❏   537

Cloud Computing Adoption in the South African Public Sector

Bonginkosi Mkhatshwa[1], Tendani Mawela [2]
[1,2]Department of Informatics, University of Pretoria, South Africa

Article Info	ABSTRACT
	Scholars have touted a variety of benefits for adopting cloud computing solutions in the public sector. However, the adoption of cloud computing has been low in the South African (SA) government context. This study investigates the factors influencing cloud computing adoption within the SA public sector. The study adopted a case study approach. The research was informed by the Technological Organisational Environmental (TOE) and the Diffusion of Innovation (DOI) theoretical frameworks to understand the trajectory of cloud computing adoption. Primary data was collected using a questionnaire and semi-structured interviews with respondents from government departments. Additionally, secondary data from government Information Technology (IT) policies and strategic documents was analysed. The results highlighted that the enablers that are critical for cloud adoption include cloud computing policy, skills, IT infrastructure and financial support. The barriers that are hindering cloud adoption are related to security risks, network connection, cloud computing policy, costs and budget availability, among others. The identified benefits that may be realised through cloud adoption include enhanced service improvement, cost savings, high system availability, green IT, centralised and shared services and accessibility. The study proposes several guiding principles for cloud computing adoption in the public sector.

Corresponding Author:

Tendani Mawela,
Department of Informatics,
University of Pretoria,
Lynnwood Road, Hatfield, South Africa
Email: tendani.mawela@up.ac.za

1. INTRODUCTION
1.1. Background

In 2002, the South African (SA) government adopted the "Batho Pele" principles as a policy position underpinning public service delivery. The principles include: "*Consultation, Service Standards, Access, Courtesy, Information, Openness and Transparency, Redress, and Value for money*" [44]. "Batho Pele" means *people first* in the Sesotho language and these principle encapsulate the values that should drive all service delivery efforts in that they should put the citizens first.

It is reported that the SA government wage bill was 587 billion Rands in 2018 [1]. One of the Batho Pele principles for Transforming public service delivery is value for money, which implies that public services should be rendered in a cost effective and efficient manner. Adopting cloud computing could be an approach that supports the SA government to accomplish its Batho Pele principle of value for money by saving on the costs currently spent on IT software and infrastructure. Cloud computing as defined by [2] and [3] is about accessing Information and Communication Technology (ICT) services through the network without ownership of the infrastructure, software and any specific platform.

SITA, the technology agency responsible for providing ICT services to the SA state organs, launched their cloud infrastructure in 2018 for hosting services to be provided to government departments. Cloud computing is regarded as a significant pillar of digital transformation in organisations [4]. The government cloud may radically lessen the ICT administrative workload as the public service can employ infrastructure,

application and platform services from the cloud [5]. Cloud computing is one of the significant pillars for reducing costs and transforming how government operates. However, the adoption of cloud computing in the SA public sector appear to be lagging. This study aimed to explore the enablers that may facilitate the uptake of cloud services in the public sector with a focus on the SA government. The research questions of interest were as follows:

- What are the enablers and barriers to cloud computing adoption in the public sector?
- What are the perceived benefits of cloud computing adoption in the public sector?
- What is the perceived readiness for cloud computing adoption in the public sector?

The study contributes to the existing body of knowledge concerning the adoption of cloud computing and used the South African context as a case study. The study contributed to the barriers, enablers and benefits that may be realised from adopting cloud computing in the public service. Theoretically, the study highlights the use of the TOE together with DOI for interrogating and understanding the essential factors towards cloud computing adoption. It also provides insights from the expriences of public sector represnetatives across urban and rural contexts within a developing country. From a practical perspective, the study offered various guiding principles that may be considered by public sector management and IT experts when adopting cloud computing.

The next section reflects on the informing literature related to the research questions.

1.2. Cloud Computing Overview

Cloud computing is a model which enables secure access to a set of flexible computing resources [6]. Cloud computing can facilitate expediency, by accessing networks through an on-demand shared supply of infrastructure, software, networks and storage services [7]. It is a model where IT resources are accessible and paid for based on the level of usage [6].

