems that are managed by external parties on remote servers in the cloud (Ryan 2011) and cloud computing is described (Dillon, Wu & Chang 2010) as a model for enabling convenient, on demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction. Unlike a simple terminal acting as a user interface to a mainframe, a computer in the cloud computing paradigm possesses significant power to provide a certain degree of local computing and caching support.

There has been a shift with the early eighties that emphasised on mainframes (Reddy 2011) then it was the client-server model that took over both operation and control of technological infrastructure from the user - now cloud computing is a new delivery model for IT services with a new consumption paradigm for its users. Therefore cloud computing has become a significant technology trend and could reshape the IT sector and the IT marketplace (Voas & Zhang 2009). Cloud computing is a breakthrough technology (Hofmann 2010) that will continue to unleash new innovations and bring new efficiencies and advantages to business where it removes infrastructure and capital expense as a barrier to entry and allows start-up companies to scale up cheaply and rapidly.

The operating models of the sixties and seventies is similar to cloud computing as it is an old trend that is coming back: centralised, shared computing resources (Bohm, Leimeister, Riedl & Krcmar 2010), the operators of today's datacenters, such as Amazon or Google, are confronted with a similar situation; they strive to utilise their immense resources in a better way - Figure 1 shows the milestones of the computing history.

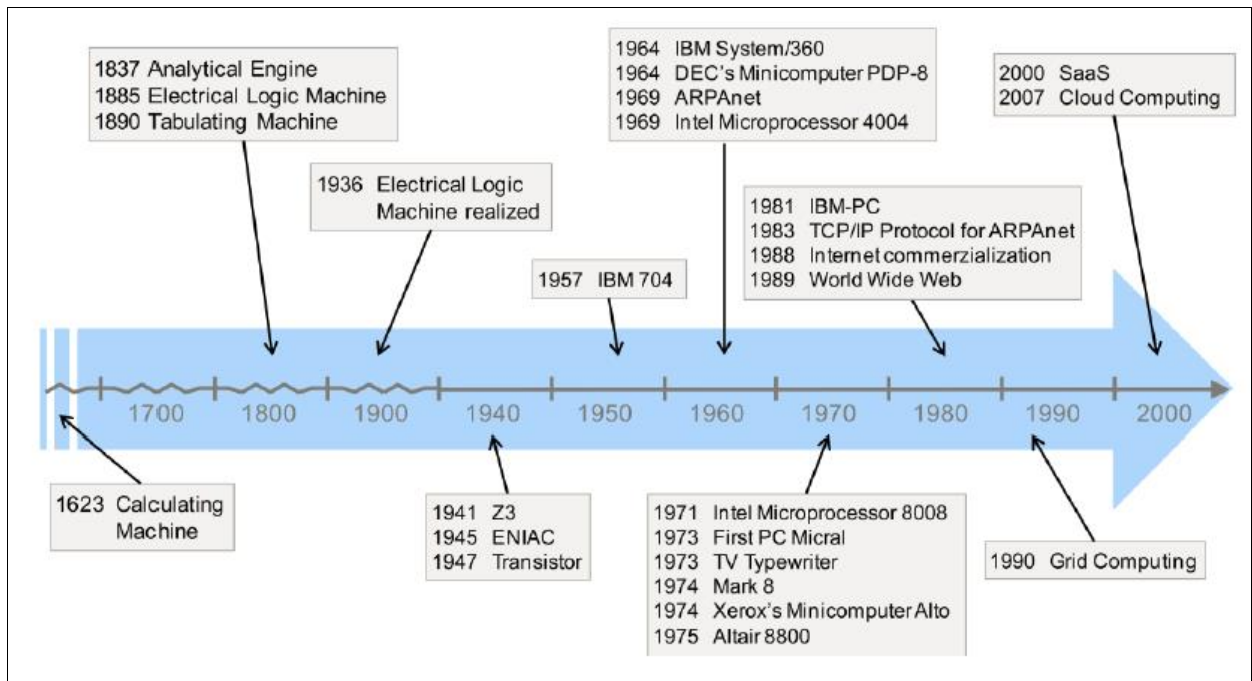


Figure 1: Milestones of Computing History
 (Source: Bohm, Leimeister, Riedl & Krmar 2010)

The approach for the literature review is in Figure 2:

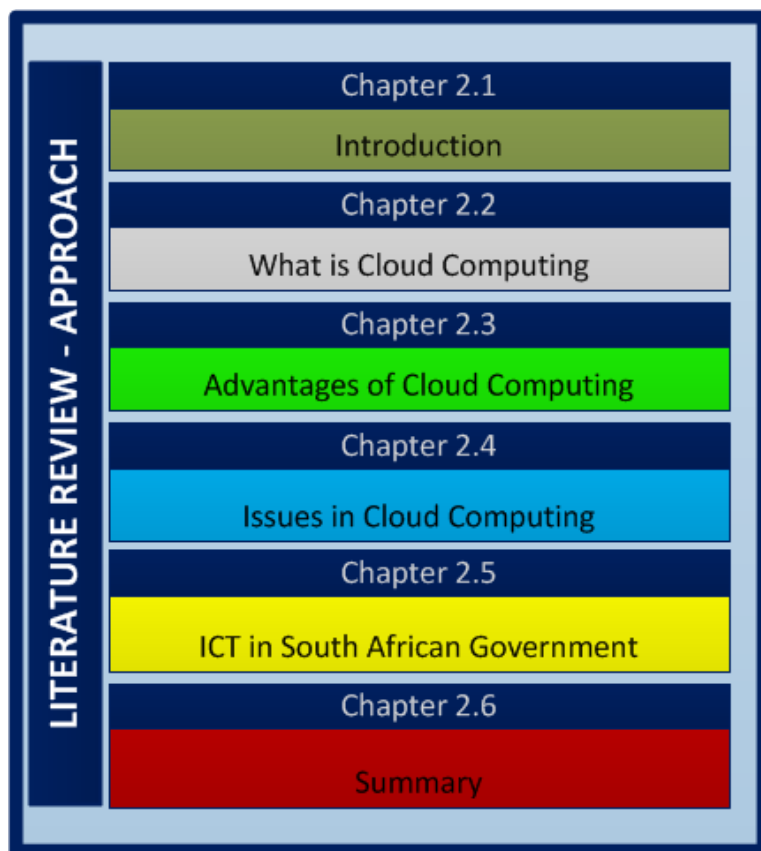


Figure 2: Literature Review Approach

2.2 What is Cloud Computing?

Cloud computing is a model of accessing a shared pool of computing resources like networks, storage, services, and applications on demand, without worrying about how these resources are made available (Sri 2011). Cloud computing clients (Ramgovind, Eloff & Smith 2010) have to now trust 3rd party cloud providers, especially on the availability of cloud service as well as data security. The resources have the intelligence to be rapidly marshalled depending on the need / rate of consumption and released when required. As a concept, cloud computing (Kim, Kim, Lee & Lee 2009) is not entirely new and it is similar to the time-sharing systems of the 1960s, and the network computing and grid computing of the 1990s. In 1961, computing pioneer John McCarthy predicted that computation may someday be organised as a public utility (Foster, Zhao, Raicu & Lu 2008). Cloud computing is thought to be an innovative term (Aymerich, Fenu & Surcis 2008) that is probably one of the most important new technologies in the ICT area.

Cloud computing is hinting at a future (Aymerich, Fenu & Surcis 2008) in which we will not compute on local computers, but on centralised facilities operated by third-party compute and storage utilities. In minimising potential security/trust issues as well as adhering to governance issues facing cloud computing, a prerequisite control measure is to ensure that a Service Level Agreement (SLA) is in place and maintained when dealing with outsourced cloud service providers (Ramgovind, Eloff & Smith 2010). Traditional security mechanisms such as identity, authentication, and authorisation are no longer enough for clouds in their current form as the security controls in cloud computing are mostly not different from security controls in any IT environment. However, because of the cloud service models employed, the operational models, and the technologies used to enable cloud services, cloud computing may present different risks to an organisation than traditional IT solutions (Hashizume, Rosado, Fernandez-Medina & Fernandez 2013). Cloud computing facilitates the delivery of computing-on-demand much like other public utilities such as electricity and gas (Wei & Blake 2010). What makes cloud computing so powerful is that it is based on a system of modularity (Greengard 2010) and the use of virtualization and a cloud platform allows organisations to break down services and systems into smaller components, which can function separately or across a widely distributed network. The growth of cloud computing (accessing computer resources provided through networks rather than running software or storing data on a local computer) exemplifies this shift to the cloud (Bughin, Chui & Manyika 2010).

Cloud computing provides a powerful IT infrastructure at a modest cost in which servers can be located almost anywhere and interfaces can be changed and customised quickly. It frees individuals and small businesses from worries about quick obsolescence and a lack of flexibility but, at the same time, large organisations can consolidate their IT infrastructure across distributed locations (Greengard 2010). The advances in technology open up new problems to be solved and new possibilities for further advancement; many people still think of knowledge as advancing towards a final state (Scardamalia & Bereiter 2006). Even government entities can benefit by enabling services to consumers on a shared basis (Greengard 2010) while consumer acceptance of Web-based cloud services for everything from e-mail to video is of course becoming universal and companies are following suit (Bughin et al. 2010). Cloud computing is defined as a large pool of easily usable and accessible virtualised resources (such as hardware, development platforms and/or services) in which these resources can be dynamically re-configured to adjust to a variable load (scale), allowing also for optimum resource utilization (Vaquero, Rodero-Merino, Caceres & Lindner 2009). The pool of resources is typically exploited by a pay-per-use model in which guarantees are offered by the provider by means of customized service level agreements (Vaquero et al. 2009).

Liu, Tong, Mao, Bohn, Messina, Badger & Leaf (2012) provided the definition of IaaS, PaaS and SaaS according to the National Institute of Standards and Technology (NIST) Cloud Computing Referencing Architecture, as shown below:

- Infrastructure as a Service (IaaS) - To provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over the operating systems, storage, deployed applications, and possibly limited control of select networking components.
- Platform as a Service (PaaS) - To deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly application hosting environment configurations.
- Software as a Service (SaaS) - To use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through a thin client interface such as a Web browser. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or

even individual application capabilities, with the possible exception of limited user-specific application configuration settings. The key security basics should be carefully considered as a fundamental part of the cloud SaaS application development (Soofi, Khan, Talib & Sarwar 2014) and deployment process include; data security, network security, data locality, data integrity, data segregation, data access, authentication and authorization, data confidentiality, web application security, data breaches, virtualisation, availability, backup and identity management.

The new architecture includes cloud computing and service-oriented architecture. It should be applied in the public sector because cloud computing permits uniformly covering the whole country with e-government solutions (Cellary & Strykowski 2009), independently of divergence of local administrative units that may be richer and poorer and better or worse prepared to provide e-services. The use of cloud technologies is rapidly increasing; many new services applying big data are appearing; there is a considerable increase in traffic, its types and quality (Pluzhnik, Nikulchev & Payain 2014), this trend requires bandwidth control and the development of new principles of operation of the network. Aymerich et al. (2008) describes that the software services are stored in the cloud, rather than being spread over the single computers connected on the Internet and another feature is the moving and storing of the data from a user's device onto a cloud, enabling the user to access information from anywhere.

Various deployment models are proposed based on the cloud computing environments availability and the intended access methods (Amini, Bakri, Safavi, Javadinia, & Toloie 2014) and the access permission or limitation depends on the type of information, business processes and organisation characteristics. Mell & Grance (2011) and Mohlameane & Ruxwana (2014) agree that the cloud deployment options are: public, private, hybrid and community cloud.

Public cloud - The cloud infrastructure is provisioned for open use by the general public. It may be owned, managed, and operated by a business, academic, or government organization, or some combination of them. It exists on the premises of the cloud provider.

Private cloud - The cloud infrastructure is provisioned for exclusive use by a single organization comprising multiple consumers (e.g., business units). It may be owned, managed, and operated by the organization, a third party, or some combination of them, and it may exist on or off premises.

Hybrid cloud - The cloud infrastructure is a composition of two or more distinct cloud infrastructures (private, community, or public) that remain unique entities, but are bound

together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds).

Community Cloud - The cloud infrastructure is provisioned for exclusive use by a specific community of consumers from organizations that have shared concerns (e.g., mission, security requirements, policy and compliance considerations). It may be owned, managed, and operated by one or more of the organisations in the community, a third party, or some combination of them, and it may exist on or off premises.

2.3 Advantages of Cloud Computing

Cloud computing can easily handle peak load situations without the need for additional hardware infrastructure that would remain largely underutilized (Aymerich et al, 2008) while the resources can be virtualised and presented to customers as virtual servers, which they manage themselves. The system delivers greater scalability as it is possible to add “on-demand” computational resources, sometimes also derived from underutilised business servers. Both developed and developing nations will benefit through cloud-based software as a service model (Greengard, 2010). For example a software product developed in the USA can be extended and supported by a developer in another place and the software can be purchased at a lower cost by eliminating components that are not relevant to a developing country’s needs.

A cloud computing user will need only to pay for the computing services and, with cloud computing, new Internet services can be developed and deployed without capital acquisitions of hardware or large human integration expenses (Wei and Blake 2010). The user benefits includes that the user is no longer tied to a traditional computer to use an application and in future any device that can access the Internet will be able to run a cloud-based application and users will not have to worry about storage capacity, compatibility or other matters when accessing an application on the cloud (Aymerich et al. 2008) - the user can be sure of getting the latest version without having to upgrade the version.

Carlin & Curran (2011) describe five key attributes of the cloud architecture over similar technology:

- **Multi-tenancy (shared resources):** Cloud computing is based on a business model in which resources are shared at the network, host and application level.
- **Massive scalability:** Cloud computing provides the ability to scale to tens of thousands of systems as well as the ability to massively scale bandwidth and storage space.

- Elasticity: Users can rapidly increase and decrease their computing resources as needed, as well as release resources for other users when they are no longer required.
- Pay As You Go (PAYG): Users pay for only the resources they actually use and for only the time they require them.
- Self-provisioning of resources: Users self-provision resources, such as additional systems (processing capability, software & storage) and network resources.

Cloud computing offers numerous competitive advantages to today's businesses (Nkhoma & Dang 2013) as it offers the distributive IT hardware and software which saves the costs of the organisation's IT infrastructure and this feature is especially beneficial for small and medium size business as they can adopt emerging software easily without requiring to purchase but share. The adoption of cloud computing is gaining momentum with the modernisation of legacy applications (Buyya, Broberg & Goscinski 2011) and positioning the updated applications in the clouds. Fresh applications are being implemented and deployed on clouds to be delivered to millions of global users simultaneously at an affordable rate. Some of the main reasons for adopting cloud computing (Babu, Babu, & Rangaewamy 2013) are economics of scale, reduce unnecessary software and IT support and increase computing power. Service provisioning is an important aspect of cloud computing because it directly impacts the user experience of the service (Whaiduzzaman, Gani, Anuar, Shiraz, Haque, & Haque 2014) as new users and companies seeking cloud services are constantly emerging with the vast diversity among the available cloud services makes it difficult for the customer to decide whose services to use or even to determine a valid basis for their selection. Cloud computing in other parts of the world; such as Vietnam (Kshetri 2010), is driven by the government's belief that this technology will help the country build a skilled workforce and the universities, government ministries and telecommunication vendors have adopted the cloud. Many United States of America (USA) government agencies are outsourcing organisational functionality of email to cloud systems such as Gmail and Google applications due to the potential for greater costs savings from scalable architectures and open products (Weber 2011). The Bangladesh government has a fragmented education systems and need to give priority to human resource development thorough education by using cloud computing technologies to achieve this (Noor, Mustafa, Chowdhury, Hossain & Jaigirdar 2010) as cloud computing technology binds the resources into a single domain.

2.4 Electronic Government

Electronic government (e-government) is the use of ICT and the Internet as a tool to achieve a better government with the use of technology (Magro 2012). Al-wazir & Zheng (2012) defines

e-government as the use of ICT as a platform for exchanging information, providing services and transacting with citizens, businesses and other arms of government. There are still many questions and concerns about the progress and future of e-government (Magro 2012) and the role of governments in shaping global economic policy will expand in the coming years. Technology is vital in this evolution by facilitating the creation of new types of public goods while helping to manage them more effectively (Bughin, Chui & Manyika 2010). The public sector should take advantage of the improved conditions for development and deployment of e-government solutions as this can be achieved through the adoption of new architectures, such as cloud computing and service-oriented architecture, in the public sector (Cellary & Strykowski 2009). An example within government is the education department that can benefit from using cloud computing and collaboration technologies can improve educational services, giving students cost-effective content and online instructors (Bughin et al. 2010). One of the most promising paradigms for education is e-learning and it is commonly referred to as the intentional use of networked ICT in teaching and learning (Alshwaier, Youssef & Emam 2012). There are many implementations of cloud computing across the public sector all around the world (Wyld 2010) and, in many instances, government will be the leading sector in the development of cloud computing across the wider economy. Cloud computing permits us to uniformly cover the whole country with e-government solutions, independently of divergence of local administrative units that may be better or worse prepared to provide e-services (Cellary & Strykowski 2009).

Governments, research institutions and industry leaders are rushing to adopt cloud computing (Foster, Zhao, Raicu & Lu 2008) to solve their ever-increasing computing and storage problems arising in the Internet Age. Technologies are changing as the knowledge advances and the technology changes what people do and what they can do (Spector 2013). The new technology trends and business models such as the emergence of Web 2.0, which is a shift from high-touch, high-margin, high-commitment provisioning of service to low-touch, low-margin, low-commitment self-service (Armbrust, Fox, Griffith, Joseph, Katz, Konwinski, Lee, Patterson, Rabkin, Stoica & Zaharia 2009) i.e. High-touch is where the customers require a lot of guidance and there is a greater degree of customisation involved and high-margin is associated with low-volume businesses while mass-market and commoditised businesses have thin margins.

Armbrust et al (2009) explains about the new application trends:

- Mobile interactive applications – This must be highly available and these services will rely on large data sets that are hosted in large datacentres. Not all mobile devices enjoy connectivity to the cloud 100% of the time.

- Parallel batch processing - Cloud computing presents a unique opportunity for batch-processing and analytics jobs that analyse terabytes of data and can take hours to finish.
- The rise of analytics – A growing share of computing resources is now spent on understanding customers, supply chains, buying habits, ranking, and so on. While online transaction volumes will continue to grow slowly, decision support is growing rapidly, shifting the resource balance in database processing from transactions to business analytics.

2.5 Issues in Cloud Computing

There have been concerns about data privacy and security associated with unauthorised access and use of information stored in the cloud for malicious purposes (Kshetri 2010). According to an October 2008 IDC report, many organisations consider security concerns to be the most serious barrier to cloud adoption. Some of the barriers facing the cloud model (Hoffman 2010) are on-going challenges with interoperability, portability and migration, where in an on-premises model, enterprises control their infrastructure and platforms at any time but in the cloud, the customer will be locked in to a provider and no longer controls their own IT. Customers are faced with challenges to choose a right cloud platform to migrate their services on and the problems are if their applications and data can be exchanged with other solutions - this defines the problems of interoperability and portability of applications, services and data (Kostoska, Gusev & Ristov 2013).

Businesses and consumers have expressed distrust in the cloud and are cautious of using it to store high-value data or important personal information (Kshetri 2010). Consumers and small organisations have relatively simpler requirements for adopting a new technology than medium to large organisations and have much less to lose if the adoption goes wrong. There are at least seven types of adoption issues for cloud computing. These include outage (availability), security, performance, compliance, private clouds, integration and cost (Kim, Kim, Lee & Lee 2009). There is a lack of well-defined SLA by cloud providers (Hoffman, 2010) and there are some who have better than best-effort SLA. Cloud computing raises privacy and confidentiality concerns (Ryan 2011) because the service provider has access to all the data and could accidentally or deliberately disclose it or use it for unauthorised purposes. Security information systems, including computers and networks, is a fundamental prerequisite for a digital government to function to the expectation of its people (Shih & Li 2006) and security is one of the biggest challenges to the cloud model. The users must trust the provider and for organisations whose existence depends upon safeguarding customer data, trade secrets, classified

information or proprietary information. The public cloud providers don't offer sufficient protection as most providers find it hard, if not impossible, to meet standards for auditability and comply with legislation such as Sarbanes- Oxley and the Health and Human Services Health Insurance Portability and Accountability Act (Hoffman 2010). There is a worry in the community about cloud computing security. One of the risks that people see is that providers have to manage millions of customers and this presents a challenge as many people are worried that the cloud service providers will not be able to cope with the large scale or that the infrastructure will not be able to scale properly with large amounts of usage (Carlin & Curran 2011).

Cloud computing and Web services run on a network structure so they are open to network attacks and one of these attacks is the distributed denial of service attack. If a user could hijack a server then the hacker could stop the Web services from functioning and demand a ransom to put the services back online. (Jamil & Zaki 2011). One of the biggest cloud computing concern is security with applications and data being hosted by a service provider. Data is no longer under the control of management and prone to vulnerabilities with hosting application and data in shared infrastructures. This increases the potential of unauthorised access and raise concerns such as privacy, identity management, authentication, compliance, confidentiality, integrity, availability of data, encryption, network security and physical security (Carroll, Van Der Merwe & Kotze 2011).