There are various deployment models for cloud computing. The Public Cloud is a deployment model that is applicable and accessed by large enterprise groups and the public in general [5, 8]. The Private Cloud computing services are accessible by internal resources through the internet and may not be shared with other businesses [2]. The Private Cloud is also defined as an internal cloud. The Community Cloud is when numerous businesses of the same cluster are found to be sharing similar computing infrastructure [2, 3]. The community cloud may be controlled by the same organisations or vendors, and it may be applicable on-premise and off-premise [2, 3]. The Hybrid Cloud is a cloud model that consists of a mixture of a private and public cloud that works together to meet the needs of an organisation [5].

According to research [9] there are three kinds of cloud services that are applicable: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). For IaaS the infrastructure such as server hosting, network, security, and storage is provided as a service to clients and managed by the vendor providing the services. PaaS includes the provision of platform services accessible through the internet for developing, configuring and customising applications according to the customer's requirements. While SaaS offers software that is accessible through the internet as a service, and a supply model for gaining access to applications, data and information everywhere and at any given time [9, 10].

1.3. Cloud Computing Benefits

Various benefits have been noted in the literature. Cloud computing is regarded as a tool that may have the ability to accelerate business strategies for the public sector entities [11]. Government departments, as well as private and non-profit organisations, are expected to gain enhanced and economical IT services when they adopt cloud computing services [10]. It is further suggested that the public sector can take advantage of cost scalability, significant agility, improved business processes, higher customer satisfaction and infrastructure scalability benefits from cloud computing [12].

Cloud computing may rapidly merge several data centres that are existing by decreasing the number of systems hosted within the SA government-owned data centres [13]. Centralising data centres may lead to ICT becoming greener, as this may reduce the costs of energy consumption and eliminate the electronic waste (e-waste) in the air which causes environmental hazards [14]. According to scholars [15] expenditure on energy consumption may be reduced.

Researchers [16] indicate that disaster recovery remains critical for resuming business after a disruptive event. Cloud restoration initiative is the most suitable option when compared to the traditional way of doing disaster recovery systems, which may recover data more punctually and in a more instant way [16]. Cloud restoration may perform an immediate recovery and decrease the costs of operations [16]. Several institutions from the public sector do not have disaster recovery sites due to excessive costs required for building or maintaining the disaster recovery site. Cloud computing remains a solution for drastically reducing costs of deployment of a disaster recovery plan, which is a subset of the business continuity plan.

Studies suggests that the data or systems hosted on the cloud are more secured than those located on the local hardware. The cloud offers a remote wiping feature which can be used in a situation where the data end up with the wrong people [15]. Moreover, the data centres that are used for hosting the cloud infrastructure containing the information or data normally abide by the global security standards.

Scholars highlight that the public sector's main value from cloud computing services is cost reduction as a result of better system efficiency [5]. The public sector can decrease the capital expenditure on IT infrastructure and resources by adopting a pay as you use cloud model [17, 18]. There is also a reduced burden for application management, maintenance and administration through transferring the function of managing IT resources to specific suppliers and vendors.

1.4. Cloud Computing Enablers

There are several supporting factors for cloud computing adoption. These are captured in the table below:

Table 1. The enablers of cloud computing adoption

Enablers	Description	Reference
Relative advantage	The perception or attitude of government employees and managers towards cloud computing offerings and benefits is critical.	[19]
Security	The solution concerning data protection, privacy, sovereignty, and data residency is perceived to be an enabler for cloud computing adoption.	[20, 21]
Compatibility	How cloud computing is perceived by the government should be consistent with the present values, work styles, experience, and requirements of public service.	[19]
IT infrastructure	This involves the readiness of the technical infrastructure of the organisation for cloud computing adoption.	[12]
Top management support	Management and executive buy-in is deemed critical for cloud computing adoption.	[18, 19, 22]
Organisational size	The size of an organisation is perceived to be influencing cloud adoption.	[23]
Organisational readiness	IT human resources and organisational users should be ready by equipping them with the necessary skills and knowledge about cloud computing.	[19]
Green computing	Cloud computing forms an integral part of the pillars for green IT as it enables organisations to centralise IT applications and reduce data centres that are existing, thereby reducing carbon emissions or air pollution. The energy consumption for the cloud is less compared to the traditional data centres.	[16, 18, 21, 24]
Cloud computing policy, regulation, and the strategy	Regulation, policy, and guidelines concerning cloud adoption or implementation are deemed critical.	[18]