Patil & Lai (2005) mentions that people have an interest in preserving their privacy and they also are interested in disclosing sufficient contextual information to colleagues to facilitate smoother communication and enable the job they need to do. Most awareness applications have permission structures that provide users with some degree of control over the information that is disclosed about them. Weber (2011) says that privacy is closely related to security and only 2% of European businesses have adopted Infrastructure as a Service (IaaS) according to the analyst company Forrester Research due to privacy concerns. Privacy is important for organisations (Carlin & Curran 2011), especially when an individual's personal information or sensitive information is being stored but it is not yet completely understood whether the cloud computing infrastructure will be able support the storing of sensitive information without making organisations liable for breaking privacy regulations - many believe that cloud authorisation systems are not robust enough.

The world privacy forum report mentioned that privacy fears are just the tip of the iceberg (Weber 2011), as people and businesses take advantage of Internet-based services, they may find trade secrets in the hands of competitors, private medical records made public and e-mail correspondence in the hands of government investigators, without any prior notice. The security will depend on the cloud deployment option that will be used, such as public, private or hybrid cloud (Ramgovind et al. 2010). Security can be defined in a three-level hierarchy:

- Management level
- System level
- Application and data level

The policies and procedures determined at the management level sets out the guidelines and rules that govern the security implementation at the other two lower levels.

Agencies assessing risk in the context of cloud computing should consider both the potential security benefits and potential vulnerabilities (Kundra, 2011). Potential security benefits of using cloud computing services include:

- The ability to focus resources on areas of high concern as more general security services are assumed by the cloud provider;
- Potential platform strength resulting from greater uniformity and homogeneity, and resulting improved information assurance, security response, system management, reliability, and maintainability;
- Improved resource availability through scalability, redundancy and disaster recovery capabilities; improved resilience to unanticipated service demands;
- Improved backup and recovery capabilities, policies, procedures and consistency; and
- Ability to leverage alternate cloud services to improve the overall security posture, including that of traditional data centres.

Wyld (2009) and Armbrust, Fox, Griffith, Joseph, Katz, Konwinski, Lee, Patterson, Rabkin, Stoica & Zaharia (2010) describe the top issues facing government leaders in the shift to using cloud computing:

1) The need for scalability

The IT resources will need to become more flexible and agile as cloud computing turns the economics of IT on its head, due to an unprecedented elasticity of resources (Wyld 2009) - in

everyday use, elasticity is commonly thought of not just as the ability of an object to stretch out when needed, but to also contract as necessary.

2) The need for high reliability and availability

Cloud providers invest a great deal in their systems to provide for reliability and assure that their services and user data will be available on demand (Wyld 2009) - cloud providers typically guarantee a particular benchmark for the availability of their services as a SLA. Organisations worry about whether utility computing services will have adequate availability and this makes some wary of cloud computing (Armbrust et al. 2010). Cloud vendors could offer specialised hardware and software techniques in order to deliver higher reliability, presumably at a high price.

3) The need for securing data in the cloud

Many of the security issues involved in protecting clouds from outside threats are divided among many parties (Armbrust et al. 2010), including: the cloud user is responsible for application-level security, the cloud provider is responsible for physical security, and likely for enforcing external firewall policies. Privacy and security concerns will need to be addressed as public data and applications move into a cloud environment as it is a very big issue for government, in terms of someone else having control of government information (Wyld 2009). The primary security mechanism in today's clouds is virtualization, which protects against most attempts by users to attack one another or the underlying cloud infrastructure. The security for intermediate layers of the software stack is shared between the user and the operator; the lower the level of abstraction exposed to the user, the more responsibility goes with it (Armbrust et al. 2010).

4) The need for open standards and interoperability

Government IT executives consistently express a fear of being locked into vendors, due to the high switching costs—both in dollars and in time and effort—that would be incurred when switching between cloud computing providers (Wyld 2009).

5) The need to revise procurement practices

One of the challenges going forward will be to make acquiring cloud-based services (Wyld 2009) as easy as possible.

6) The need to resolve potential legal issues

A legal issue is the question of transfer of legal liability where cloud computing providers would want customers to be liable and not them. An incident occurred where the Federal Bureau of Investigation (FBI) raided a Dallas data centre because a company whose services were hosted there was being investigated for possible criminal activity but a number of innocent bystander companies hosted in the same facility suffered days of unexpected downtime, and some went out of business (Armbrust et al. 2010). IT functions and data are shifting to cloud computing as there are significant legal concerns that impact both the private and the public sectors where current software licenses commonly restrict the computers on which the software can run (Wyld 2009) and users pay for the software and then pay an annual maintenance fee.

7) The need to regulate the cloud market

Due to the economies of scale and scope involved, cloud computing could lead to a huge monopoly (Wyld 2009). This could make Windows versus Apple look like kid's stuff - competition may well make cloud-based applications and storage even more attractive on a cost basis to potential enterprise customers. This area needs to be monitored closely by governmental authorities to assure competition and choice among cloud providers (Wyld 2009).

8) The need to redefine the roles of the IT workforce

Gain cultural buy-in from employees to get them to do something differently, as it is absolutely essential that cultural change must accompany the technology shift (Wyld 2009). Many in IT will have to overcome the idea of data and applications not residing within their control.

9) The need to assess the return on investment of cloud computing

Cloud computing can deliver cost savings by outsourcing IT operations and as much as three to five times more cheaply than in-house data centres and hosted applications (Wyld 2009).

10) The need for government cloud coordination

Government agencies will establish their own private cloud environments; analysts have forecast that we are likely to see agencies sharing data centres and cloud services to facilitate collaboration and to share costs (Wyld 2009).

2.6 Summary

Cloud computing is a model of accessing a shared pool of computing resources like networks, storage, services, and applications on demand, without worrying about how these resources are made available (Sri, 2011). What makes cloud computing so powerful is that it is based on a system of modularity (Greengard, 2010) and the use of virtualisation and a cloud platform allows organisations to break down services and systems into smaller components, which can function separately or across a widely distributed network.

As technologies are evolving, knowledge is also advancing which influences what people can do (Spector 2013). Governments, research institutions and industry leaders are rushing to adopt cloud computing (Foster, Zhao, Raicu & Lu 2008) to solve their ever-increasing computing and storage problems arising in the Internet Age. The adoption of cloud computing is gaining momentum with the modernisation of legacy applications (Buyya, Broberg & Goscinski 2011) and positioning the updated applications in the clouds. The main reasons for adopting cloud computing (Babu, Babu, & Rangaewamy 2013) despite the many advantages that cloud computing brings to the companies are related to economics of scale that includes spending on hardware and software and IT support.

Cloud computing in other parts of the world; such as Vietnam (Kshetri 2010), is driven by the government's belief that this technology will help the country build a skilled workforce and the universities, government ministries and telecommunication vendors have adopted the cloud. Cloud computing can easily handle peak load situations without the need for additional hardware infrastructure that would remain largely underutilised (Aymerich et al. 2008) while the resources can be virtualised and presented to customers as virtual servers, which they manage themselves. The system delivers greater scalability as it is possible to add "on-demand" computational resources, sometimes also derived from underutilised business servers. Both developed and developing nations will benefit through cloud-based software as a service model (Greengard 2010). The benefits of using cloud computing includes: just-in-time infrastructure, usage based costing, virtual administration, multi-tenancy, disaster recovery and business continuity and enhanced security (Varia 2010).

Security information systems, including computers and networks, is a fundamental prerequisite for a digital government to function to the expectation of its people (Shih & Li 2006) and security is one of the biggest challenges to the cloud model. Businesses and consumers have

expressed distrust in the cloud and are cautious of using it to store high-value data or important personal information (Kshetri 2010). Consumers and small organisations have relatively simpler requirements for adopting a new technology than medium to large organisations and have much less to lose if the adoption goes wrong. There is a lack of well-defined SLA by cloud providers (Hoffman 2010) and there are some who have better than best-effort SLA. Cloud computing raises privacy and confidentiality concerns (Ryan 2011) because the service provider has access to all the data and could accidentally or deliberately disclose it or use it for unauthorised purposes.

Chapter 3. Research Design

3.1 Research Objectives

The research aims to determine the perceptions of cloud computing in the SA government. The primary objectives are to determine the awareness of government IT employees about cloud computing and the understanding of cloud computing, cloud computing adoption, issues about cloud computing and factors to be considered in the South African government context. This chapter will describe the components of the research, the design and testing of the survey.

3.2 Research Question

The research question for this paper is: Does the South African government users understand the basic concepts, challenges and adoption for cloud computing.

3.3 Research Approach

The approach that was chosen was a quantitative one as it provides more flexibility to reach a wider audience that is not limited to a specific location. This was a requirement as the target audience was located throughout South Africa.

The research collection method that was used was an on-line survey (SurveyMonkey). An e-mail was sent to the respondents with a message. The 1st pilot and 2nd pilot survey emails can be found in Appendix A.

The on-line survey made it easy for the respondents to use, rather than e-mail or hard copy surveys, and all the data was saved to a central database for data analysis. The survey was anonymous and no personal information was captured. When the survey closed, the data was extracted into Microsoft Excel and then analysed. The complete survey can be found in Appendix B.

3.4 Target Audience

Cloud Computing is a new IT paradigm and therefore the target audience were selected based on them working in an IT role in the different government departments. In order to obtain a wide range of responses, it also includes the different spheres of government i.e. local, provincial and national.

The sampling approach used was to obtain respondents from different departments to identify any issues with regards to the on-line survey tool and/or with the questions, including the context, wording, technical terms, ease of understanding and time to complete the survey. Five respondents were selected for the 1st pilot survey and then ten respondents were selected for the 2nd pilot survey. There were more respondents in the 2nd survey as the survey was updated with feedback from the 1st survey and a wider audience was required to give input before the finalisation of the final survey.

The 1st draft survey design was completed on 4 October 2013 and the respondents were provided with the survey via email. The feedback to improve the survey is below:

- Three questions were not clear;
- One question was ambiguous;
- One question was confusing and needed to be simplified;
- Four questions needed more detail;
- Two questions were repeated although worded differently;
- It was difficult to answer from an email survey as the format gets distorted; and
- Overall, the survey was too long as it had fifty questions and took on average between 12 to 15 minutes to complete a single survey.

From the above feedback received on the 1st draft survey, the 2nd draft survey was designed and made available to a wider audience using the on-line survey tool (SurveyMonkey), This was completed on 24 October 2013. There were no changes requested to the on-line survey as all the concerns were addressed.

The following limitations were encountered for the survey:

- Some respondents had difficulty connecting/completing the survey;
- Not to make every question mandatory as respondents would cancel the whole survey;
- Some respondents could not answer the survey due to lack of knowledge; and
- The respondents had to be continuously reminded to answer the survey.

3.5 Survey

3.5.1 Process and Design

The survey was designed from the lessons learnt from the literature review and the process behind formulating the questions began with the following high-level questions:

- 1) General
 - The respondent's demographics
- 2) User Perceptions (Sri, 2011); (Ramgovind, Eloff & Smith, 2010); (Liu, Tong, Mao, Bohn, Messina, Badger & Leaf 2012); (Aymerich et al. 2008) and (Mell and Grance 2011)
 - Do government employees know what cloud computing means?
 - Do government employees know the different forms of cloud computing?
 - Do government employees understand the advantages and disadvantages?
- 3) Cloud Computing Opportunities (Greengard, 2010); (Wei & Blake, 2010); (Carlin & Curran 2011) and (Buyya, Broberg & Goscinski 2011)
 - Do government employees understand the opportunities that cloud computing creates?
- 4) Adoption of Cloud Computing (Foster, Zhao, Raicu & Lu, 2008); (Spector 2013) and (Armbrust et al. 2009).
 - Do government employees understand the requirements for adopting cloud computing?
 - Are government IT employees ready to implement cloud computing solutions
- 5) Administrator Perceptions (Kundra 2011); (Ramgovind et al. 2010); (Kshetri 2010); (Hoffman 2010); (Ryan 2011) and (Carlin & Curran 2011).
 - Do government employees know how to deploy cloud computing solutions?
 - Do government employees understand what were the challenges for implementation?
 - Do government employees know what were the different deployment options?
- 6) Cloud Computing Challenges (Wyld 2009) and (Armbrust et al. 2010).
 - Do government employees understand the challenges for adopting cloud computing?

The survey comprises of mainly closed questions that are quick and easy to answer to achieve a higher response rate.

3.5.2 Method for Analysis

The qualitative research is used for this paper in the form of a survey. By using qualitative research is to identify and confirm relationships of the data and before qualitative data can be used, it must be edited, coded and maybe transformed to ensure that it can be properly used in statistical analysis (Hair, Money, Samouel & Page 2007) – the qualitative data will be analysed as below:

- Prepare data for analysis
 - Editing
 - Missing data
 - Data transformation
- Conduct analysis
 - Descriptive analysis
 - Statistical analysis
- Evaluate findings to assess whether they are meaningful

The format adopted for the majority of the survey questions is the five-point Likert scale as this scale is easily understood by the respondents and it has specific options that must be chosen. According to the Oxford dictionary definition, a Likert scale is a scale used to represent people's attitudes to a topic.

The five-level Likert scale is:

- Strongly agree
- Agree
- Neither agree nor disagree
- Disagree
- Strongly disagree

3.5.3 Response Rate

The target was to obtain as many responses as possible.

3.5.4 Final Survey

The final survey (Appendix B and C) was made available on the Internet via SurveyMonkey on 25 October 2013 after receiving input from the draft and the final on-line survey was created.

Chapter 4. Data Results and Analysis

Once the survey had been completed, it was analysed as shown below:

- To compile the data collected
- To verify if there was a complete understanding of the questions
- To check the areas that are doing well
- To check the areas that need improvements

The results are shown in graphs and/or tables with detailed explanation and feedback for each question. Thereafter the linking of the data to the literature review will show whether there is agreement or not, the obstacles that were encountered for the research and recommendations regarding the perceptions of cloud computing in the SA government, as well as the suggestions for future research that relates to cloud computing.

4.1 Responses

The survey closed on 7 November 2013 and there had been a good response to the survey with the overall response rate of 48% as shown in Figure 3:

Respondents invited	149
Surveys completed	71
Response rate	48%

Figure 3: Survey Results

The response rate of 48% is acceptable for this study and the survey was hosted on a secure server by the survey service provider. The survey was closed on 7 November 2013 and this data was downloaded into a Microsoft Excel spreadsheet. The actual responses have been downloaded to analyse the data.

4.2 Results Approach

The results were presented in seven categories and the design of the survey (3.4.1 Process and Design) is aligned to the results analysis (4.2 Results Approach). To ensure data integrity and validity, no data was added for any missed questions by the respondents.

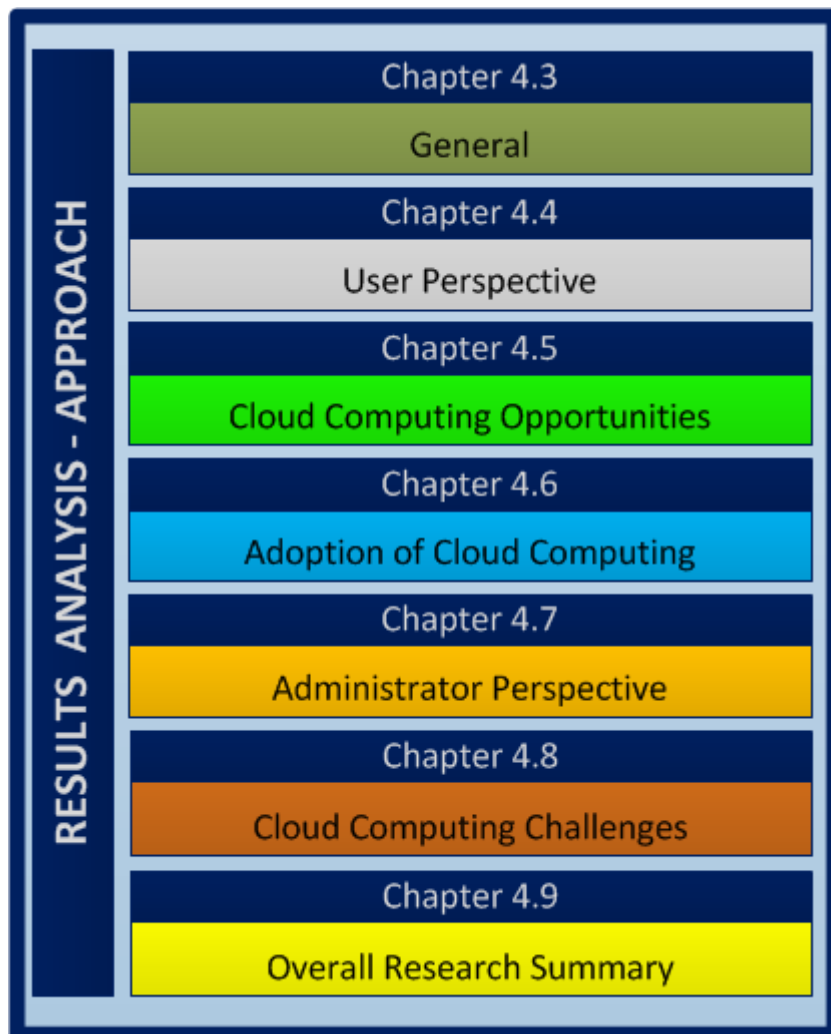


Figure 4: Results Analysis – Approach

4.3 General

To gain a better understanding about the respondents, they were first asked general questions about their job level, time working in government, number of employees and level of government.

Question 1: What is your job level?

To determine what the job levels are, the respondents could choose from the four options: operational, management, senior management or other. The results in Figure 5 show that the majority of the responses are in management, followed by the operational level and the lowest being senior management. This may lead to the results being more from a management perspective.

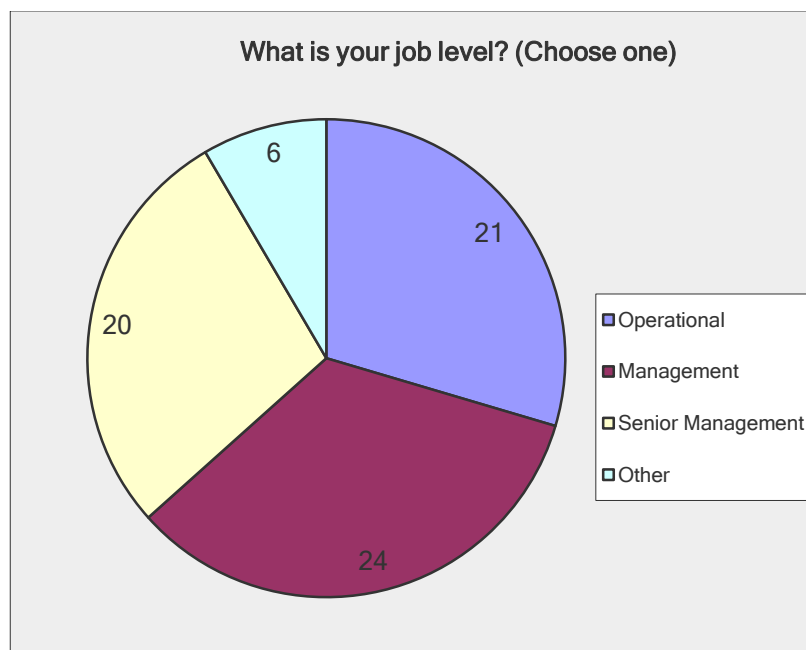


Figure 5: Job Level

Question 2: What technology decisions do you make?

To assess the decision-making in government departments, the respondents indicated what were the decisions they make around technology. The results in Figure 6 show that the highest response was for the purchase of software and the lowest being the design of the network. However, 24 of the respondents indicated that they do not have an influence on the technology decisions, which indicates that these respondents may fall into the operational job level from Question 1. The 16 respondents indicated other, in which their technology decisions include advisory, problem management, development & integration, process implementations, security and architecture. The biggest drivers for technology decisions that are made are for the purchase of hardware and software.

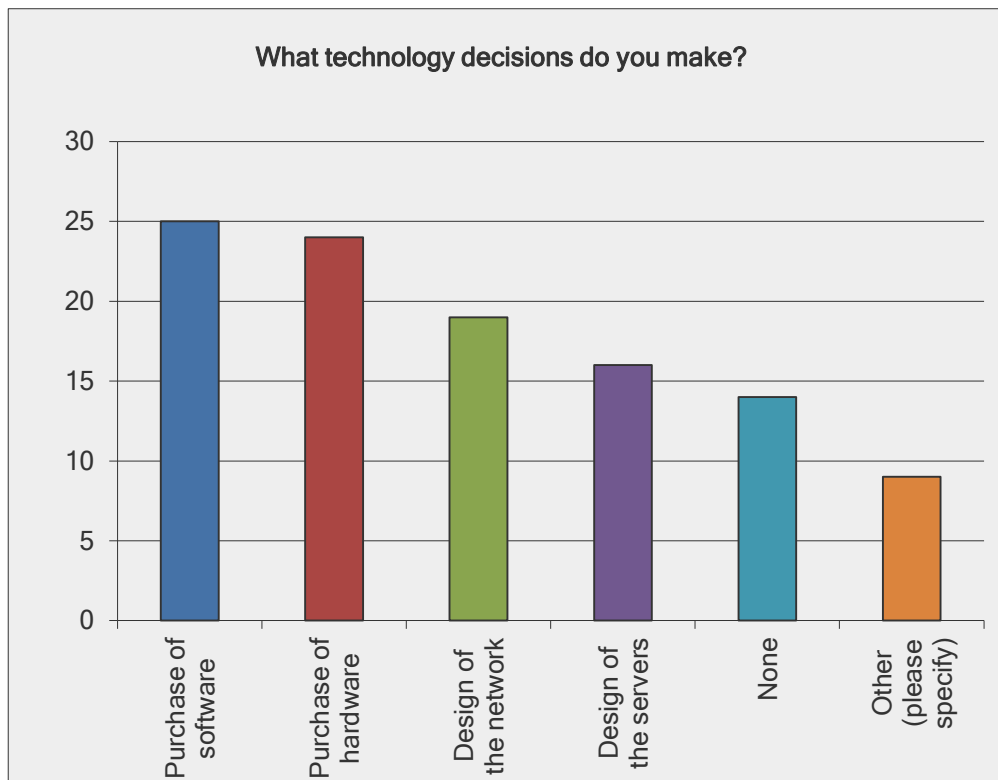


Figure 6: Technology Decisions

Question 3: How long have you been working in government?

The time spent working in government provides a good indicator of the respondent's experience. The more experience in years shows an increase in maturity of understanding government. The results in Figure 7 show that there is good representation of 45 respondents who have been in government for more than 10 years. Only 3 respondents have been in government for less than a year and in total 60 respondents have been in government for more than four years, which shows a good understanding of government. The respondents with more than ten years' service show that management makes up the majority, which indicates that management in government is the easiest way that leads to promotion.

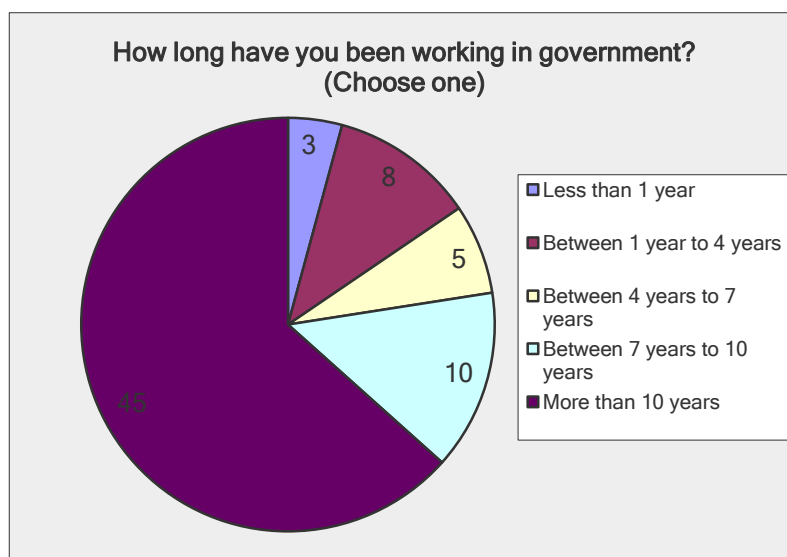


Figure 7: Years in Government

Question 4: What is the total number of employees in your government department?

The size of a government department may be measured by the number of employees. The respondents could choose from four options and the results in Figure 8 show that the majority of responses are between 1 000 and 3 000 and the following band is between 3 000 and 10 000 – the results together is 54 respondents. This shows that the respondents are from medium to large departments.

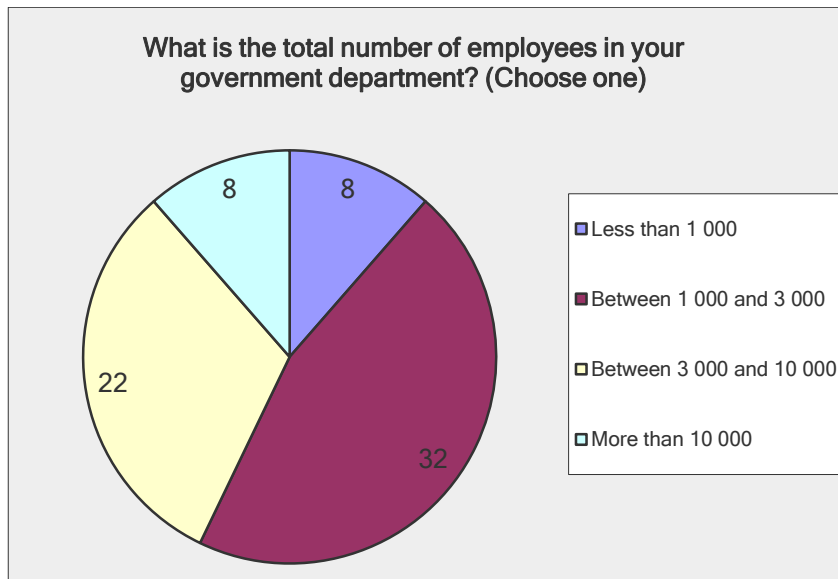


Figure 8: Number of Employees

Question 5: At what level within the South African government, does your government department operate?

Government departments operate at different levels within government; the respondents were provided with three options: local, provincial or national level. This is important as local, provincial and national governments have different focus areas and priorities. From the results in Figure 9, the majority of responses are from the national level departments and the least represented is the local level. This implies that the survey is representative of the national level and includes only a small portion from provincial (6 respondents). These results will be more accurate for national level and not so much for provincial and even less applicable to the local government because 62 respondents are from the national level.

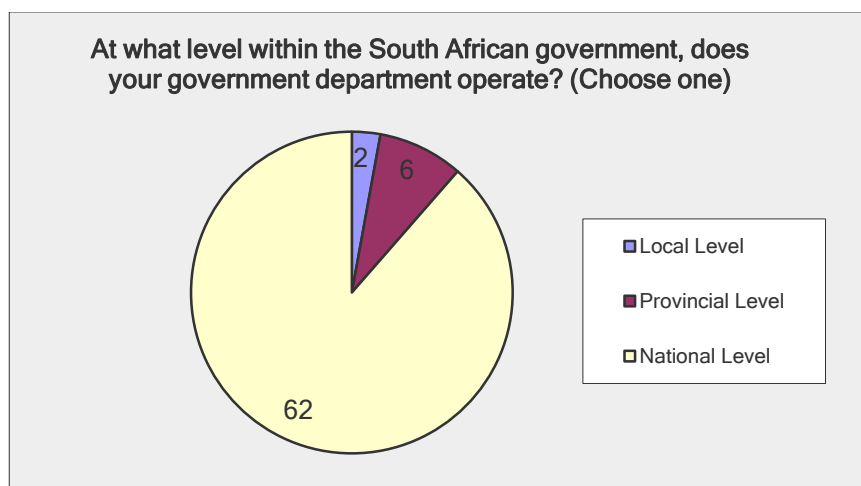


Figure 9: Level of Government Department

Summary

The management and senior management are the majority of the respondents. The decision making is spread across the different job levels and not limited to management or senior management only. 45 Respondents are working for more than 10 years in government and the bulk of the respondents are from medium to large departments with 62 respondents in national departments.

4.4 User Perspectives

Introduction

The respondents provided their view about awareness on cloud computing, the basic administrator capabilities and general questions about their departments.

Question 6: Have you heard about cloud computing?

To determine whether there is awareness about cloud computing, the respondents were asked whether they heard about cloud computing. They were provided with five options and the results in Figure 10 show that the majority had heard about cloud computing in which 68 respondents had selected strongly agree or agree. This adds validity to the results of the survey and it is expected that the respondents will be able to provide good feedback based on their views. No respondents indicated that they disagree or strongly disagree about hearing about cloud computing. There was 1 respondent who indicated that they neither agree nor disagree - that was at an operational level with more than 10 years in government. Going forward the data set for the 1 respondent that selected neither agree or agree will be removed.

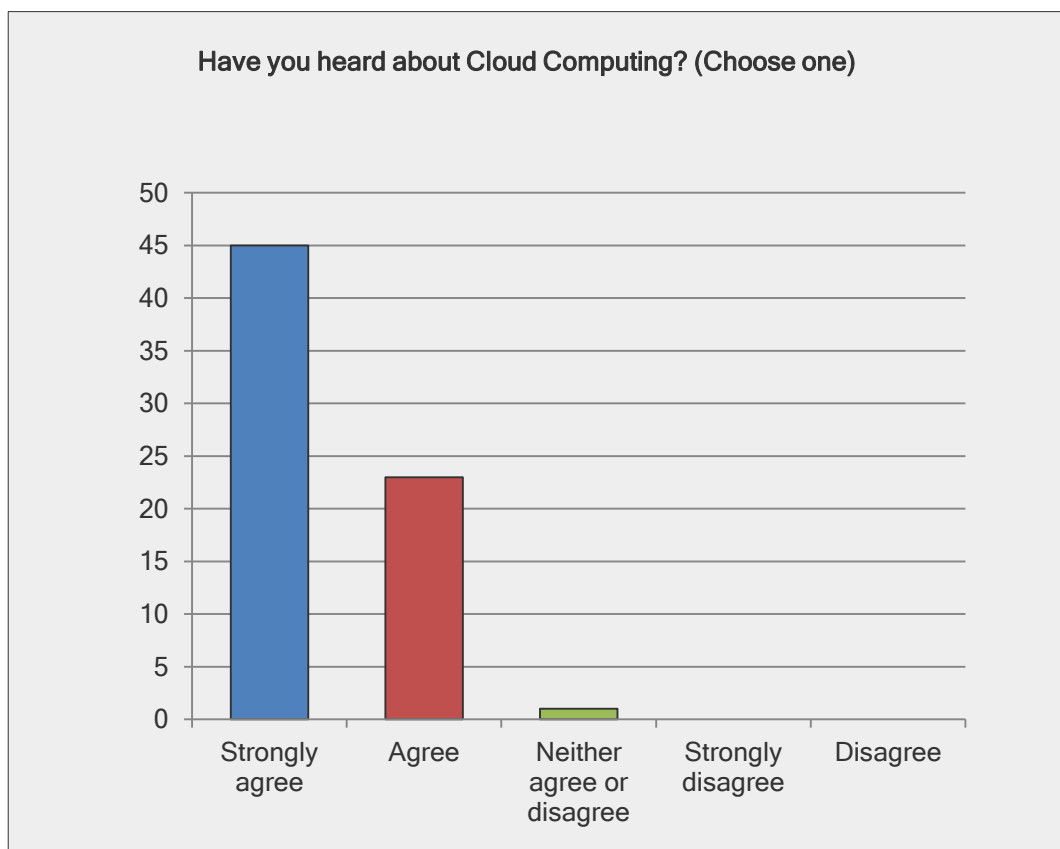


Figure 10: Heard About Cloud Computing

Question 7: Do you think that the government should use cloud computing?

Government wants to make IT services more assessible and cost effective to citizens. The respondents had to think about whether government should use cloud computing. In Figure 11, 55 respondents were in favour of government using cloud computing while 4 respondents did not agree on using cloud computing. The respondents in the larger departments that had 1 000 or more employees were more in favour of cloud computing.

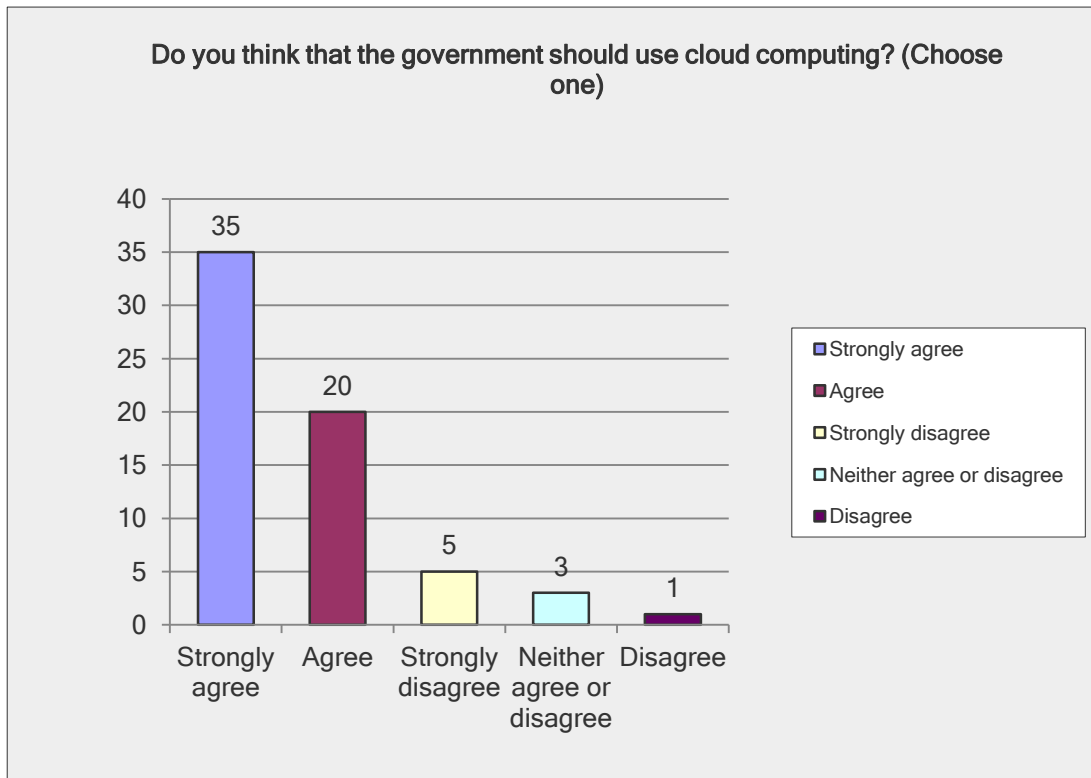


Figure 11: Government using Cloud Computing

Question 8: Have you used a cloud computing application?

The respondents were presented with two options in order to determine whether they have used a cloud computing application so they may already have a view of the advantages and disadvantages. The two options: yes or no; and 48 respondents selected that they used a cloud computing application. The results in Figure 12 show the 16 that selected they have not used a cloud application and from this 13 respondents have been in government for more than 10 years. They also may not be fully aware that they could have used a cloud computing application without knowing it was a cloud service, for example: Gmail, Yahoo mail, Dropbox and even this

survey (SurveyMonkey). The chances are very likely that most if not all the respondents have in fact used a cloud service.

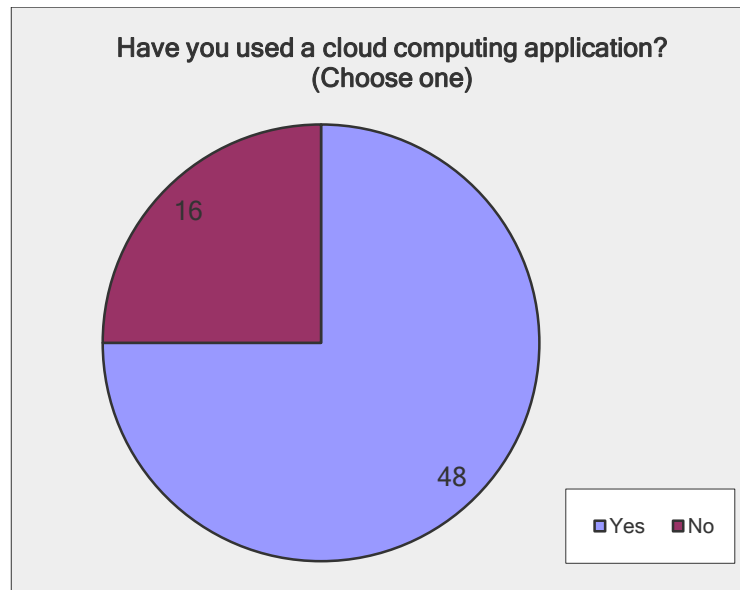


Figure 12: Used a Cloud Computing Application

Summary

68 respondents have heard about cloud computing and many of the larger departments (1 000 and more employees) were in favour of cloud computing to be used in government. Cloud computing services are readily available over the Internet and the majority of respondents indicated that they have used this service.

4.5 Cloud Computing Opportunities

Introduction

Cloud computing will create opportunity and the respondents were asked about their perception of government, the new way of using cloud services, usage of specific software and important drivers of cloud computing.

Question 9: Do you think that government is currently utilising technology effectively to deliver better services to the citizen?

To determine whether government is using technology effectively to deliver better services, the respondents were presented with five options and only 7 respondents indicated that government is utilising technology effectively. 48 Respondents do not think that the government is using technology effectively to deliver better services and this indicates that government is lacking in using technology effectively.

A comparison is made to the job levels in government in order to determine the perceptions among the different job levels. For responses where they do not think government is using technology effectively, the majority of responses (as shown in Table 1), are from the management and senior management levels. The managers and senior managers have the power to lead and direct the use of technologies in government.

Job level	Government is not using technology effectively	Government is using technology effectively	Row Total	Expected Frequency
Senior Management	17	1	18	16
Management	18	2	20	17
Operational	9	4	13	11
Other	4		4	3
Column Total	48	7	55	

Table 1: Technology Usage

By using the chi-square test of independence:
Frequency observed (Fo) & Frequency expected (Fe)

The $(F_o - F_e)^2 / F_e$ formula is used to determine if there is a relationship.

Senior Management - $(F_o - F_e)^2 / F_e = (17-16)^2 / F_e = 0.12$ (not related)

Management - $(F_o - F_e)^2 / F_e = (18-17)^2 / F_e = 0.11$ (not related)

Operational - $(F_o - F_e)^2 / F_e = (9-11)^2 / F_e = -0.36$ (not related)

Other - $(F_o - F_e) * 2 / F_e = (4-3) * 2 / 3 = 0.66$ (not related)

The above calculation using the chi-square analysis indicates that there are no relationships.

Question 10: Based on the last few years, what do you think government is doing to embrace new technologies?

Government has used technology to provide services to citizens; the respondents had to think whether government is embracing new technologies. They were presented with four options and Figure 13 show 38 respondents have highlighted that government is trying to implement new technologies while 32 and 28 respondents have indicated that government is focusing on mobile and Internet services respectively.

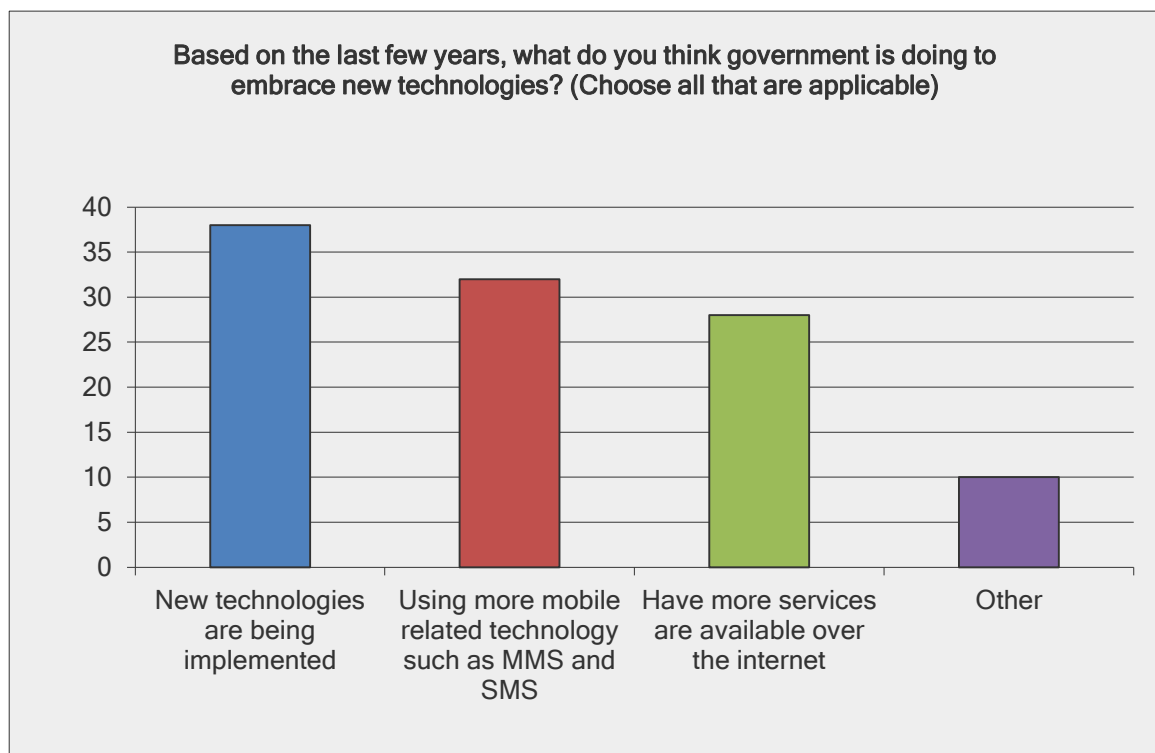


Figure 13: Trends

From the respondents' feedback it shows that government is not doing enough to embrace technology as an enabler; below is some of the feedback:

- Bureaucratic red tape prevents embracing new technology;
- Government departments are unsure about their current environments, and therefore do not know what to do next;
- Implementation and delivery execution is always a problem even when having the most brilliant solutions;

- Lack of skills within government;
- Very little is happening to embrace and use new technologies; and
- Very slow to respond to industry trends.

Question 11: What can enhance or make the IT services better than what is currently being provided by the government?

As technology is changing, government needs to embrace new technologies. The respondents had to think about what they would like government to focus on for the emerging technologies and they were presented with nine options; the results in Figure 14 show the top two items that can enhance the existing IT services provided by government are to make more services available over the Internet and understand what the user requirements from government are. Surprisingly, none of the respondents selected ‘do not change anything’ - this indicates that the current IT services must be improved.