The literature highlights several key enablers of cloud computing that support the referenced table. Scholars have identified cost savings, relative advantage, and compatibility as crucial factors that expedite the adoption of cloud computing [12, 18]. Additionally, scholarly research emphasises the significance of green computing practices and the regulatory environment as enablers that play a pivotal role in accelerating cloud adoption within the public sector [18]. The influence of top management and organisational size is also recognised as influential enablers that shape the consideration of cloud computing adoption [27]. Furthermore, infrastructure readiness, encompassing aspects such as network infrastructure, private cloud capabilities, bandwidth availability and broadband connectivity, is deemed critical and serves as an enabling factor for successful cloud adoption [12]. Security also emerges as a noteworthy enabler for cloud computing adoption, with research publications highlighting its dual impact of both hindering and accelerating the adoption process [20]. These scholarly insights underscore the importance of understanding and leveraging these enablers to facilitate effective cloud adoption and maximise its benefits.

1.5. Cloud Computing Barriers

There are several impeding factors for cloud computing adoption. These are captured in the table below:

Table 2. The barriers towards cloud computing adoption

Barriers	Description	Reference
Poor network connectivity and bandwidth	Bandwidth and speed of broadband may be a barrier for fully adopting and making use of cloud adoption.	[25, 26]
Security	Data sovereignty, privacy and residency, are security-related issues faced with concerning cloud computing adoption.	[21, 24]
Complexity	The degree to which cloud computing is perceived as challenging to understand and use may affect cloud adoption.	[26, 27]
Compatibility	Compatibility issues may influence cloud computing adoption.	[23, 26, 28]
Buy-in by executive or management	Lack of buy-in and support by the executive and management may have a detrimental effect on cloud adoption.	[27]
Trust	Lack of trust for cloud computing may negatively influence cloud computing adoption.	[27]
Skills, knowledge, awareness and attitudes	IT resources and management lacking skills and knowledge concerning cloud computing.	[26, 29]
Budget availability and high costs	Budgetary constraints/excessive costs may be a stumbling block for cloud adoption.	[12, 27, 30]
Unreliable power supply	The unreliable power supply may influence cloud adoption.	[25, 31]
Transborder information flow	Data hosted and stored on data centres that are situated outside the SA borders.	[25, 29, 31]
Legislation, lack of national cloud policy, guidelines	Lack of an overarching policy, regulation, strategy, and regulation in government.	[12, 13, 15, 24, 31]

The barriers outlined in the aforementioned table have been substantiated and justified in the existing literature. The lack of trust and buy-in from executive management has been identified as a significant obstacle to the adoption of cloud computing [27]. Furthermore, the absence of a comprehensive national cloud policy and clear guidelines for governing the implementation of cloud computing has been highlighted as a major hindrance to achieving the desired objective of cloud migration [31]. The insufficiency of network infrastructure in remote areas, leading to poor connectivity, has been consistently acknowledged and supported by scholarly research as a significant barrier to the adoption of cloud computing [25]. Consequently, the imperative need for expanding and enhancing such infrastructure in South Africa has become readily apparent.

Budgetary constraints, coupled with an unreliable power supply, have also been acknowledged as substantial impediments preventing the public sector from embracing cloud computing [25, 31]. The dual nature of security, being both an enabler and a barrier, has been a recurrent theme in cloud computing adoption literature [21, 24]. Compatibility issues arising from legacy systems have the potential to cause significant delays in the adoption and expeditious implementation of cloud computing solutions [23, 26]. Lastly, the dearth of knowledge and skills pertaining to cloud computing within organisations has been shown to exert a negative influence on the inclination to consider and gain endorsement for cloud adoption from management [26, 29]. In summary, these identified barriers, grounded in scholarly research, underscore the multifaceted challenges that organisations encounter when adopting cloud computing technologies. Addressing these barriers is paramount for successful cloud integration and realising the numerous benefits associated with cloud computing.

1.6 Cloud Computing Readiness

It is specified [32] that cloud migration necessitates that elementary services be cloud equipped, up and running. Authors[33] suggest that an evaluation that focuses on the readiness for cloud is an important consideration. It is noted that little has been done to assess the cloud adoption readiness in the SA government[31]. Scholars [31] further identified the infrastructure, institutions, and environment as readiness pointers that may be aspects of adopting cloud. It is also suggested that a readiness assessment on security requirements, service characteristics, network infrastructure, applications and data, government departments, skills required for cloud, policies and standards need to be conducted before considering the adoption of cloud[13].

Additionally, upon deciding to adopt cloud computing organizations should outline a clear migration strategy. The migration strategy for cloud adoption in the public sector serves as a catalyst concerning the migration to cloud services and the supported implementation process [13]. The roadmap for the adoption of cloud should consider aspects such as the following:

Policy Framework and the National ICT Strategy - The cloud policy and framework should be aligned with all government ICT policies such as the Government-Wide Enterprise Architecture, National e-Strategy, ICT Policy Framework, and other standards that are regarded as best practice [32, 34].

Governance, Obligation and Standardisation - Cloud computing standards are the agreements that are regarded as the forefront technique to ascertain interoperability, so that consumers may use data, instruments, systems, virtual pictures, and more in a different cloud environment with slight alterations required [32].

Security Risk Assessment -Since the cloud computing services are outsourced to the preferred service provider, risk management is identified as one of the critical ways that may be used for assessing the capability of a vendor when adopting the cloud computing environment for government [13].

Broadband Connectivity - The implementation of cloud services are depended on internet access over the hypertext transfer protocols (HTTP), and a fruitful cloud adoption strategy must take into account the dependable and sufficient internet connection and availability to both the organisation and the end-users [32]. Universal broadband or internet connectivity set up is significant to the accomplishment of the implementation of cloud computing in government [35].

*Training, Skills, Awareness, and Consultatio*n – Scholars[32] suggest that public service should form a partnership with universities to enlarge their developments and review their current programme to shape the knowledge and expertise required in cloud computing. The public service is required to address the landscape of "nation-wide education policy", incorporating ICT into the learning programme, in professional teaching, education, and research at higher education level [15, 36].

Centralisation of procurement - The unified system for procurement by public sector agencies could address the existing state of disjointed, poorly managed and rigid IT procurement procedures. Cloud computing services can adjust the procurement model of software, applications and computing cycles that can be purchased as a commodity on a pay as you go basis [43]. Similarly, this means that the adoption of cloud computing implies that the operational cost model would imply paying for resources as they are used [36].

Cloud Infrastructure Configuration for Execution - The cloud computing migration is the network and internet dependent which requires the public sector to invest much in improving the existing network infrastructure and ensure that it is enhanced [32]. The cloud infrastructure such as setting up a data centre and making provision for reliable sources of energy to support the data centres is critical for cloud readiness, infrastructure configuration and implementation [32].

In light of the extant literature, this study sought to investigate the perceived benefits, barriers, enablers and state of readiness for cloud computing adoption relevant to the South African government context.

The next section highlights the theoretical basis of the study and research methods.

2. RESEARCH METHOD
2.1. Theoretical Foundation

The study focuses on cloud computing adoption in the public sector. The study employed the Technological Organisational Environmental (TOE) framework in conjunction with the Diffusion of Innovation (DOI) theory to address the research questions. The TOE and the DOI have been employed to understand cloud computing adoption in previous studies, see for example: [7, 18, 22, 23, 25, 27, 37]. The TOE framework describes the key aspects that influence the choice of an enterprise to adopt IT from a technological, organisational and environmental perspective that present both obstacles and opportunities concerning the acceptance of IT [37]. The DOI theory primarily defines innovation adoption and diffusion procedures [38]. Various scholars acknowledge DOI as being capable of identifying "perceived" crucial characteristics of technological innovations (involving compatibility, relative advantage, complexity, trialability and observability) that may affect the attitude of possible managers to adopt or reject information systems [39]. The DOI features applicable for the employed innovations (i.e., IT) and the adopters (i.e., enterprises) have been acknowledged as critical for the innovation adoption procedure, which is in accord with the TOE theory [37]. The factors of TOE framework in conjunction with the aspects of DOI were used to support the objectives of the study.