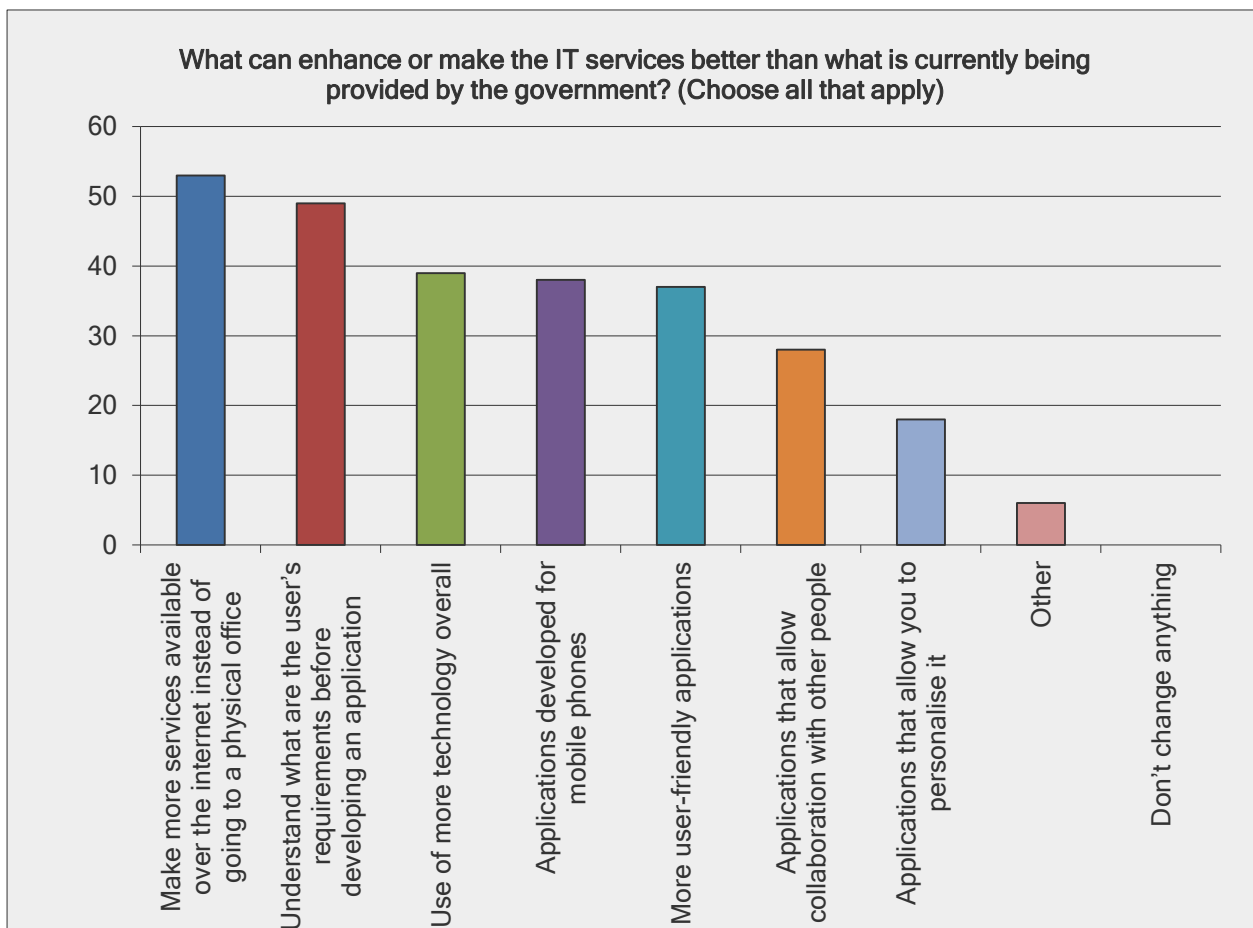


Figure 14: Enhance IT Services

Question 12: The traditional way to get software was to buy it and then you can use it according to the licensing. The new paradigm is that you can “rent” the software you need over the Internet and only pay for what you have used. Would you prefer to pay only for what you use?

The traditional way to get software was to buy it and then use it according to the licensing; and the new paradigm is that the software can be rented over the Internet - the user pays for only what they use. In order to understand the change in behaviour from the old approach to the new approach, Figure 15 shows that 49 respondents are willing to use the new approach by renting the software while 6 respondents will not change to use the cloud computing software by continuing to use the traditional way. This is indicative that the users are adapting to the new way of working as they understand the benefits of using the cloud services.

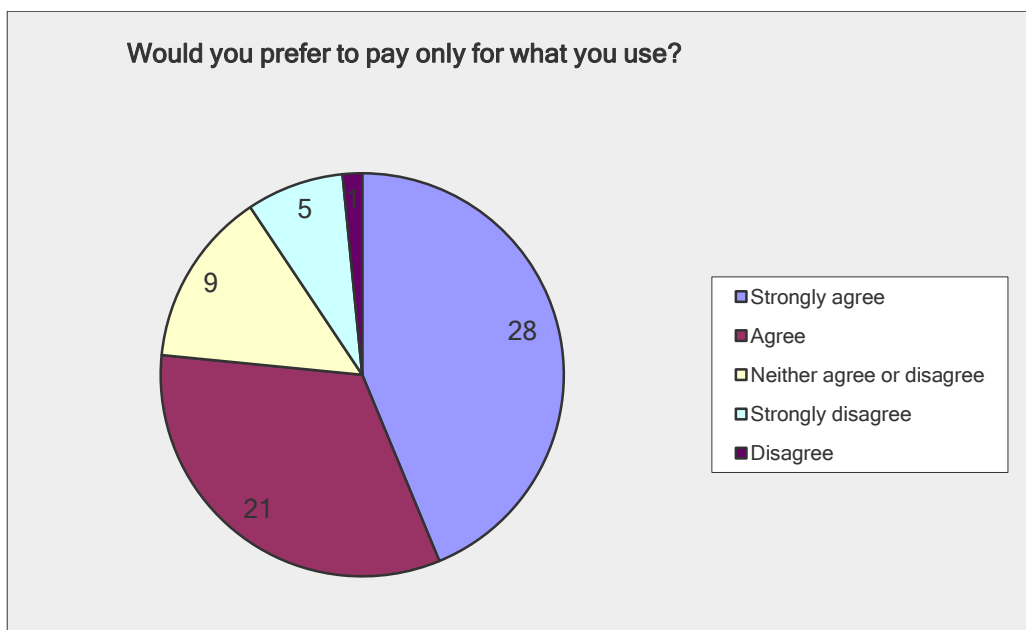


Figure 15: Traditional Approach

Question 13 to Question 15:

To understand the current software that is being used in government, the respondents were presented with three questions:

- Question 13 - Which software are you currently using?
- Question 14 - Which software are you considering to use in the near future that you are not using currently?
- Question 15 - Which software do you think should move to the cloud?

The results are shown in Table 2 in which most respondents are using E-Mail , ECM and ERP software. The most likely software that respondents are considering to use in the near future that you are not using currently includes Procurement, HR and ERP software. The HR, Procurement and Project Management software are the most likely to move to the cloud.

<i>Observed Frequency (Fo)</i>	E-Mail	ECM	ERP	Project Management	HR	Procurement	Other	Row Total
Which software are you currently using?	55	54	52	41	30	22	12	266
Which software are you considering to use in the near future that you are not using currently?	7	6	8	0	9	15	17	62
Which software do you think should move to the cloud?	38	41	36	31	28	29	9	212
Column Total	100	101	96	72	67	66	38	540

Table 2: Software Used in Government (Observed Frequency)

To determine the expected frequency, the formula used is: multiple the sum of the row by the sum of the column and divide by the number of people.

<i>Expected Frequency (Fe)</i>	E-Mail	ECM	ERP	Project Management	HR	Procurement	Other
Which software are you currently using?	49	12	26	35	33	32	18
Which software are you considering to use in the near future that you are not using currently?	11	12	11	8	8	8	4
Which software do you think should move to the cloud?	39	40	38	28	26	26	15

Table 3: Software Used in Government (Expected Frequency)

By using the chi-square test of independence, the formula $((F_o - F_e)^2 / F_e)$ is used to determine if there is a relationship. The results are shown in Table 4.

<i>Chi-Square Analysis</i>	E-Mail	ECM	ERP	Project Management	HR	Procurement	Other
Which software are you currently using?	0.24	7.00	2.00	0.34	-0.18	-0.63	-0.67
Which software are you considering to use in the near future that you are not using currently?	-0.73	-1.00	-0.55	0.00	0.25	1.75	6.50
Which software do you think should move to the cloud?	-0.05	0.05	-0.11	0.21	0.15	0.23	-0.80

Table 4: Software Used in Government (Chi-Square Analysis)

The highlighted areas indicate that there are relationships that exist.

Question 16: How can government leverage cloud computing but also be secure by having the data to stay within the government network?

To evaluate the knowledge of the respondents about network security, they were presented with four options and Figure 16 shows the majority are aware of security. 53 Respondents selected the government cloud and a community cloud, which indicates they are well informed. The government Community Cloud is where the cloud infrastructure is provisioned for exclusive use by a specific community of consumers from the different government departments that have shared concerns (e.g., mission, security requirements, policy and compliance considerations). A comparison was done with Question 25 (basic administrator capabilities) and it reflects that 16% of the respondents selected disagree or neither agree nor disagree for the basic administrator capabilities question but selected the correct response for this question. This indicates that they understand some of the aspects about cloud computing.

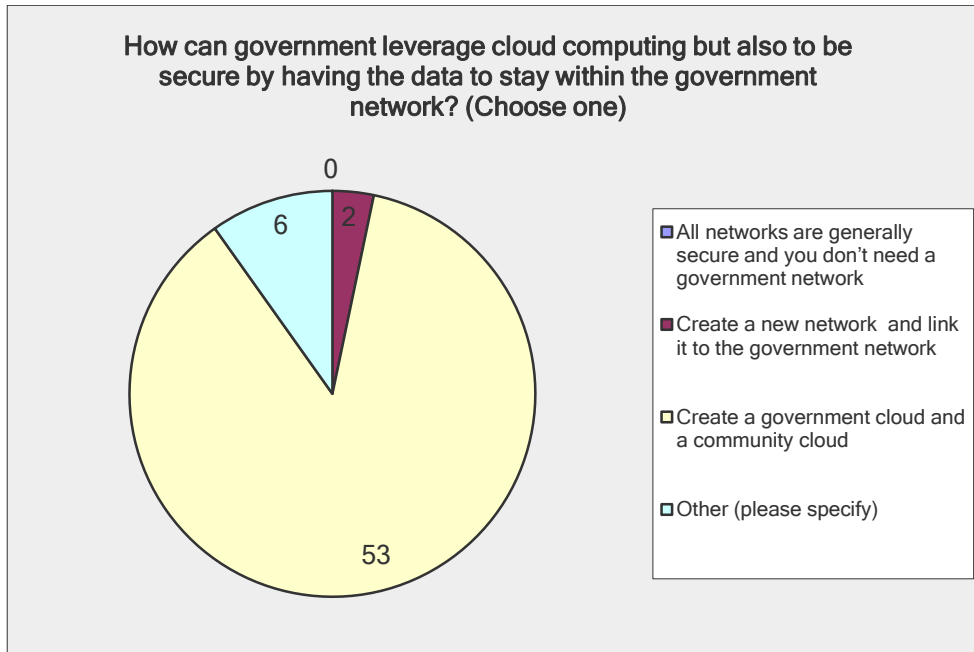


Figure 16: Leverage Cloud Computing

Question 15 and Question 17:

A comparison is made between question 15 and question 17

Question 15 - Which software do you think should move to the cloud?

Question 17 - Which software would you like to deploy in the cloud immediately, so you can use this to promote more buy-in from government?

In order to gain a better understanding of the priorities from government, the respondents had to select the software that they think that should move to the cloud and thereafter select the software that can move to the cloud to get government buy-in. Figure 17 shows the results of the comparison between the two questions and it is clear that the ECM has been selected as the software that is most likely to be deployed in the cloud immediately, followed by e-mail and ERP.

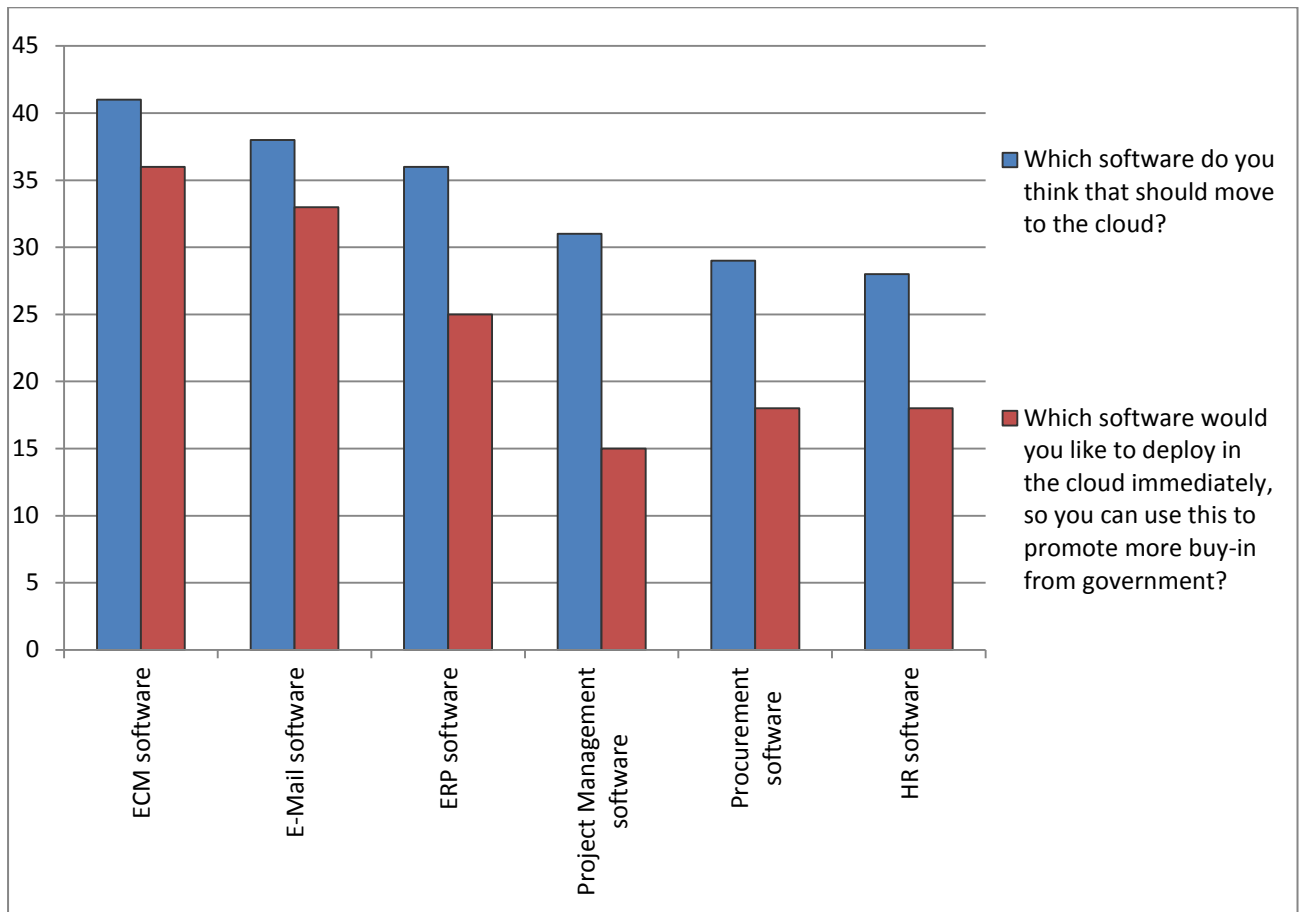


Figure 17: Deploy in the Cloud

Summary

Many of the respondents do not feel that government is utilising technology effectively to deliver better services to citizens. However, in the last few years government is embracing new technologies such as mobile technology and services over the Internet. There is support for more services to be made available over the Internet and understanding the users' requirement before developing an application in order to make IT services better than what is currently being provided. The software that are in demand that will need to be cloud-ready includes: procurement software, ERP software and HR software.

4.6 Adoption of Cloud Computing

Introduction

The adoption of cloud computing considers some factors such as: who should be accountable for the adoption of cloud computing, who will benefit from cloud computing, the understanding of cloud computing and adoption of new technology. These factors will determine whether cloud computing can be successfully adopted in the SA government.

Question 18: Who within your department should be held solely accountable for the adoption of cloud computing within your department?

Assigning accountability is important in cloud computing adoption as it shows the importance of it in the department. The respondents were asked who within their department should be held solely accountable for the adoption of cloud computing. Figure 18, show that top management should be accountable for cloud computing and the top three accountable people are:

- 1) Chief Information Officer (CIO)
- 2) Chief Executive Officer (CEO)
- 3) Chief Operations Officer (COO)

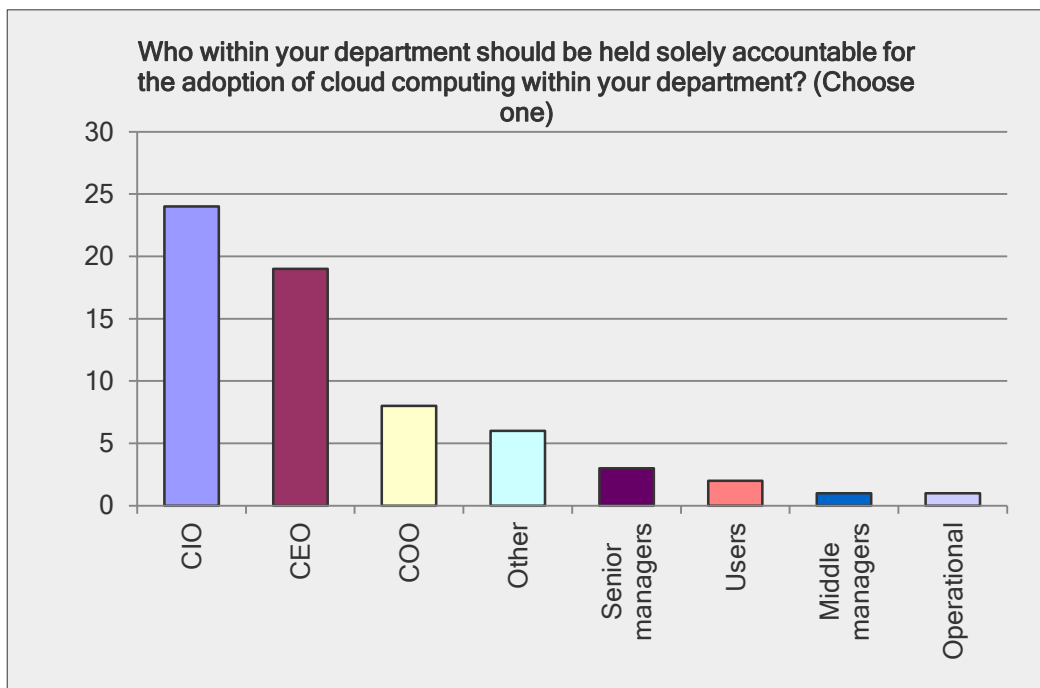


Figure 18: Accountability for Adoption

A comparison was done between years in government and the top three accountable people. The respondents who worked 10 years or more selected the COO and then the CEO. This shows the maturity in their thinking as cloud computing should not be driven from a CIO level as it is more strategic and affects business more than IT. Assigning the accountability to the CEO or COO gives cloud computing the highest levels of importance within the department and also accords importance for a successful adoption.

Question 19: Who within your department will greatly benefit from the adoption of cloud computing?

Cloud computing has many benefits and the respondents had to think about who within the department will benefit the most from the adoption of cloud computing. Figure 19 shows the result that it is unanimous that everyone will benefit by adopting cloud computing. This again shows that the general understanding is good as it will not be a single role that will benefit but everyone will benefit.

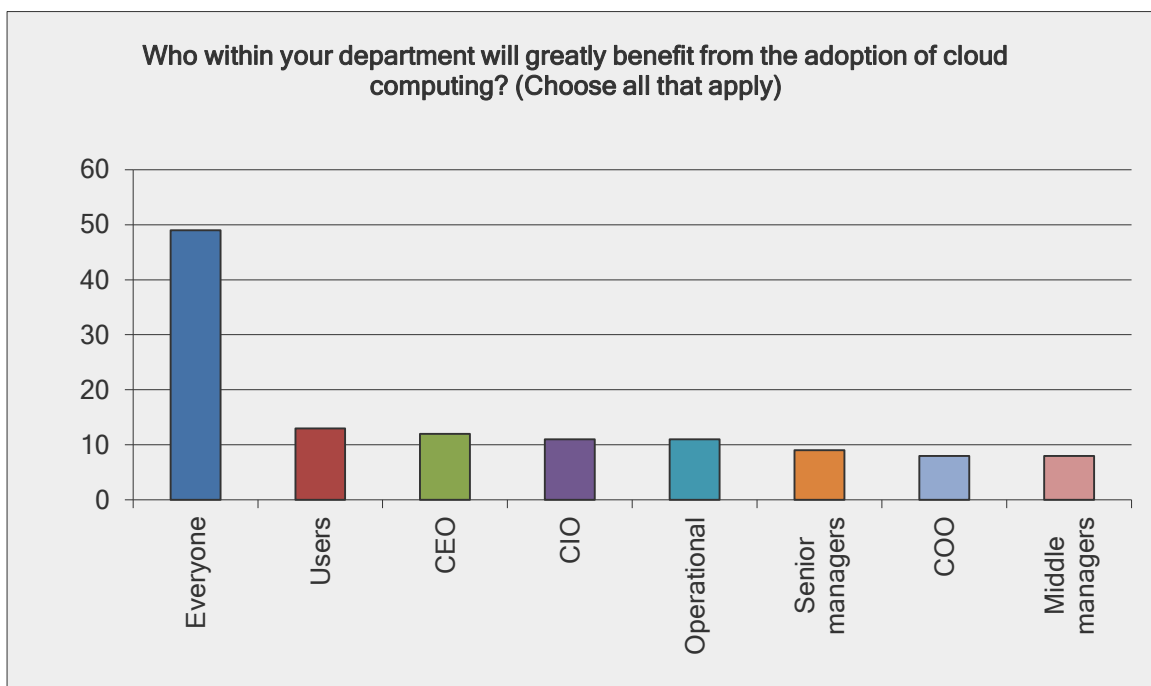


Figure 19: Benefits

Question 20: How has your department adopted new technologies such as cloud computing?

In order to gain more information on how the department adopted new technologies such as cloud computing, the respondents were prompted to provide feedback on how government has adopted new technologies. They could select from four options and Figure 20 shows there has been the overwhelming response that 46 respondents will use new technologies such as cloud computing in the future and 8 respondents are already using it. The 4 respondents that indicated that they will not use it are all from the operational job level. This suggests that either they are not aware of it or choose not to use it. However, the overall feedback shows that there is willingness from the departments to adopt new technologies, going forward.

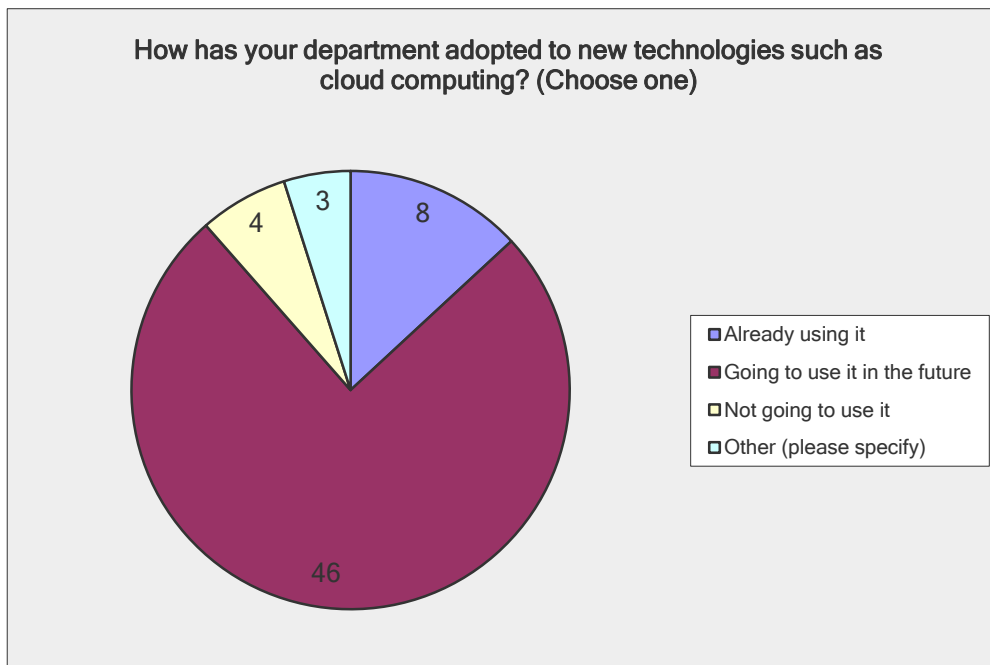


Figure 20: Adoption of New Technologies

Question 21: If your department has adopted cloud computing, indicate which has been adopted?

To establish what has already been adopted in government, the respondents had to provide information on the current adoption of solutions within their department. The 8 respondents in Question 20 that selected they are currently using cloud computing, Figure 21 shows the result that 3 respondents are using SaaS with PaaS and IaaS have 2 respondents. This indicates that there is more focus to use the cloud software services.

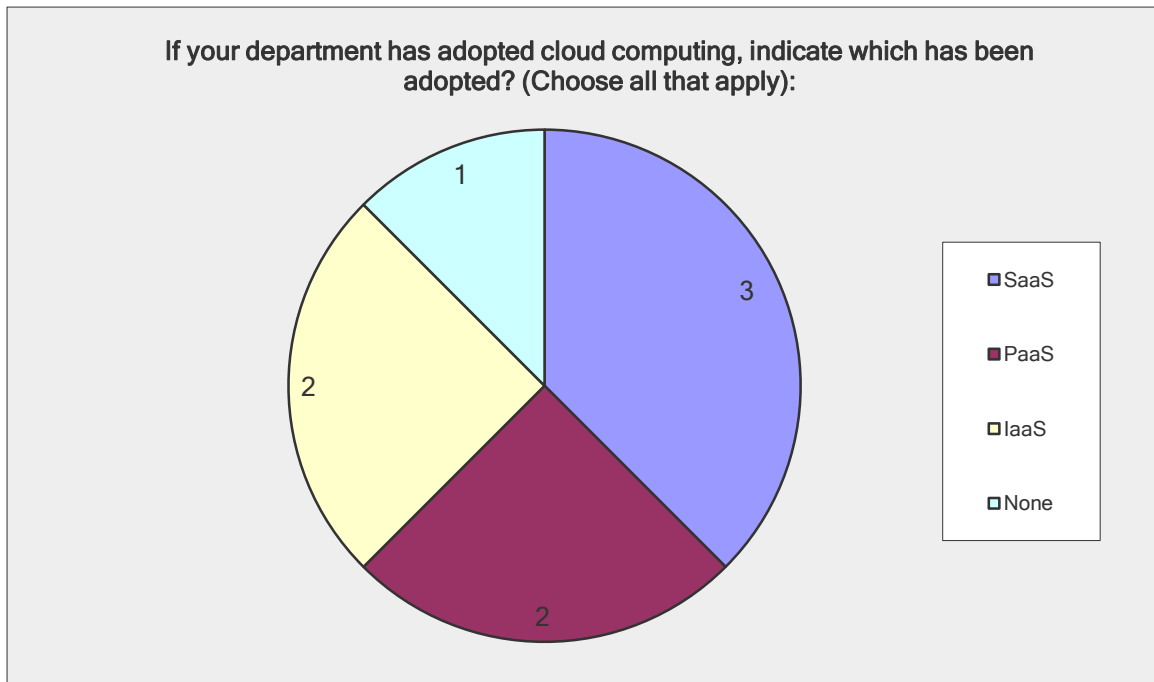


Figure 21: Adoption in Government

Question 22: How will the citizens be impacted with the adoption of cloud computing?

The adoption of new technology will impact the citizens and the respondents had to evaluate the impact of adopting cloud computing. This may require citizens to be trained in a new way of working and change management may need to be addressed. Figure 22 shows the result that indicate 26 respondents agree that training and a new way of working are vital for the successful adoption of cloud computing. A comparison was done with Question 25 (basic administrator capabilities) and there were 11 respondents who answered agree or strongly agree to Question 25 but then answered ‘nothing will change’ for this question. This indicates that they may not fully understand the impact that cloud computing is going to have and these respondents are across the different job levels.

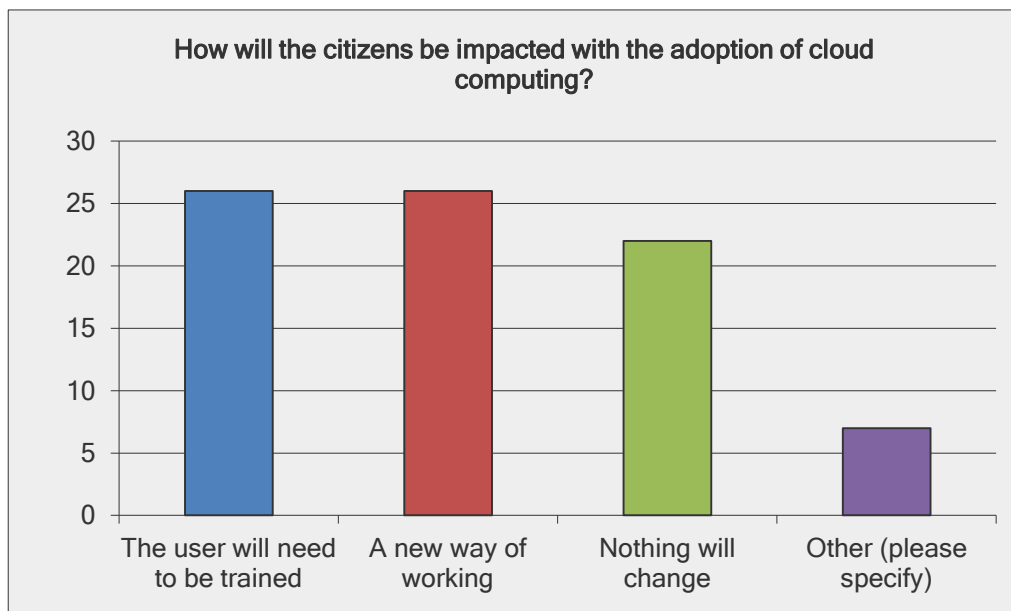


Figure 22: Adoption for Citizens

Question 23: Will you need to develop standards and/or policies to assist in the adoption of cloud computing?

The respondents had to determine whether standards and/or policies would assist with cloud computing adoption. Figure 23 shows there was strong support for policies and standards, in which 57 respondents agree that this is important to assist in cloud computing adoption. The respondents see the value of creating and having standards and policies that will assist in the adoption of cloud computing.

A comparison is made with Question 24 (important drivers for cloud computing). 71% that selected option 3 (Scalability of infrastructure, reduce cost as you pay for what is used and to ensures business continuity) also strongly agree or agree with standards and policies that will assist with the adoption of cloud computing. This shows alignment of the expected outcomes of cloud computing and standards and policies supporting the transition.

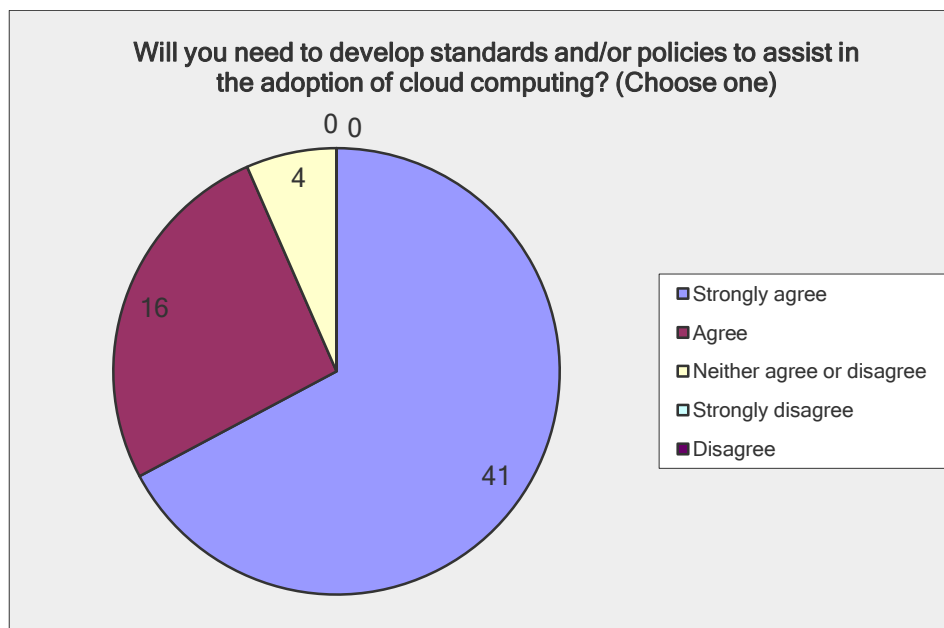


Figure 23: Standards and Policies

Question 24: What would you consider as important drivers for the adoption of cloud computing?

The respondents had to evaluate the important drivers for cloud computing and the result are shown in Figure 24. Option 1 and option2 were used to determine whether the respondents understood the differences between on-premise technology and cloud computing. On-premise technology cannot be used for cloud computing and 43 respondents selected the option for scalability of infrastructure, reduce cost and ensure business continuity. In a comparison with Question 16 (how can government leverage cloud computing but also be secure by having the data stay within government network), 65.6% who selected to create a government cloud and a community cloud had also selected scalability of infrastructure, reduce cost as you pay for what you use and ensures business continuity. This shows that the respondents are knowledgeable about the important drivers of cloud computing that will also assist in the adoption of cloud computing.

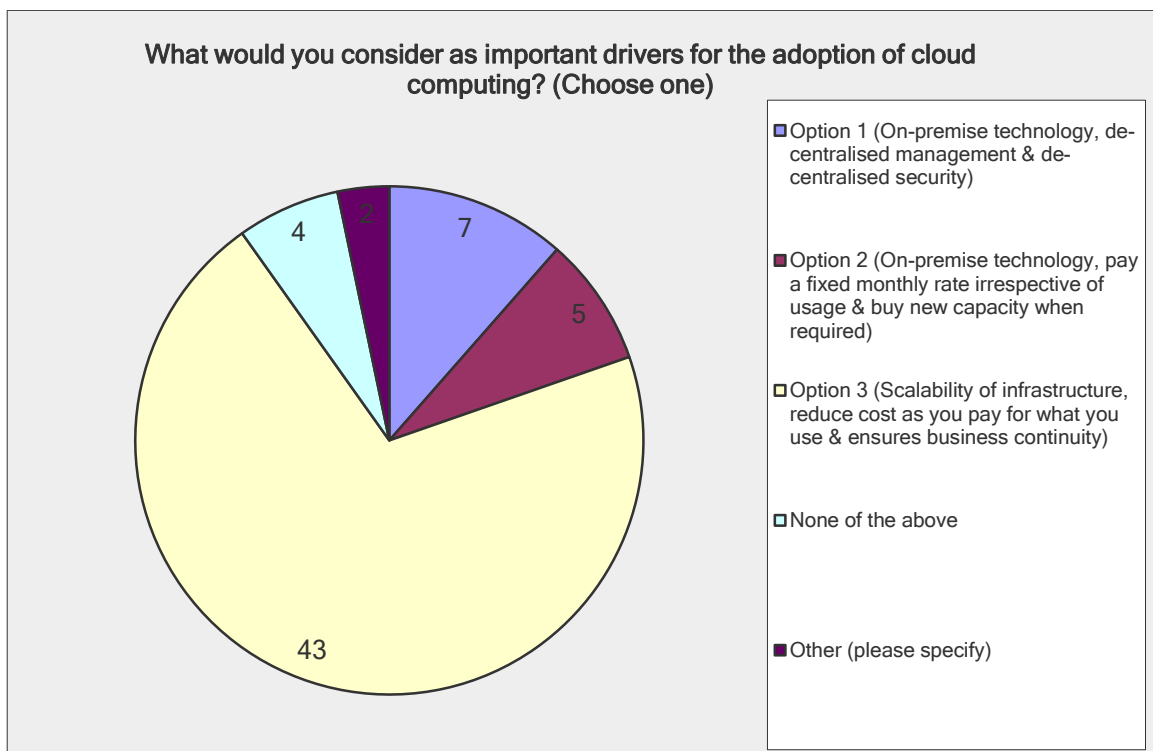


Figure 24: Important Drivers

Summary

There is a common understanding that everyone will benefit from adopting cloud computing as 46 respondents indicated that they will use it in future. The users will be impacted as they will need to be trained and it will be a new way of working. The most important drivers for the adoption of cloud computing are the scalability of infrastructure, reduce cost and ensure business continuity of cloud computing. The standards and policies will assist in the adoption of cloud computing as it will provide the boundaries and guidelines and the accountability for the adoption of cloud computing should be with top management, which includes the CEO, COO and CIO.

4.7 Administrator Perspectives

Introduction

The administrator perspective covers the basic administrator understanding, cloud deployments and the current provisioning of software.

Question 25: Would you agree that you understand the basic administrator capabilities available on cloud computing?

To understand the level of knowledge about cloud computing, the respondents were asked about the basics of administration for cloud computing. 53 Respondents understand the basic administrator capabilities that were available on cloud computing. To understand if there is relationship in understanding of basic admin capabilities and the job roles in government, a comparison is done in Table 5.

Job level	Years in government	Knows the basic admin capabilities (Fo)	Does Not Know the basic admin capabilities	Row Total	Expected Frequency (Fe)
Management	Less than 1 year	16	4	20	17
Operational	Between 1 year to 4 years	17	1	18	16
Senior Management	Less than 1 year	14	3	17	15
Other	Less than 1 year	6	0	6	5
Column Total		53	8	61	

Table 5: Basic Administrator Capabilities

By using the chi-square test of independence:

Frequency observed (Fo) & Frequency expected (Fe)

The $(Fo - Fe)^2 / Fe$ formula is used to determine if there is a relationship.

Management - $(Fo - Fe)^2 / Fe = (16-17)^2 / Fe = -0.11$ (not related)

Operational - $(Fo - Fe)^2 / Fe = (17-16)^2 / Fe = 0.12$ (not related)

Senior Management - $(Fo - Fe)^2 / Fe = (14-15)^2 / Fe = -0.13$ (not related)

Other - $(Fo - Fe)^2 / Fe = (6-5)^2 / Fe = 0.4$ (not related)

The above calculation using the chi-square analysis indicates that there are no relationships.

Question 26: How has cloud computing been deployed in your department?

In order to determine which cloud computing deployments are more prominent in government, the respondents had a choice of five options that they could select. The results in Figure 25 shows that cloud is not deployed by 38 of the respondents and 21 respondents have deployed cloud computing for private and public cloud accounts - These are mainly from the national level departments. The deployment of cloud computing is still at an infancy stage in government.

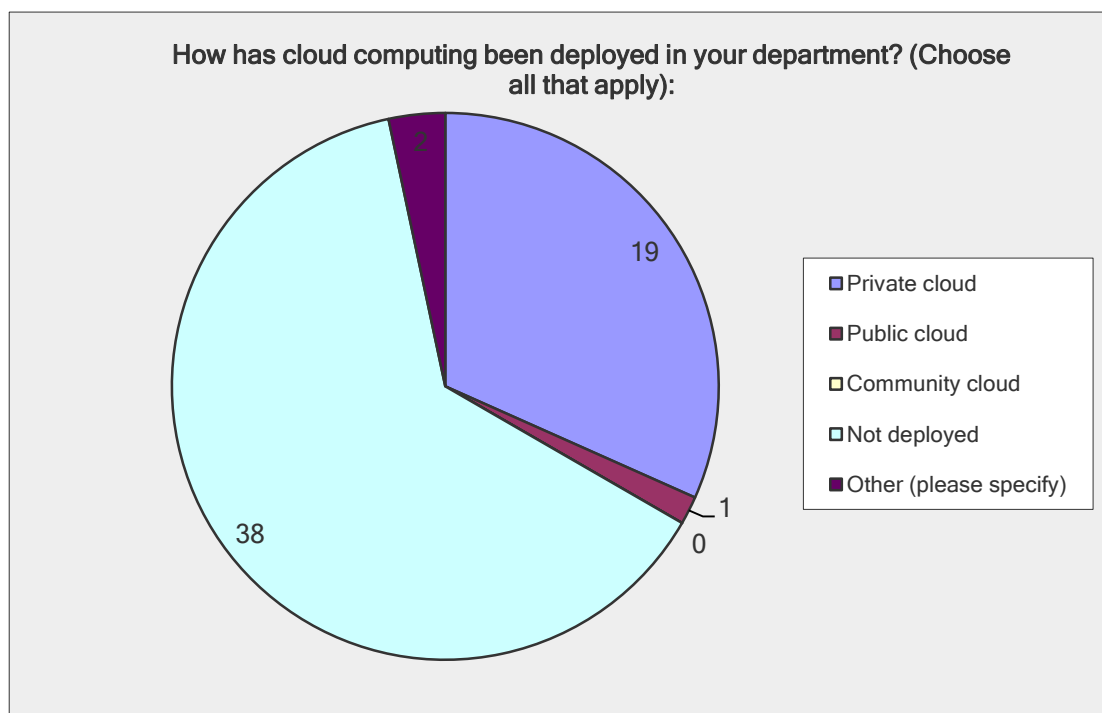


Figure 25: Cloud Deployment

Question 27: Cloud computing has three different paradigms, which are: IaaS, PaaS and SaaS. Which option should be deployed to ensure the hardware, software and network of cloud computing is in place?

To order to understand the respondents' knowledge about cloud computing, they were asked about the descriptions of the different options of cloud computing, which were:

- Infrastructure as a Service (IaaS);
- Platform as a Service (PaaS); and
- Software as a Service (SaaS)

They were asked which option should be deployed to ensure the hardware, software and network of cloud computing is in place and the results in Figure 26 show that 39 respondents are aware of

the phase to build the cloud computing capabilities. The 22 respondents that selected PaaS or SaaS indicates that they are lacking knowledge about the understanding of cloud computing.

The 32 respondents that selected PaaS (11 respondents), SaaS (11 respondents) or did not answer (10 respondents) about knowing the cloud computing basic admin capabilities, will be removed from question 28 onwards to show a true representation from the respondents that understand cloud computing.