2.2. Research Design

This study aimed to gain an understanding of the critical enablers, barriers, benefits as well as the factors influencing the readiness for cloud adoption. The study employed the case study strategy [40]. Secondary data was collected in the form of government documents. Documents such as ICT policies, standards, acts,

strategies, frameworks, and other relevant documents were collected and analysed for this study. Primary data was collected via interviews and an online qualitative questionnaire with public sector respondents including: IT managers, CIOs and other technical support staff within government entities. The study had a total of 33 respondents representing various spheres of government. The majority of the respondents (61%) work in national government departments. An overview of the respondents is highlighted in Figure 1 and Figure 2.
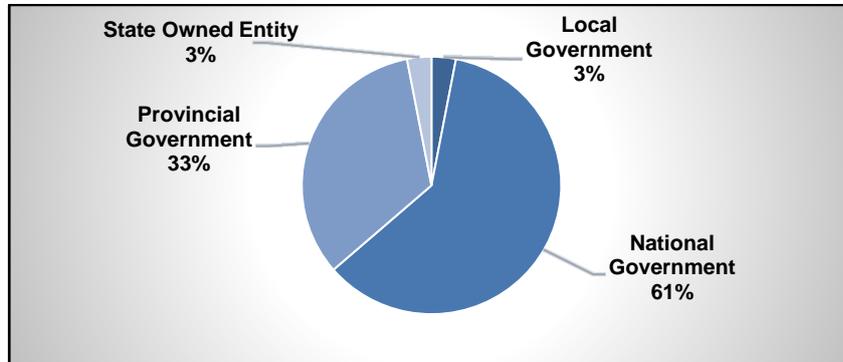

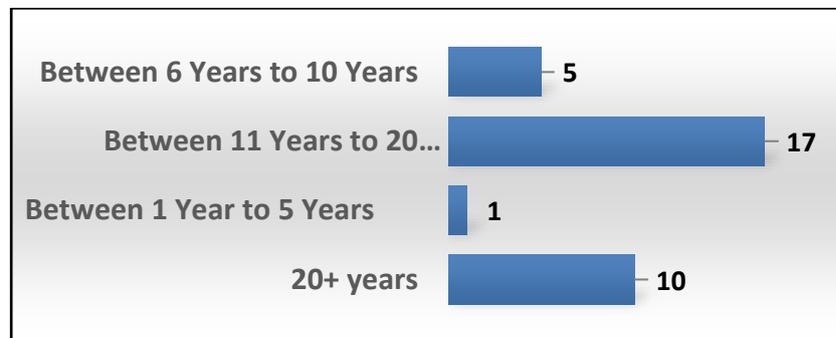Figure 1. Respondents' Government Department (Source: Authors' Own)

Figure 2. Respondents Total Number of Years of Public Sector Experience (Source: Authors' Own)

The study adopted the deductive thematic analysis approach and the data analysis was supported by the Atlas.ti software underpinned by the of TOE framework in conjunction with the aspects of DOI. The deductive thematic analysis approach helped in understanding the factors that influence cloud computing adoption and developing the guidelines for cloud computing adoption in the public sector.

2.3. Case Description and Context

The case for this study focused on the factors influencing the adoption of cloud computing in the SA government. According to Chapter 3 of the SA constitution, the SA public service is instituted as national, provincial, and local spheres of the state which are unique, dependant on one another and related or interconnected to each other. The country consists of 9 provinces, which are the Eastern Cape, Western Cape, Mpumalanga Province, Northern Cape, North West, Gauteng Province, KwaZulu-Natal and Limpopo province.

South Africa has acknowledged the significance of ICT's in the operations of government and have published an Electronic Government (e-Government) strategy. The strategy aims to apply ICT throughout the three domains of the public service for more positive effect and improvement of the supply of services to all South Africans [41]. In April 2017, the National e-Government Strategy was established and issued by the Department of Telecommunication and Postal Services as stipulated in the Electronic Communication, and Transactions Act (ECTA). The strategy was intended for guiding the digital transformation of the SA government into a complete digital ecosystem where all people can gain from the opportunities afforded by the digital technologies to make their quality of life better [42]. e-Government in South Africa involves the usage of ICT to ensure that internal and external processes of public service are automated. The strategy consists of several elements that are critical for the adoption of cloud computing, such as the plans on managing technological modernisation, which includes cloud computing. Moreover, the e-government strategy further stipulates that executing the planned common cloud ICT architecture will facilitate the deployment of Government-to-Government (G2G) services [42]. The adoption of cloud computing in government forms an integral part of the e-Government initiatives that are planned to be rolled out across the country.

3. RESULTS AND DISCUSSION

3.1. Public Sector Perceptions of Cloud Computing Enablers

This section addresses the question: What are the enablers and barriers to cloud computing adoption in the public sector?