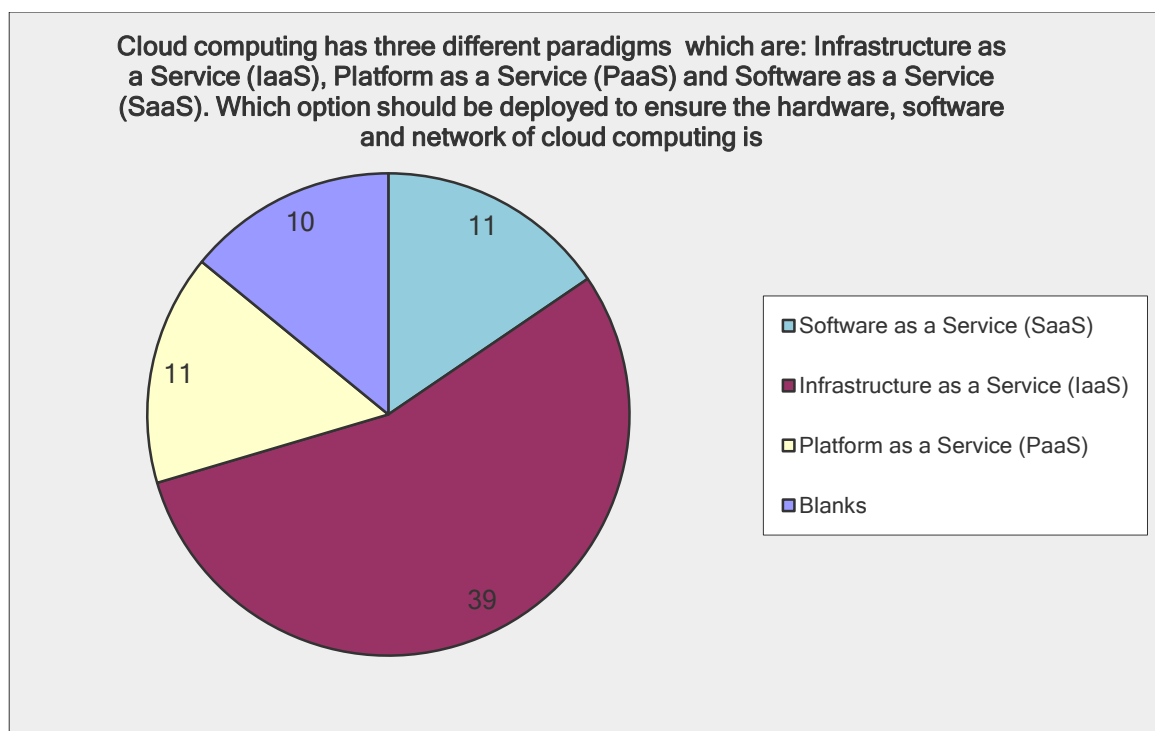


Figure 26: Different Paradigms

Question 28: For the software you are currently using, is it in-house (non-cloud), on a local cloud (servers in-house), remote cloud or nothing?

To better understand what software is used in government, the respondents were presented with four options and the results are shown in Figure 27. The most responses were for in-house software (non-cloud) being most prevalent. This indicates the current adoption of cloud is very low and the traditional approach is still being used. Across all the software, the remote cloud offering is almost non-existent, which indicates that government has not yet started to get the application to be cloud ready in order for it to move to the cloud. This is a critical finding as this is the baseline for software applications in government and the drive for cloud computing needs to happen for the commonly used applications first, such as e-mail, ECM and ERP applications that will add the most value.

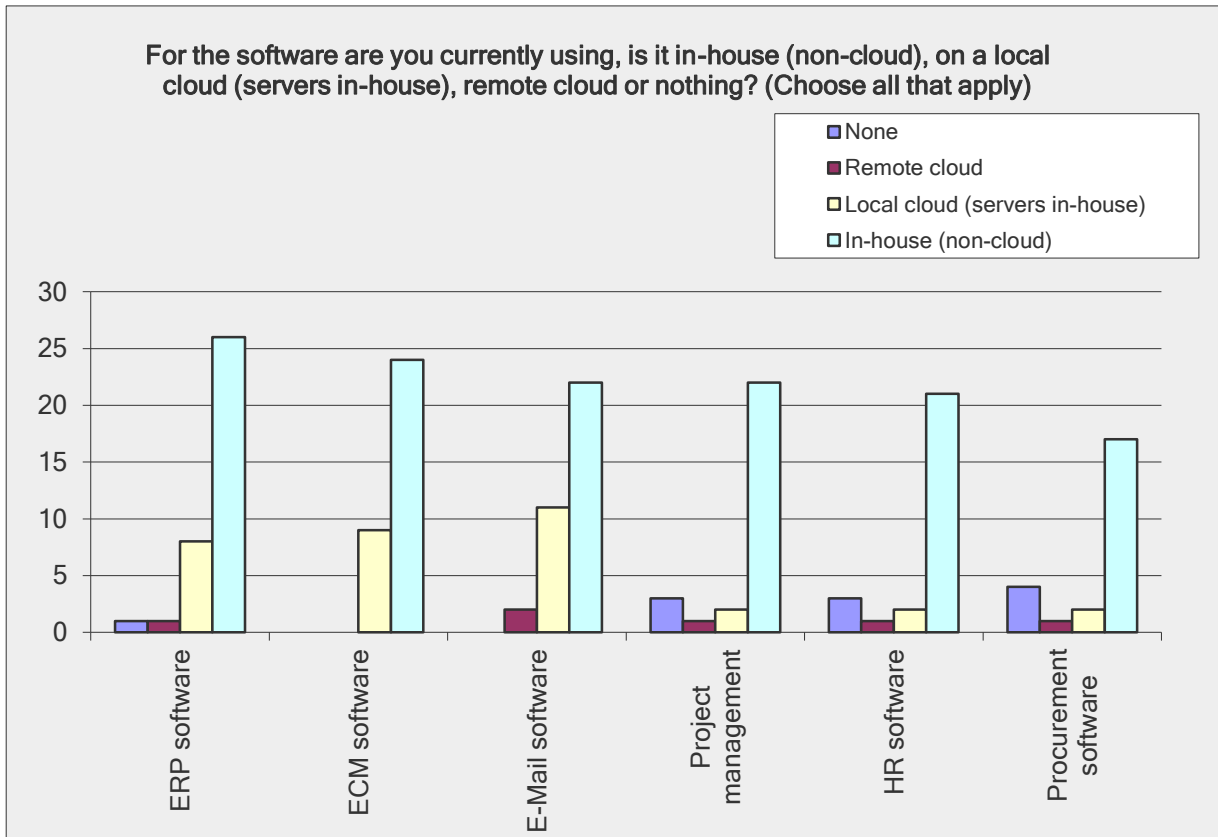


Figure 27: Current Software

Summary

53 Respondents understand the basic administrator capabilities for cloud computing, which shows that the majority of respondents are aware of cloud computing. However, 38 respondents indicated that cloud is not deployed, especially for national level departments. There is an understanding of the different phases of cloud computing with 39 respondents agreeing that hardware, software and networking of cloud computing is done at the IaaS phase. The in-house (non-cloud) model is very prevalent in government and the remote cloud use is very minimal.

4.8 Cloud Computing Challenges

Introduction

The challenges cover the disadvantages of cloud computing, data security, concerns about the cloud adoption, obsolete technology, skills and the investment into cloud computing.

Question 29: What are the disadvantages of cloud computing compared to other IT technologies?

In order to determine the disadvantages in comparison with other IT technologies, the respondents had to think critically about cloud computing and the results are shown in Figure 28. The respondents have indicated that huge upfront costs and poor security are the top two disadvantage with using cloud computing. The low upfront costs was selected the least, which shows that respondents are aware of the investment needed for cloud computing.

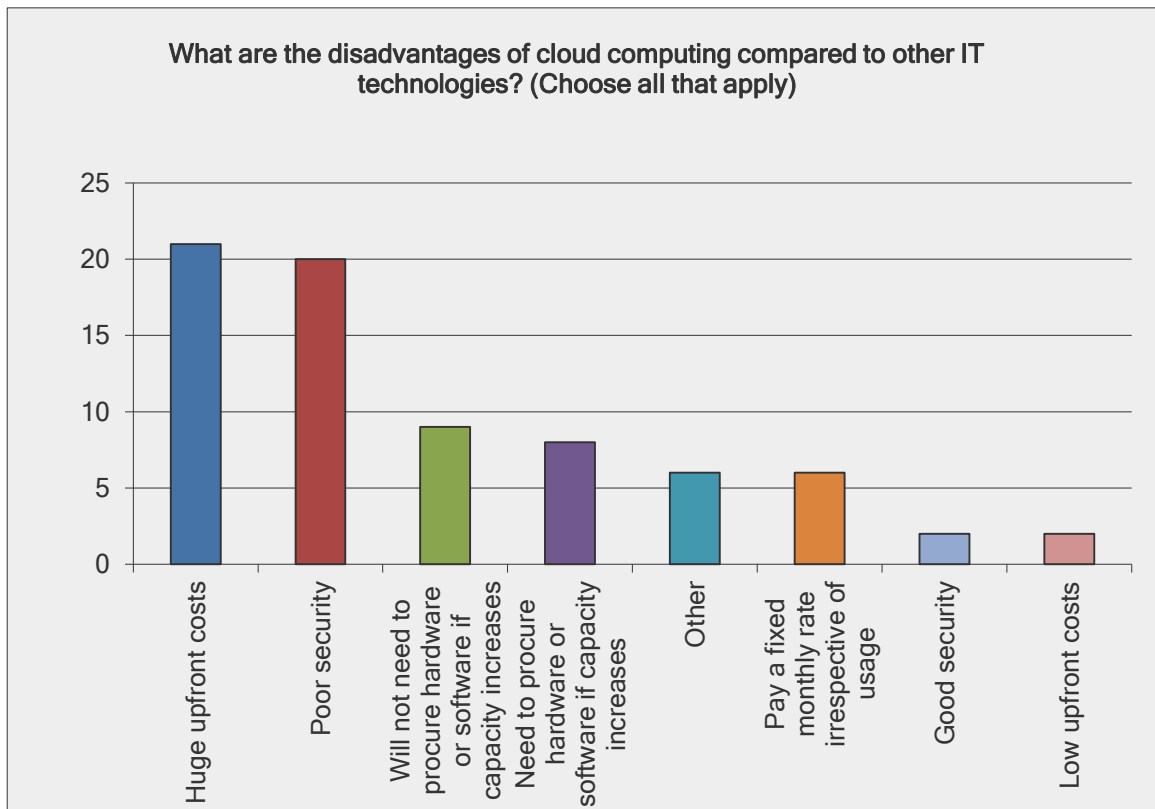


Figure 28: Disadvantages

The other comments include:

- Difficult to do billing as it service based;
- There is a lack of skills;
- There is no control over the data;
- A security risk – offsite data storage; and
- No control over the hardware and software.

Question 30: Do you think cloud computing is secure?

To evaluate the security perception of cloud computing, the respondents had to select one of the five options and the results are shown in Figure 29. The majority (18 respondents) agree that cloud computing is secure while 12 respondents neither agree or disagree. This is of concern as

security is one of the most important considerations when using software and also may indicate that the respondents have mixed feelings about the security or may not fully understand cloud computing.

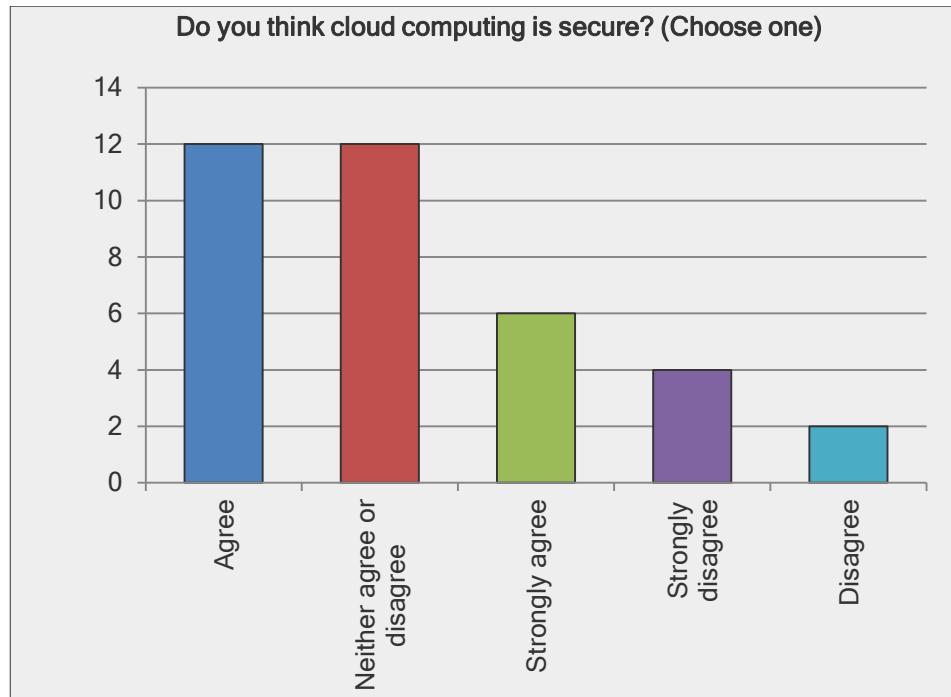


Figure 29: Cloud Secure

Question 31: How will you ensure that the data in cloud computing is kept secure?

The respondents were given an opportunity to provide solutions on how they think cloud computing can be kept secure. They were presented with five options and results are shown in Figure 30. It is clear that the department must ensure the data in cloud computing is kept secure. There is strong emphasis that the service provider and users must also strive to keep it secure - everyone has a part to play.

Other comments include:

- It is a combined effort between the department as well as the service provider;
- Security is a multi-faceted approach; and
- The adoption of cloud will be private, as there is no control over the location and security of the data in a public cloud.

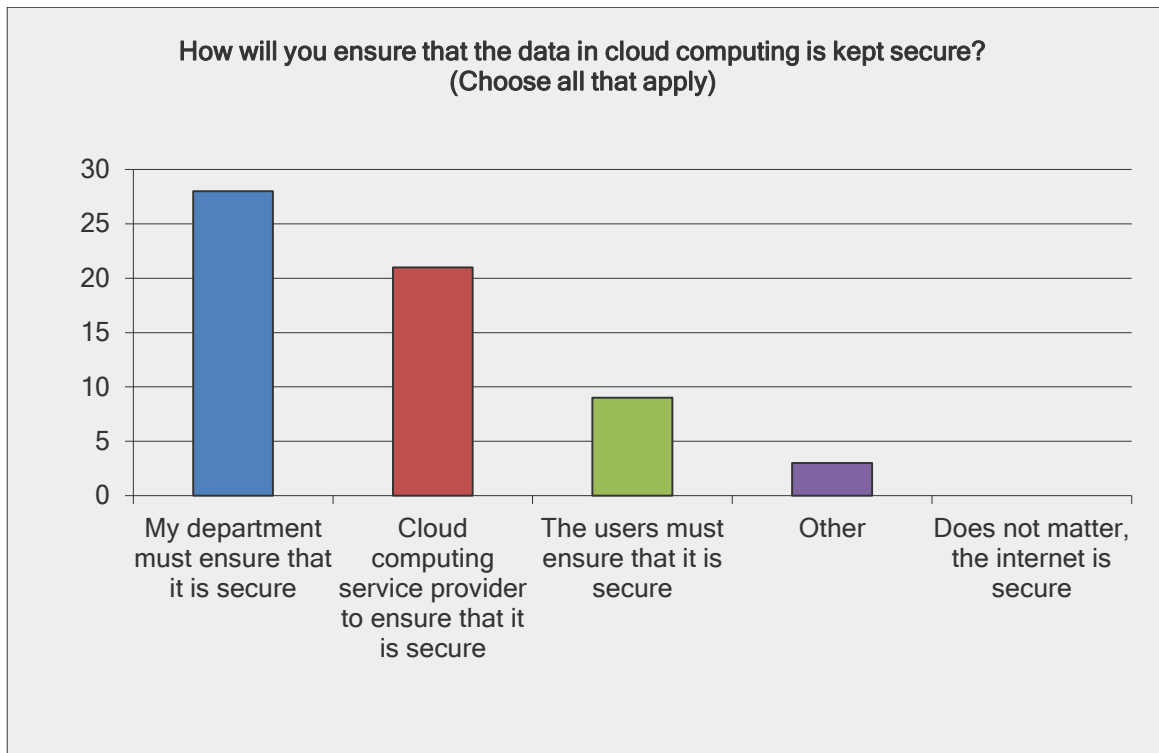


Figure 30: Data in Cloud

Question 32: What are the concerns from your department about the adoption of cloud computing?

To obtain the concerns around cloud computing, the respondents were presented with seven options and Figure 31 shows the results. The highest concern was the migration of old or obsolete applications to be cloud ready, followed huge upfront cost with the lowest being top-management buy-in. Security concerns features at fourth most important concern (together with huge upfront costs). The respondents understand that the migration of old applications may be a challenge to move to cloud computing as many of the older applications were not based on Service Orientated Architecture (SOA).

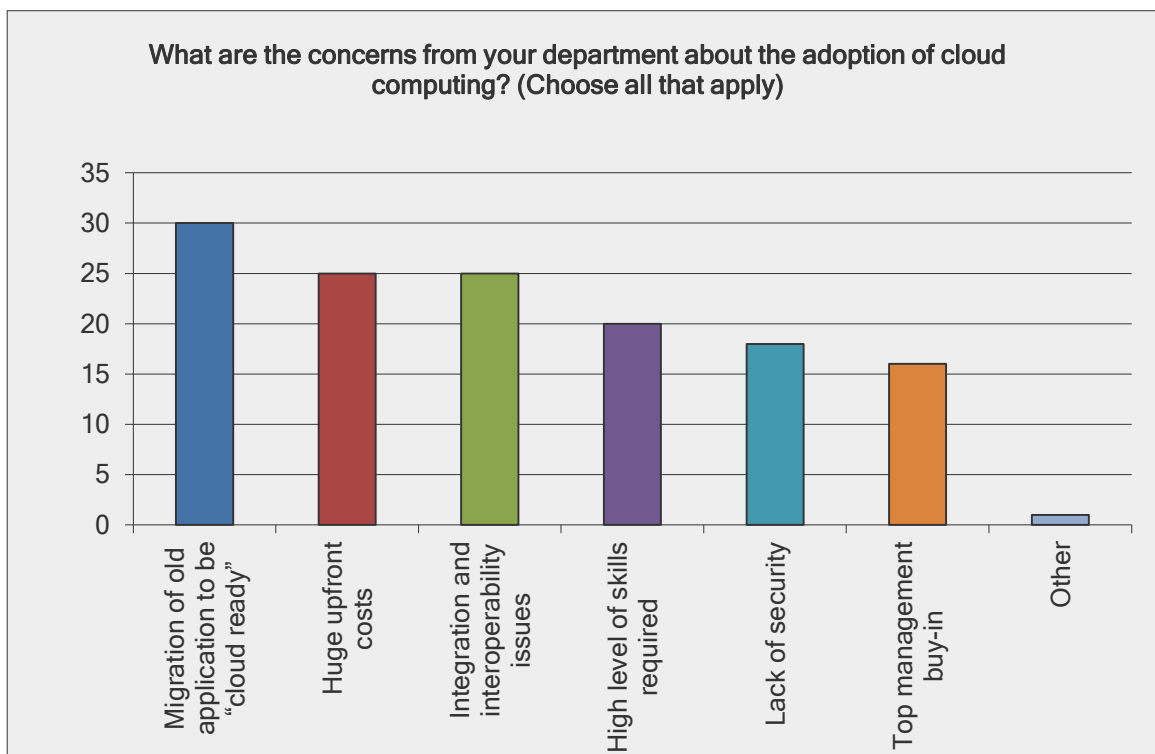


Figure 31: Concerns about adoption of Cloud Computing

Question 33: What are the challenges that you are facing in adopting cloud computing?

To conclude the challenges encountered with adopting cloud computing, the respondents were provided with options and the results are shown in Figure 32. It indicates that the majority selected old or obsolete applications followed by migration of applications and change management issues. A comparison was done with the job levels and the majority of the responses were from the management and senior management. For every challenge, it was either management or senior management who had the highest overall response.

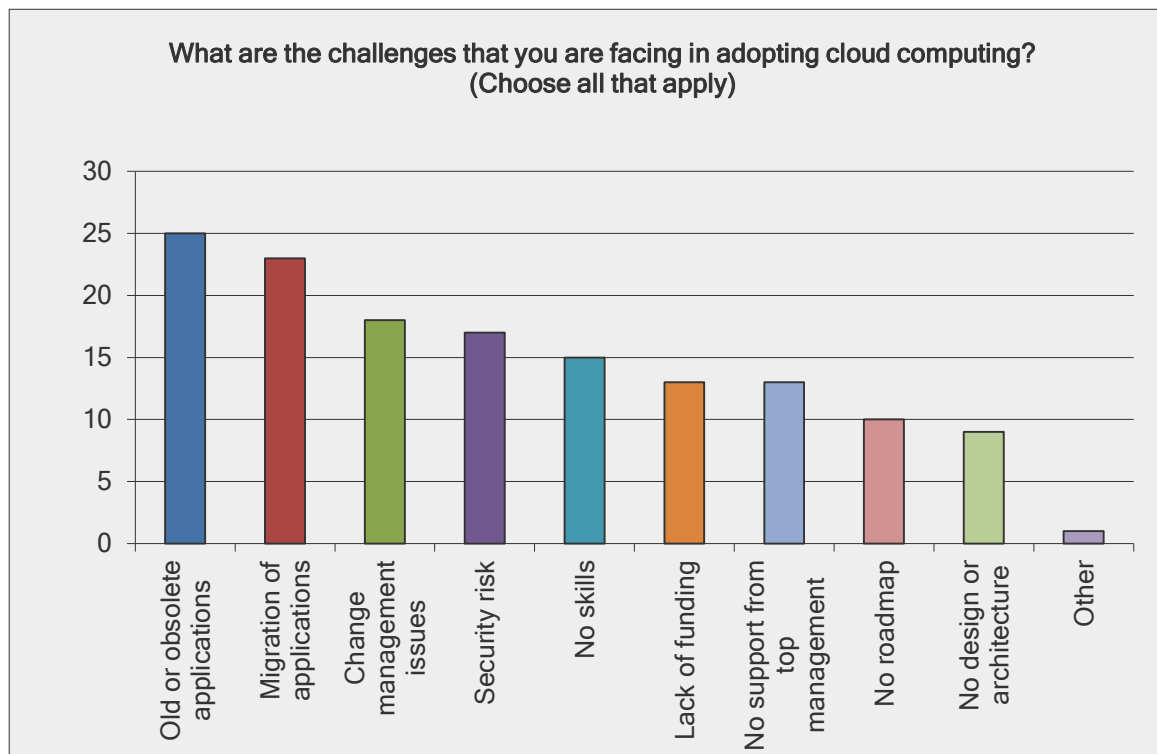


Figure 32: Challenges

Question 34: How will you ensure that the technology you deploy for cloud computing will remain relevant and not get obsolete as technology advances?

Technology is evolving at a rapid pace and the respondents had to think strategically to ensure that the technology that is deployed for cloud computing will remain relevant. The results in Figure 33 show that the majority of the respondents selected the life-cycle management for the technology and then to keep up with the industry technology trends. This question will be relevant to the cloud service provider.

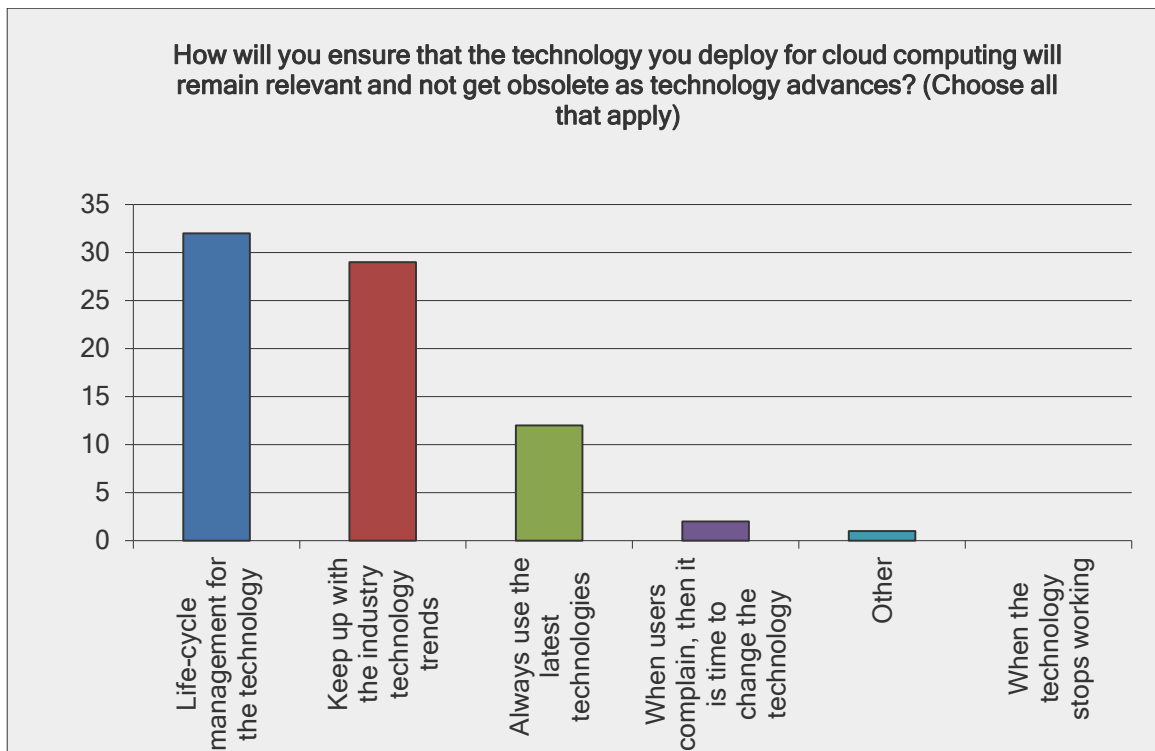


Figure 33: Relevant Technology

Question 35: Do you think the investment in the adoption of cloud computing is worth its value?

For cloud computing there has to be investments made to reap the benefits. The respondents had to provide their views about the value of cloud computing. The results in Figure 34 show that there is strong support of 32 respondents that think the investment made in cloud computing will be worth it but 1 respondent disagree with this and 2 respondents were unsure about whether cloud computing is a good investment or not.

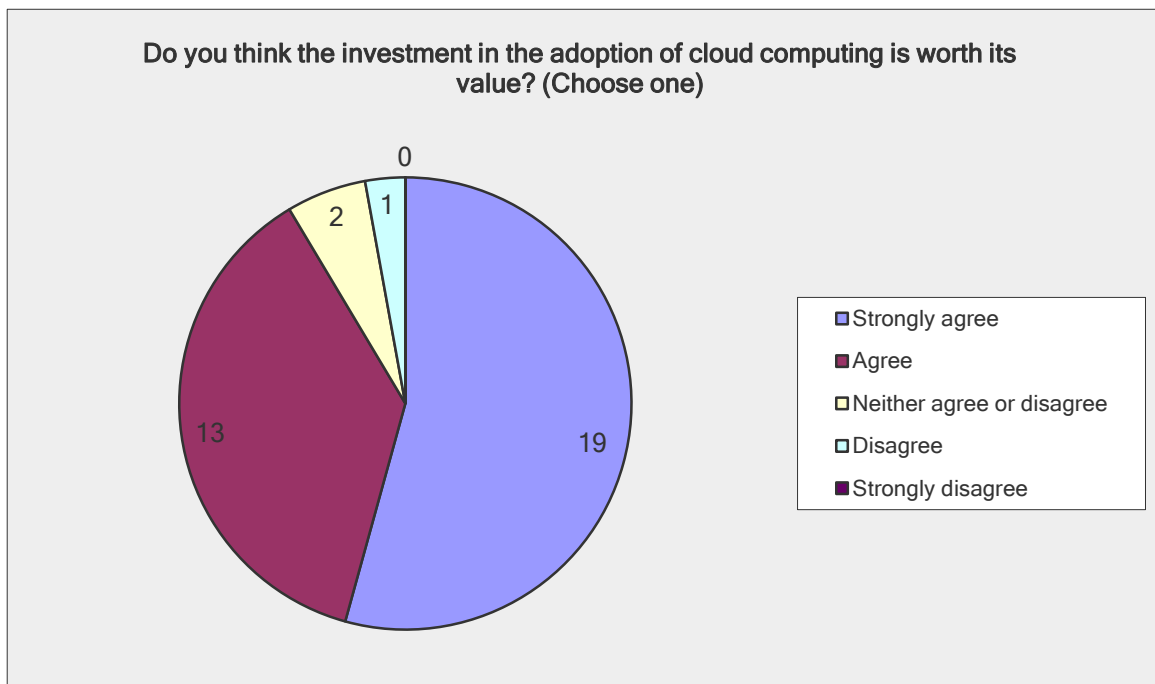


Figure 34: Investment

Question 36: One of the big drivers for the adoption of cloud computing is the cost saving. What is the estimated cost saving by adopting IaaS (not managing hardware), PaaS (not managing stacks or frameworks) and SaaS (not managing service software)?

One of the biggest drivers for the adoption of cloud computing is the cost saving and the respondents were required to estimate the cost saving by adopting IaaS (not managing hardware), PaaS (not managing stacks or frameworks) and SaaS (not managing service software). The results in Figure 35 show that the bulk of the responses (15 respondents) selected that the cost saving was more than 20% and 11 respondents selected that it would be between 10% to 20% cost saving. This highlights that cost is really a big driver for the adoption of cloud computing.

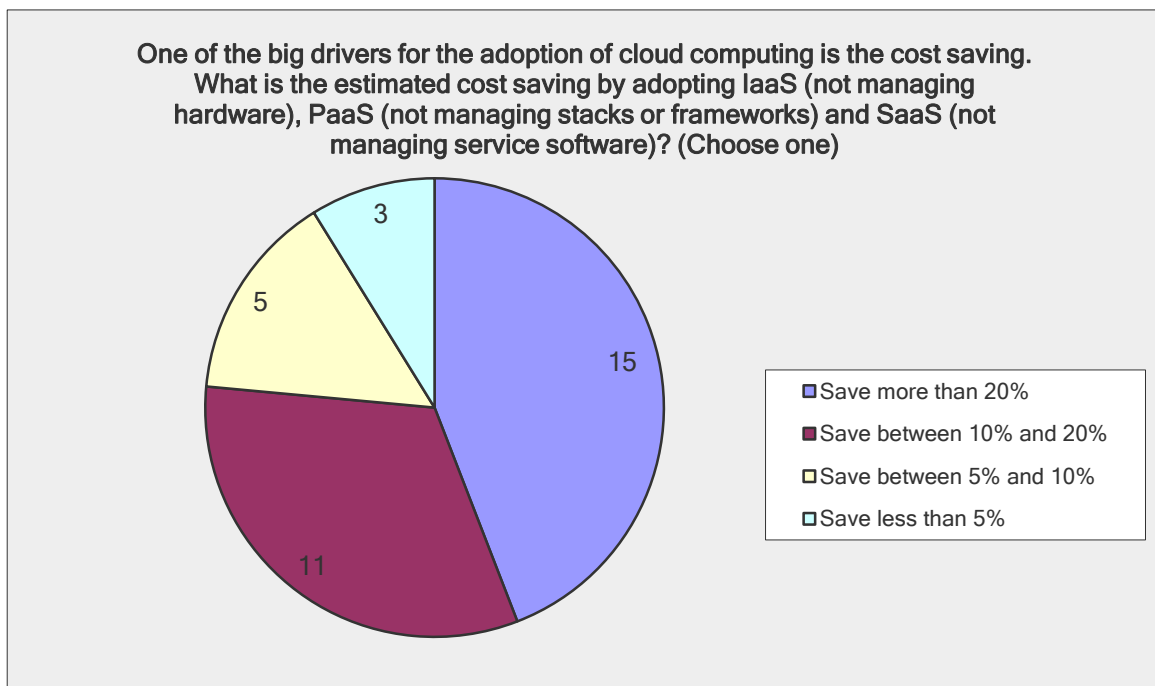


Figure 35: Drivers for Adoption

Question 37: How will you determine what skills you will require for the adoption of cloud computing?

To determine what skills are required for the adoption of cloud computing, the respondents could contribute to the solution to determine the skills required for cloud computing. The results in Figure 36 show that the majority of responses will map the skills to the applications and technology that they intend to implement, followed by seeking advice from industry for the required skills. Following this approach, the skills will be relevant and industry can provide guidance on the technology trends that will influence the skills decisions.

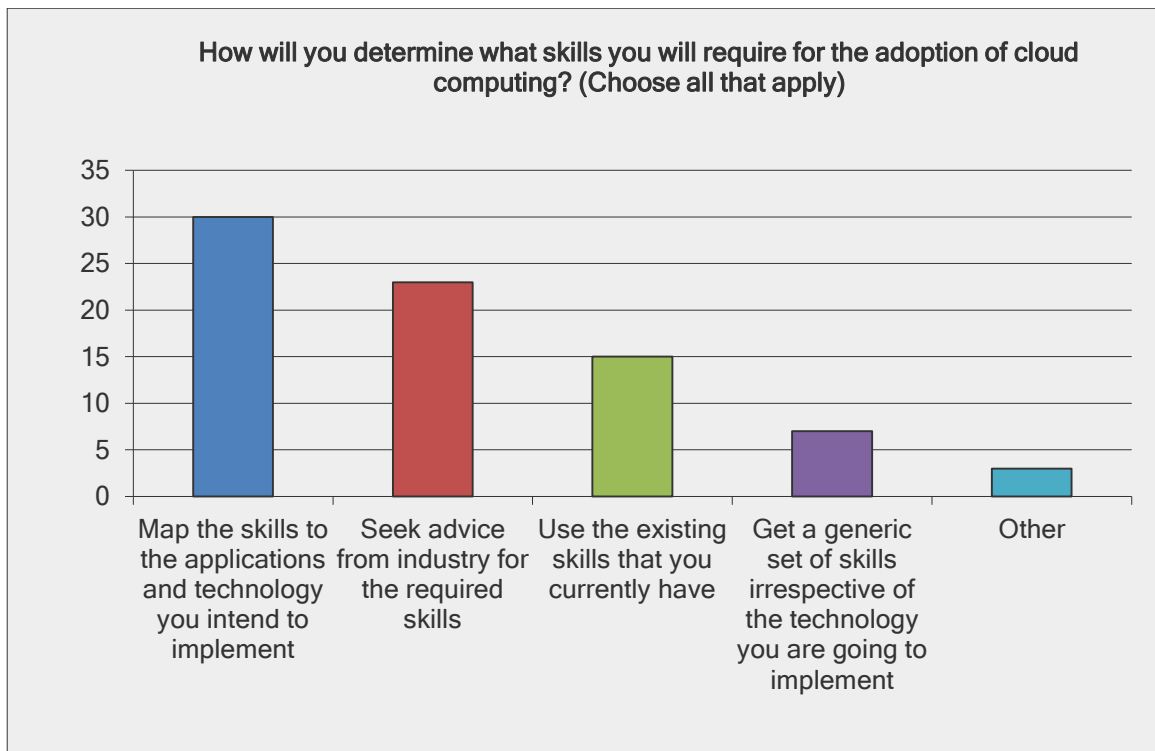


Figure 36: Skills

Question 38: What is your long term plan for your current IT skills?

The long term plan for the current IT skills was to assist in the transition of IT skills and the respondents were required to critically think about what is going to happen to the current skills. The results in Figure 37 show clearly that the majority of the respondents are aware that the skills need to be transitioned and they have selected to have a development plan to re-skill the people and to move people with obsolete skills to other areas within IT, if they cannot be re-skilled.



Figure 37: Long Term Plan for Skills

Summary

The main disadvantage is the poor security followed by the huge upfront costs and the government needs to ensure that the data is kept secure although they may use cloud service providers. The concerns from the adoption is the migration of old or obsolete applications to be cloud ready and then integration and interoperability issues. All software that will be in the cloud needs to be developed so it is cloud ready and also be tested for integration and interoperability with other systems. For cloud computing technology to remain relevant and not get obsolete, a life-cycle management approach needs to be used. 32 Respondents think that cloud computing is worth the value it will bring and 26 respondents believe there will be a cost saving of more than 10%. The skills will need to align to cloud computing by having a development plan that maps the skills to the applications and technology that is going to be implemented and also seek advice from industry so the skills remain relevant.

4.9 Overall Research Summary

There was a good overall response rate for most of the questions and some comments about the respondents' thinking and views. The survey has revealed the perceptions, as below:

User perspective

The majority of respondents:

- Are from medium to large department (1 000 employees or more);
- Are from national level departments;
- Are in favour of government using cloud computing;
- Have heard about cloud computing; and
- Have used a cloud application.

Cloud computing opportunities

The majority of respondents agree that:

- To enhance the existing IT services provided by government is to make more services available over the Internet;
- Cloud computing is a new paradigm - renting software instead of buying software;
- The most used software in government are: E-Mail, ECM and ERP software and these software have been identified to move to the cloud;
- The government cloud and community cloud should be used to keep data secure;
- The government is not using technology effectively to deliver better services; and
- The government is not doing enough to embrace technology as an enabler.

Adoption of cloud computing

The majority of respondents agree that:

- The top management should be accountable for cloud computing and accountable people are: CEO, COO and CIO;
- Everyone will benefit with the adoption of cloud computing;
- The cloud computing has not been fully adopted but it will be used in future;
- IaaS and SaaS are used;
- The training and a new way of working are vital for the successful adoption of cloud computing;
- There is support for policies and standards; and

- The important drivers includes: scalability of infrastructure, reduce cost and ensure business continuity.

Administrator perspectives

The majority of respondents agree that:

- They understand the basic administrator capabilities that are available on cloud computing;
- The deployment of cloud computing is minimal mainly from the national level departments;
- They are aware of the phases (IaaS, PaaS and SaaS) to build the cloud computing capabilities; and
- The in-house software (non-cloud) are the most prevalent in government.

Cloud computing challenges

The majority of respondents agree that:

- Poor security is the number one disadvantage;
- The government department must ensure that the data in cloud computing is kept secure;
- The main concerns about adopting cloud computing was the migration of old or obsolete applications to be cloud ready;
- The life-cycle management approach will be used for the technology and also to keep up with the industry technology trends;
- The investment made in cloud computing will be worth the value;
- By adopting cloud computing, there will be cost saving of more than 20%;
- The skills will be mapped to the applications and technology that they intend to implement; and
- The skills will need to be transitioned and to have a development plan to re-skill the people and to move people with obsolete skills to other areas within IT, if they cannot be re-skilled.

Some interesting findings about the respondents include:

- 63% have more than 10 years' experience in government
- 62% are from national level departments
- 98.5% have heard about cloud computing
- 85.9 agree that government should use cloud computing
- 47.5% think that cloud computing is secure

- 20.6% indicated that e-mail software is the most commonly used software
- 24% indicated that ECM software is the software they most likely would like to deploy in cloud computing, immediately

Chapter 5. Conclusion

The objective of the research is to determine the perceptions of cloud computing in the SA government. The client-server model took over both operation and control of technological infrastructure from the user - now cloud computing is a new delivery model for IT services with a new consumption paradigm for its users. Cloud computing has become a significant technology trend and could reshape the IT sector and the IT marketplace (Voas & Zhang, 2009). Cloud computing is a breakthrough technology (Hofmann, 2010) that will continue to unleash new innovations and bring new efficiencies and advantages to business where it removes infrastructure and capital expense as a barrier to entry and allows start-up companies to scale up cheaply and rapidly. A survey was designed and conducted to test and evaluate the perceptions from the SA government.

The learning from the literature review and the survey results has provided the perceptions of the SA government that have been summarised into the following four research questions.

Question 1 - What is cloud computing?

The majority of government respondents have heard about cloud computing and many indicated that they have used a cloud computing application. Government would like to work differently to the traditional way in which software was bought and then used according to the licensing agreements. However, the new paradigm is that software can be rented over the Internet and only pay for what is used. Many are willing to use the new cloud computing approach and everyone will benefit from using this. There is good understanding of the cloud computing concepts as the majority of respondents were able to distinguish that hardware, software and network is done in the IaaS phase. There are many advantages of cloud computing and there is a good understanding of cloud computing in government. They are willing to use it and understand that this will result in a change whereby IT is not bought but rented.

Question 2 – What is the adoption of cloud computing?

The adoption of cloud computing is gaining momentum as governments and companies understand the benefits of adopting cloud computing. Governments believe that technology will help the country build a skilled workforce and outsourcing of common services such as email to cloud will result in cost saving from scalable architectures. The government should adopt new computing architectures and the introduction of e-government leads to opportunities for using ICT and the Internet as a tool to achieve a better government.

The accountability for the adoption of cloud computing needs to reside with top management such as: CEO, COO or CIO. Few of the departments have already adopted cloud computing for IaaS and SaaS, with many other departments that will start using cloud computing technology in the near future. The adoption of cloud computing will naturally result in a new way of working in which the users will be trained to use cloud technology and to map the skills to the applications and technology to be implemented. The long term plan for skills will be to re-skill staff according to a development plan that is aligned to cloud computing. The majority of government users understand the basic administrator capabilities that are available on cloud computing with standards and policies that will need to be developed to assist in the adoption of cloud computing. For the adoption to be successful, the important drivers include: scalability of infrastructure, reduce cost and ensures business continuity. The majority of government users believe that cloud computing will offer 10% to 20% cost saving, which highlights a big driver for the adoption of cloud computing.

Question 3 - What are the challenges in cloud computing?

There are concerns about the cloud computing model, such as performance, compliance, private clouds, integration and cost. However, security is one of the main concerns because the applications and data are being hosted by the service provider in a shared infrastructure. This may lead to unauthorised access, privacy, identity management, authentication, compliance, confidentiality, integrity, availability of data, encryption and network security issues. There are security benefits of using cloud computing, such as: focus resources on areas of high concern, improved resource availability, improved backup and recovery capabilities and the ability to leverage alternate cloud services to improve the overall security posture.

Security is considered the main disadvantage of cloud computing according to the respondents in comparison with other IT technologies, followed by the huge upfront costs to create the cloud capability. However, they feel that their departments must ensure that cloud computing is kept secure. The main concerns facing the adoption of cloud computing includes: migration of applications, old or obsolete applications and change management issues. A lifecycle management approach will be used to keep the cloud technology relevant. The majority of government respondents think that the investment in cloud computing will be worth its value because of the many benefits that cloud computing offers.

Question 4 - What are the deployment considerations for cloud computing?