The main enablers that were noted in the data are as follows:

Table 3. Respondents perceptions on the enablers of cloud computing

Enablers	Main Findings	Sample Respondents'' Quotations
Security	The national security framework or policy was identified as an enabler for cloud adoption. The data classification, data security, data residency, compliance with the legal prescripts and privacy of information were identified as enablers for cloud adoption. Compliance with the legal prescripts is essential for adopting cloud.	Participant 9, indicated that "*there is a need for security and clarification on the security issues regarding cloud computing*". The view shared by Participant 15 is that "*what can accelerate the adoption is people trusting in the security found in the cloud*".
ICT infrastructure readiness	The infrastructure readiness concerning the adoption of cloud computing was identified as an enabler for cloud adoption. The infrastructure readiness is concerning the universal network infrastructure such as the broadband coverage across the country, including rural areas or remote areas and access to high-speed bandwidth. The access to a highly secured private cloud that offers scalable resources and high availability of services for the government.	Participant 12 indicated that "*having the right infrastructure*" could expedite the adoption of cloud adoption in the South African government. Participant 19 shared the following sentiment as he indicated that you need to have: "*adequate bandwidth for people to access the cloud offering*".
Research and innovation	The research and innovation were identified as barriers to cloud adoption. This was supported by the identified and analysed documents for this study. The research and innovation were found to be critical for any new IT initiative or innovation, including cloud computing.	This sentiment was strongly shared by Participant 16, who indicated that "*we need to invest more in innovation and research. Gone are the times where we looked at research and innovation as not an IT thing. Most of the ICT organisations when they consider restructuring, they now involve or are informed by innovation*".
4th industrial revolution	The 4IR was supported by the identified and analysed documents for this study as an enabler for cloud computing adoption.	This view was shared by Participant 10, who indicated that the "*4th Industrial Revolution is the driver that is forcing us to a possible move to the adoption of cloud computing*".
Skills, knowledge and understanding	The applicable human resources with technical skills for managing and administering the cloud platforms were identified as an enabler for cloud adoption. The upskilling of resources, training provided, workshops, and awareness provided for cloud computing were identified as an enabler for cloud computing adoption. The skills programme recommended entails changing the education programme, partnerships with third parties for providing training, skills transfer, and a skills development programme. Several role players in government should collaborate to ensure that this enabler is realised.	The perceptions of considering skills, knowledge and understanding as an enabler for cloud computing were shared by Participant 12 who indicated that "*the enabler is the IT skillset that we need to have and the maturity thereof because cloud computing is evolving exponentially compared to how technology was transforming traditionally*". This point of view was also supported by Participant 4, who indicated that "*the skills to manage the consumption of cloud is also an enabler for cloud adoption*".
Budget and financial resources	The budget and availability of financial resources are deemed pivotal in adopting cloud computing in the public sector. The deployment of cloud computing requires a financial support for cloud adoption.	The budget availability was expressed by Participant 16 who indicated that "*you need to estimate as per the budget that you have and prove that you do have the source of funding before you can commit*". Participant 16 further indicated that "*funding, is a basic requirement for cloud adoption as it is using the consumption model*". Participant 11 indicated that the "*budget availability to implement infrastructure to maintain and support cloud environment*" is an enabler for cloud adoption and she further stated that the "*budget that we are talking about is for human resources and it is the budget that will ensure that you get the right resources*".
Leadership and management support	Leadership and executive support were suggested as an enabler for cloud computing adoption. The political buy-in was suggested and supported as the main enabler for cloud adoption. This enabler has a positive influence on cloud adoption.	Participant 14, indicated that "*you need to get political buy-in at an executive, council or cabinet level. I think that is important because once you get that buy-in, then you get support, which is key. After all, if you don't get that support you won't win*". The buy-in by the leadership and executive in SA government were expressed by Participant 23 who indicated that the level of buy-in "*has gone up due to Covid-19 pandemic and hope that it will not change for the worst*".