Cloud Computing is still in an infancy stage in government as most departments have not deployed cloud computing. The technology decisions that are made in government are mostly for software and hardware purchasing. Government is in favour of using cloud computing as it makes IT services more assessible and cost effective to citizens. Government has started embracing new technologies by having some mobile related technologies and some services are available over the Internet. However, many people think that government is still not using technology effectively. Government can improve this perception by making more services available over the Internet, understand the user's requirements before developing an application and make services more user-friendly. The most widely used software in government are: email software, ECM software and ERP software, with procurement software and HR software going to be used in the near future. The top software that is recommended to be moved to the cloud are: e-mail software, ECM software and ERP software. A government cloud and a community cloud should be created to ensure that government can leverage cloud computing and also be secure by having the data stay in the government network.

The four research questions have provided the perceptions of the SA government in which cloud computing is understood, the cloud computing adoption in government is still at its infancy, there are many concerns about cloud computing with the main concern being security and the SA government needs to create the cloud capability so that the data stays in the government network.

Linkage of the Survey and the Literature Review

There are linkages from the survey to the key finding in the literature review that are described below.

What is Cloud Computing?

In chapter 2.2, Sri (2011) describes cloud computing as a model of accessing a shared pool of computing resources like networks, storage, services, and applications on demand, without you worrying about how these resources are made available to you.

In chapter 2.2, Greengard (2010) tells us that cloud computing is so powerful because it is based on a system of modularity and the use of virtualization and a cloud platform allows organisations to break down services and systems into smaller components.

In chapter 2.2, Wei and Blake (2010) describe that cloud computing facilitates the delivery of computing-on-demand much like other public utilities such as electricity and gas. Ellis (2011) also confirms that cloud computing enables operational agility to scale the infrastructure in a short time and the applications will scale accordingly. Cloud computing provides a powerful IT infrastructure at a modest cost in which servers can be located almost anywhere and interfaces can be changed and be customised quickly. It frees individuals and small businesses from worries about quick obsolescence and a lack of flexibility but at the same time, large organisations can consolidate their IT infrastructure across distributed locations (Greengard, 2010).

The survey asked the respondents about their awareness about cloud computing and 68 respondents have heard about cloud computing as a new technology trend while 48 respondents do not think that government is utilising technology effectively. Some to the technology that government has adopted includes: more services are available over the internet (28 respondents) and using more mobile related technology such as MMS and SMS (32 respondents).

The technology trends can add value to the government as can be seen from the responses. The literature shows a big push towards cloud computing as one of the main technology trends currently. The respondents want a lot more of the new technology to add value to their lives.

Cloud Computing Opportunities

In chapter 2.4, Magro (2012) defines e-government as the use of ICT and the Internet as a tool to achieve a better government in the use of technology. Bughin, Chui & Manyika (2010) confirms that technology is vital in the evolution by facilitating the creation of new types of public goods while helping to manage them more effectively. The public sector should take advantage of the improved conditions for development and deployment of e-government solutions as this can be achieved through the adoption of new architectures, such as cloud computing and service-oriented architecture, in the public sector (Cellary & Strykowski, 2009).

In chapter 2.4, (Al-wazir & Zheng, 2012) the benefits of e-government are many and not only the citizens of a country receive a quality service and empowerment but the government and other stakeholders also benefit by adoption of an e-government system.

The respondents indicated that government can enhance the current service offering by making more service available online rather than going into a physical office (53 respondents), more applications for mobile phone due to the prevalence of mobile phones in SA (38 respondents), applications that are more user-friendly (37 respondents), the user's requirement must be considered before developing an application (49 respondents) and use of more technology (39 respondents). When asked whether they would prefer to "rent" software instead of "buying" it which means in a new paradigm shift – 49 respondents was willing to "rent" the software which is the principle in which cloud computing works.

E-Government is the term for all electronic government services and this means huge opportunities to add value. The literature shows us that by making use of these services the citizens will get empowered to get the services, when they require it and not wait in long queues. The respondents want more services to be made available on line and more software focusing on the mobile phones due the explosion of mobile phones in SA.

Adoption of Cloud Computing

In chapter 2.5, the IT resources will need to become more flexible and agile as cloud computing turns the economics of IT on its head, due to an unprecedented elasticity of resources (Wyld, 2009).

In chapter 2.5, the primary security mechanism in today's clouds is virtualization in which it is a powerful defense (Armbrust et al. 2010), and protects against most attempts by users to attack

one another or the underlying cloud infrastructure and the security for intermediate layers of the software stack is shared between the user and the operator; the lower the level of abstraction exposed to the user, the more responsibility goes with it.

The most important drivers for the adoption of cloud computing (agreed by 43 respondents) includes: scalability of infrastructure, reduce cost as you pay for what you use and ensure business continuity. The users will be impacted by the adoption of cloud computing and the respondents indicated that a new way of working and users to be trained are the top two priorities. However 22 respondents selected that nothing will change by the adoption of cloud computing. There are 19 respondents that have used the private cloud deployment over the public cloud deployment and community cloud deployment.

The 53 respondents have an idea of the basic administrator functionality for cloud computing and aligns to the 48 respondents that have used a cloud application such as Gmail, Drop box, etc. Based on the responses, the CEO and CIO are the people most likely to be accountable for the cloud computing projects as they have a direct interest in whether the project will be a success. The respondents (68) are aware about cloud computing and 39 respondents knew that IaaS was the option that included the hardware, software and networks, which shows there is good overall understanding about cloud computing. The top three applications that the respondents identified that should move to the cloud are: ECM, E-Mail and ERP software. The departments are going to use cloud computing in the future as indicated by 46 respondents while 8 respondents are already using it.

The term cloud computing was previously used as the silver-bullet for all of IT's challenges - this was not true as cloud computing had a specific focus areas i.e. IaaS, PaaS and SaaS. Awareness has been improved and there is a strong drive to move the critical applications to the cloud because of all the advantages. The progress for the adoption of cloud computing in government is happening at a very slow pace although there are many benefits of moving to cloud computing that has been identified but there are also many challenges with adopting cloud computing such as up-front cost, poor security perception, skills, etc.

Cloud Computing Challenges

In chapter 2.6, security is one of the biggest challenges to the cloud model. The users must trust the provider and for organisations whose existence depends upon safeguarding customer data, trade secrets, classified information or proprietary information, public cloud providers don't

offer sufficient protection (Hoffman, 2010). The biggest cloud computing concern is security with applications and data being hosted by a service provider. Data is no longer under the control of management and prone to vulnerabilities with hosting applications and data in shared infrastructures increases the potential of unauthorised access and raise concerns such as privacy, identity management, authentication, compliance, confidentiality, integrity, availability of data, encryption, network security and physical security (Carroll, Van Der Merwe & Kotze, 2011).

The main disadvantage that has been evident throughout the survey was poor security as the respondents perception is that cloud computing is not secure. This will be a barrier for the adoption if security is still considered a risk as government does not want to put out information that is not secure.

Good security is one of the main requirements for any IT project or technology. Cloud computing needs to raise awareness about security and from the literature it shows that cloud computing is a shared technology and uses economies of scale to create the cost saving and flexibility to up-scale and down-scale according to the demand.

The contribution of this study has provided a view on cloud computing in government that includes awareness about the understanding of cloud computing, the opportunities that are available with cloud computing, the transition of old technology to the adoption of cloud computing, the challenges with adopting cloud computing and the administrator perspectives.

The limitations of the study include:

- The lack of knowledge from some of the respondents about the basic concepts in cloud computing;
- Poor representation of respondents from the local and provincial level government departments;
- The survey was anonymous therefore it could not be determined from which government department each respondent belonged to; and
- Respondents (outliers) that had to be removed from question 28 onwards as they did not have sufficient knowledge about cloud computing to show a true representation from the respondents that understand cloud computing.

Chapter 6. Future Research

There are areas in which further research can be done to provide more insight into cloud computing within the SA government.

The governance of cloud computing in SA government for a new paradigm of computing. A possible research question is: “What is the new cloud computing governance in the SA government?”

The number of cloud computing projects will start to increase in future therefore research into the adoption of cloud computing will be important. A possible research question is: “What are the critical considerations for successful adoption of cloud computing in the SA government?”

One of the main concerns about cloud computing is poor security. This needs to be researched and a possible research question is: “How to secure cloud computing by developing an enterprise security architecture for the SA government?”

With the huge upfront investment of cloud computing, a possible research question is: “How to make cloud computing an enabler to government objectives?”

Annex A : Draft Surveys

1st Draft Survey

From: Deena Chetty
Sent: 04 October 2013 10:51 AM
To: Carlyn Williams; Nataly Engelbrecht; Ronelle Bezuidenhout; Brodwyn Appanna; Aletta Klopper
Subject: Cloud Computing - 1st Draft Questionnaire

Good Morning,

I am busy with the Masters in IT degree through the University of Cape Town (UCT) and part of my studies is to complete the research project. My chosen topic is "[Perceptions of Cloud Computing in the South African Government](#)".

Please find attached the 1st draft of the questionnaire in Microsoft Word format - the final survey will be available on-line via the internet and no personal information will be captured.

I would like your assistance by answering the questionnaire (*Make a cross next to your answer*).

Please provide me feedback, as below:

- Questions that are not clear or ambiguous
- Questions that need more detail
- Questions that I should include that are missing
- Overall questions layout
- All improvements welcome
- All comments welcome

If you could provide me feedback by latest, Monday (07 October), it will be appreciated.

Regards
Deena
083 452 8509

2nd Draft Survey

From: Deena Chetty
Sent: 24 October 2013 05:00 PM
To: Nataly Engelbrecht; Ronelle Bezuidenhout; Carlyn Williams; Brodwyn Appanna; Aletta Klopper; Dinesh Chetty; Vuyeya Mabelane; Jacob Rapoo; Walter Siwele; Abel Motau
Subject: Draft Cloud Survey

Afternoon,

This is the 2nd draft of my survey and once I receive your feedback, I include the changes and will distribute the final survey.

I am busy with the Masters in IT degree through the University of Cape Town (UCT) and part of my studies is to complete the research.

My chosen topic is "[Perceptions of Cloud Computing in the South African Government](#)".

I would like your assistance by answering the survey and the survey can be access by this URL - <https://www.surveymonkey.com/s/HLVCS5H> and no personal information will be captured. It is a short survey and it will take you between 5 to 10 minutes to complete.

Please provide me feedback, as below:


- Questions that are not clear or ambiguous
- Questions that need more detail
- Questions that I should include that are missing
- Overall questions layout
- All improvements welcome
- All comments welcome

Thank you for your time to complete the survey and providing me feedback.

Regards
Deena Chetty

Annex B : Message to Respondents

Cloud Computing Survey Exit

 20%

Good Day,

My name is Deena Chetty and I am completing the Master of IT degree from the University of Cape Town (UCT). Part of my degree is that I conduct a research study on the perceptions of cloud computing in the South African government. The aim of the survey is to determine the perceptions of people working in the SA government, both from a user and administrator's point of view and the on-line survey will take approximately 5-10 minutes to complete as it consists of 39 questions related to general, user-facing cloud services and administrator cloud services.

The South Africa government has old IT equipment, no central management, no sharing of resources (hardware and software), silo solutions, lack of security and long lead times to procure new hardware and software. The government's priority is to serve the citizens by providing better service delivery. Cloud computing can enable government to better serve its citizens as it is a technology that changes the way that IT provides services to its customers. The new paradigm is that infrastructure, platform and software can be offered as a service over the internet as the majority of the citizens do not own computers and the wide spread of cellphones has exceeded the number of computers, the citizens now have an opportunity to access government services.

Your participation in this survey is completely voluntary and you may exit the survey at anytime by clicking on the "exit" button from the online survey. The survey is for research purposes only and all responses will be kept confidential and it is anonymous as no personal information will be required.

If you would like to receive feedback on the survey or have any comments, please feel free to contact me on chtdee001@myuct.ac.za.

Regards
Deena Chetty

Next

Annex C : Survey

Cloud Computing Survey

Exit

1. What is your job level? (Choose one)

Operational

Management

Senior Management

Other (please specify)

2. What technology decisions do you make? (Choose all that apply)

Purchase of software

Purchase of hardware

Design of the network

Design of the servers

None

Other (please specify)

3. How long have you been working in government? (Choose one)

Less than 1 year

Between 1 year to 4 years

Between 4 years to 7 years

Between 7 years to 10 years

More than 10 years

4. What is the total number of employees in your government department? (Choose one)

Less than 1 000

Between 1 000 and 3 000

Between 3 000 and 10 000

More than 10 000

5. At what level within the South African government, does your government department operate? (Choose one)

- Local Level
- Provincial Level
- National Level

6. Have you heard about cloud computing? (Choose one)

- Strongly agree
- Agree
- Neither agree or disagree
- Strongly disagree
- Disagree

7. Do you think that the government should use cloud computing? (Choose one)

- Strongly agree
- Agree
- Neither agree or disagree
- Strongly disagree
- Disagree

8. Have you used a cloud computing application? (Choose one)

- Yes
- No

9. Do you think that government is currently utilising technology effectively to deliver better service to the citizen? (Choose one)

- Strongly agree
- Agree
- Neither agree or disagree
- Disagree
- Strongly disagree

10. Based on the last few years, what do you think government is doing to embrace new technologies? (Choose all that are applicable)

- Using more mobile related technology such as MMS and SMS
- Have more services are available over the internet
- New technologies are being implemented
- Other (please specify)

11. What can enhance or make the IT services better than what is currently being provided by the government? (Choose all that apply)

- Applications developed for mobile phones
- Applications that allow you to personalise it
- Applications that allow collaboration with other people
- More user-friendly applications
- Use of more technology overall
- Make more services available over the internet instead of going to a physical office
- Understand what are the user's requirements before developing an application
- Don't change anything
- Other (please specify)

12. The traditional way to get software was to buy it and then you can use it according to the licensing. The new paradigm is that you can “rent” the software you need over the internet and only pay for what you have used, for example: you can “rent” an email software for 5 days and pay only for the 5 days you use it. Would you prefer to pay only for what you use? (Choose one)

- Strongly agree
- Agree
- Neither agree or disagree
- Strongly disagree
- Disagree

13. Which software are you currently using? (Choose all that apply)

- Human resource software
- Procurement software
- Project management software
- Electronic mail (email) software
- Electronic content management (ECM) software
- Enterprise resource planning (ERP) software
- Other (please specify)

14. Which software are you considering to use in the near future that you are not using currently? (Choose all that apply)

- Human resource software
- Procurement software
- Electronic mail (email) software
- Electronic content management (ECM) software
- Enterprise resource planning (ERP) software
- Other (please specify)

15. Which software do you think that should move to the cloud? (Choose all that apply)

- Human resource software
- Procurement software
- Project management software
- Electronic mail (email) software
- Electronic content management (ECM) software
- Enterprise resource planning (ERP) software
- Other (please specify)

16. How can government leverage cloud computing but also to be secure by having the data to stay within the government network? (Choose one)

- All networks are generally secure and you don't need a government network
- Create a new network and link it to the government network
- Create a government cloud and a community cloud
- Other (please specify)

17. Which software would you like to deploy in the cloud immediately, so you can use this to promote more buy-in from government? (Choose all that apply)

- Human resource software
- Procurement software
- Project management software
- Electronic mail (email) software
- Electronic content management (ECM) software
- Enterprise resource planning (ERP) software
- Other (please specify)

18. Who within your department be held solely accountable for the adoption of cloud computing within your department? (Choose one)

- Chief Executive Officer (CEO)
- Chief Operation Officer (COO)
- Chief Information Officer (CIO)
- Senior managers
- Middle managers
- Operational
- Users
- Other (please specify)

19. Who within your department will greatly benefit from the adoption of cloud computing? (Choose all that apply)

- Chief Executive Officer (CEO)
- Chief Operation Officer (COO)
- Chief Information Officer (CIO)
- Senior managers
- Middle managers
- Operational
- Users
- Everyone

20. How has your department adopted to new technologies such as cloud computing? (Choose one)

- Already using it
- Going to use it in the future
- Not going to use it
- Other (please specify)

21. If your department has adopted cloud computing, indicate which has been adopted? (Choose all that apply):

- Software as a Service (SaaS)
- Platform as a Service (PaaS)
- Infrastructure as a Service (IaaS)
- None

22. How will the users be impacted with the adoption of cloud computing? (Choose all that apply)

- The user will need to be trained
- A new way of working
- Nothing will change
- Other (please specify)

23. Will you need to develop standards and/or policies to assist in the adoption of cloud computing? (Choose one)

- Strongly agree
- Agree
- Neither agree or disagree
- Strongly disagree
- Disagree

24. What would you consider as important drivers for the adoption of cloud computing? (Choose one)

- Option 1 (On-premise technology, de-centralised management & de-centralised security)
- Option 2 (On-premise technology, pay a fixed monthly rate irrespective of usage & buy new capacity when required)
- Option 3 (Scalability of infrastructure, reduce cost as you pay for what you use & ensures business continuity)
- None of the above
- Other (please specify)

25. Would you agree that you understand the basic administrator capabilities available on cloud computing? (Choose one)

- Strongly agree
- Agree
- Neither agree or disagree
- Strongly disagree
- Disagree

26. How has cloud computing been deployed in your department? (Choose all that apply):

- Private cloud
- Public cloud
- Community cloud
- Not deployed
- Other (please specify)

27. Cloud computing has three phases, which are: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). Which phase should be deployed to ensure the hardware, software and network of cloud computing is in place? (Choose one)

- Software as a Service (SaaS)
- Infrastructure as a Service (IaaS)
- Platform as a Service (PaaS)

28. For the software are you currently using, is it in-house (non-cloud), on a local cloud (servers in-house), remote cloud or nothing? (Choose all that apply)

	In-house (non-cloud)	Local cloud (servers in-house)	Remote cloud	None
Human resource software	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Procurement software	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Electronic mail (email) software	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Electronic content management (ECM) software	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Enterprise resource planning (ERP) software	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Project management	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

29. What are the disadvantages of cloud computing compared to other IT technologies? (Choose all that apply)

- Huge upfront costs
- Low upfront costs
- Poor security
- Good security
- Will not need to procure hardware or software if capacity increases
- Need to procure hardware or software if capacity increases
- Pay a fixed monthly rate irrespective of usage
- Other (please specify)

30. Do you think cloud computing is secure? (Choose one)

- Strongly agree
- Agree
- Neither agree or disagree
- Strongly disagree
- Disagree

31. How will you ensure that the data in cloud computing is kept secure? (Choose all that apply)

- Cloud computing service provider to ensure that it is secure
- My organisation must ensure that it is secure
- The users must ensure that it is secure
- Does not matter, the internet is secure
- Other (please specify)

32. What are the concerns from your department about the adoption of cloud computing? (Choose all that apply)

- Huge upfront costs
- Lack of security
- High level of skills required
- Integration and interoperability issues
- Migration of old application to be "cloud ready"
- Top management buy-in
- Other (please specify)

33. What are the challenges that you are facing in adopting cloud computing? (Choose all that apply)

- Change management issues
- No support from top management
- Lack of funding
- No design or architecture
- No roadmap
- Security risk
- No skills
- Old or obsolete applications
- Migration of applications
- Other (please specify)

34. How will you ensure that the technology you deploy for cloud computing will remain relevant and not get obsolete as technology advances? (Choose all that apply)

- Always use the latest technologies
- Keep up with the industry technology trends
- Life-cycle management for the technology
- When users complain, then it is time to change the technology
- When the technology stops working
- Other (please specify)

35. Do you think the investment in the adoption of cloud computing is worth its' value? (Choose one)

- Strongly agree
- Agree
- Neither agree or disagree
- Strongly disagree
- Disagree

36. One of the big drivers for the adoption of cloud computing is the cost saving. What is the estimated cost saving by adopting IaaS (not managing hardware), PaaS (not managing stacks or frameworks) and SaaS (not managing service software)? (Choose one)

- Save less than 5%
- Save between 5% and 10%
- Save between 10% and 20%
- Save more than 20%

37. How will you determine what skills you will require for the adoption of cloud computing? (Choose all that apply)

- Seek advice from industry for the required skills
- Map the skills to the applications and technology you intend to implement
- Get a generic set of skills irrespective of the technology you are going to implement
- Use the existing skills that you currently have
- Other (please specify)

38. What is your long term plan for your current IT skills? (Choose all that apply)

- Development plan to re-skill the people
- No change as the skills will not get obsolete
- Move people with the obsolete skills to other areas within IT if cannot be re-skilled
- Other (please specify)

39. Did you know by accessing this survey, you have used a cloud computing service, this survey is an example of Software as a Service (SaaS). If you have any comments about this survey, you can enter it below.

Thank you for taking the time to complete this survey and please click "Done" to finish the survey.

Prev

Done

Annex D : Summary of Survey Responses

The screenshot shows the SurveyMonkey dashboard for a survey titled "Cloud Computing Survey". The interface includes a navigation bar with "Home", "My Surveys", "Survey Services", and "Plans & Pricing". A "Create Survey" button is visible in the top right. The survey title "Cloud Computing Survey" is displayed, along with the category "Industry Specific". Navigation tabs for "Design Survey", "Collect Responses", and "Analyze Results" are present. A message informs the user about collectors and provides an "Add Collector" button. A promotional banner for "Buy a Targeted Audience" is also shown. Below this is a table listing the current collector.

Collector Name (Method)	Status	Responses	Date Modified	Actions
cloud survey (Web Link)	● CLOSED	72 responses	November 12, 2013 9:48 PM	Edit Clear Delete

Annex E : Abbreviations

IaaS	Infrastructure as a Service
ICT	Information and Communications Technology
IT	Information Technology
PaaS	Platform as a Service
PAYG	Pay As You Go
SA	South Africa
SLA	Service Level Agreements
SaaS	Software as a Service
WWW	World Wide Web

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