Enablers	Main Findings	Sample Respondents'' Quotations
Trust	The increase in trusting cloud computing is an enabler for computing. The perceived level of trust for cloud computing received positive feedback in terms of adopting and using cloud computing adoption. The interpretation concerning the described level of trust for cloud adoption has shown to be positive.	The level of trust was identified as an enabler for cloud adoption. For example, Participant 15, expressed that "*what could accelerate the adoption is people trusting in the security found in the cloud*".
Policy, framework, standard, strategy and guidelines	The national cloud computing policy, standards, strategy and framework were deemed as critical for cloud adoption. The applicable national cloud policy may expedite the adoption cloud. The overarching countrywide cloud policy was the main enabler for cloud computing. The cloud strategy and the framework were also deemed critical for the successful implementation of cloud computing adoption as other developed countries followed this practice.	Participant 4 indicated that "*the cloud policy is very critical for enabling cloud*" and this was supported by Participant 32 who said that the "*approved policy and standards on cloud adoption*" are enablers for cloud adoption. Participant 18 indicated: "*We have bits and pieces of the legislation. There's no legislation that talks about cloud computing.*" Participant 12: *There is a need for a centralised cloud computing policy.*"

The cloud adoption strategy and the cloud-first policy have been identified as enablers that surpass national boundaries and are applicable across various countries examined in this study, including the United States of America, Japan, the United Kingdom, and New Zealand [18, 13, 15, 35]. In addition to the enablers discussed in the study, namely trust, 4IR (Fourth Industrial Revolution) readiness, leadership support, skills and understanding, and budget, it is important to note that their supporting evidence in the literature may be limited or not explicitly mentioned [3]. However, these enablers have been identified and explored in this study as potential factors that contribute to successful cloud adoption. In conclusion, while the supporting literature for these specific enablers may be limited, their significance in facilitating cloud adoption has been recognised in this study. Leveraging these enablers can empower countries to employ the transformative potential of cloud computing and achieve positive outcomes in their public sector initiatives.

3.2. Public Sector Perceptions of Cloud Computing Barriers

This section addresses the question: What are the barriers to cloud computing adoption in the public sector?

The main barriers that were noted in the data are as follows:

Table 4. Respondents perceptions on the barriers towards cloud computing adoption

Barriers	Main Findings	Sample Respondents'' Quotations
Security	Security was again identified as a barrier for cloud computing adoption in public service. Data security, data sovereignty, security breaches, data residency, data protection and malicious use of data were identified as the security concerns for cloud adoption. The main security concerns are around where the data is hosted, who have access to the data, and the security breaches that may occur if data is hosted on the cloud. Vendor lock-in also emerged as a barrier to cloud computing.	Participant 28 stated that "*security issues, especially cybersecurity are a barrier for cloud adoption. The fear of loss of data and a feeling of not having 100% control of one's data as it is assumed to be sitting elsewhere*". This perspective was affirmed by Participant 32, who indicated that "*uncertainty of information security that is hosted on the cloud is a barrier for cloud adoption*". According to Participant 30, "*reputable service providers must be used with security measures in place*".
Lack of ICT infrastructure	The lack of ICT infrastructure was also identified as a barrier to cloud adoption. The lack of broadband in remote and rural areas was flagged as a barrier to cloud adoption. The lower speed for bandwidth and high costs of data were also findings, which are deemed as barriers for cloud adoption. The lack of private cloud for government, which may be more secured and mitigate several security risks was also identified as a barrier for cloud adoption.	Participant 26 indicated that the "*internet network infrastructure and bandwidth required to connect to these services*" were flagged as barriers for cloud computing adoption. These are the words that were shared by Participant 9. The network in its totality was put as one of the barriers: "*we do not have fast data or connectivity lines between departments to the SITA network. We still have old and very slow connectivity*" .Participant 4 indicated that "*connectivity in general, in rural area and local offices at the municipalities is a challenge*".
Compatibility	To a certain extent, compatibility was identified as a barrier for cloud computing adoption. The main compatibility issue that was identified is concerning the transversal systems and other legacy systems applicable in government. The transversal and legacy systems were found to be operating using very old systems so, therefore, cannot be compatible with the cloud platforms. The responses received from the participants were supporting the urgent	This perspective was affirmed by Participant 1, who indicated that "*there are old applications such as the transversal systems (BAS, Logis and Persal) and these may not be compatible with the cloud solution*". The legacy systems were also flagged as barriers for cloud adoption as Participant 17 indicated that "*most government legacy applications may not be compatible with the public cloud because that is where value can be realised when the*

Barriers	Main Findings	Sample Respondents'' Quotations
	need for setting up the private cloud for government to leverage the benefits if the cloud is adopted.	*cloud is adopted. There is a need to improve the application systems*".
Shortage of skills	The lack of skills, understanding and knowledge was identified as a barrier for cloud computing in the public sector. The lack of technical skills for managing and administering cloud services was identified as a barrier to cloud adoption. The lack of understanding and knowledge by managers and the executive was also identified as a hindrance for cloud adoption. The shortage of skills for managing the contractual agreements with the 3rd parties was also identified as an obstacle for cloud adoption.	Participant 20, saying "*it is difficult to adopt cloud computing if you do not have the right skills and knowledge*". Participant 15 also touched on the issue of "*skills concerning the administrative user roles that are to be performed on the cloud computing platform*", so this requires the "*the right skills for driving the cloud migration*" as confirmed by Participant 12.
Budget and financial constraints	The lack of budget and a costing model, as well as financial constraints, were also highlighted as a barrier to cloud adoption. The SA government follow the model of paying after the service has been rendered while the billing model for cloud services uses the dollar currency and the pay as you use service model.	Participant 13 indicated that "*it may sound nice to invest and adopt cloud, but when you start looking at the cost of this, the numbers become quite frightening*". To some degree, Participant 3 shared a similar view concerning the costs of cloud as he indicated that "*the costs are not so clear when it comes to cloud services, it can run very wild or very quickly and it can get people into a lot of trouble*". According to Participant 10, "*it becomes a barrier if the budget is not enough to maintain cloud computing and if the departments are still operating in a very old way of doing things*".
Governance	The lack of government controls was identified as a barrier to cloud adoption. The barriers concerning governance were around the compliance issues, systems and control measures for cloud computing adoption.	The perspective provided by Participant 14 is that "*what needs to be done from a governance perspective, the important thing is having a cloud computing policy that encapsulates and defines ISO standards such as information security standards*". This perspective was supported by Participant 13 who indicated that "*the governance in terms of security is critical for cloud adoption*". Participant 11 further affirmed these perspectives by indicating that "*you need to have proper governance around your data*".
Lack of cloud policy, framework standard and strategy	The lack of an overarching national cloud policy, strategy, standard and framework was also identified as a barrier for cloud adoption.	Participant 9 was very specific as he said: "*I need a national policy, national guidelines that will say you must do this, this is how we are going to do it, and then we do it*". Participant 20 shared the same views by indicating that "*in the absence of guidance, it will be very complex to implement cloud, so we need proper guidance and proper policy frameworks in place before we adopt*".
Legislation and regulations	The contradicting regulations such as Protection of Personal Information (POPI) Act, Minimum Information Security Standard (MISS), Minimum Interoperability Standard (MIOS), Electronic Communication, and Transactions (ECT) Act, Promotion of Access to Information Act (PAIA), etc. were identified as a barrier for cloud adoption. The lack of compliance with the legal prescripts was also one of the barriers for cloud adoption.	Participant 11 indicated that: "*Some acts contradict with each other.*" Participant 1 shared: ""*Cloud computing needs to be aligned to the POPI Act and the rest of the other pieces of legislation as they currently hinder the adoption of cloud computing.*"
Energy limitation	The power outages and cable theft were identified as barriers for cloud adoption.	The issue of the power outage was for example supported by Participant 3, who indicated that "*it can happen at any time that you can fail to have power for weeks because of cable theft or whatever the case may be*".

The barriers hindering cloud computing adoption in the public sector have been extensively studied, and their impact on specific countries, such as Ethiopia and South Africa, has been analysed. In both contexts, key barriers include data privacy concerns, security issues, legislation and regulatory constraints, as well as a lack of trust in cloud computing technologies [2, 35]. These factors are identified as leading determinants that impede the adoption of cloud computing in both Ethiopia and South Africa. Data security emerges as a significant barrier, as organisations are cautious about potential breaches and unauthorised access to sensitive information. Legislative and regulatory frameworks pose challenges, as they may not adequately address the unique considerations associated with cloud computing.

Concerns related to data privacy further exacerbate the barriers to cloud adoption, as organisations strive to ensure compliance with privacy regulations and protect the confidentiality of user data. The identified hindrances in both countries also highlight the absence of comprehensive cloud policies and frameworks. The lack of clear guidelines and strategies specifically tailored to cloud computing adoption further compounds the

challenges faced by organisations seeking to embrace cloud technologies [2, 35]. In summary, the perceived barriers to cloud computing adoption, including data privacy, security concerns, legislation, and a lack of trust, have been recognised as common hindrances in South Africa and comparatively also in Ethiopia. Addressing these barriers and establishing robust policies and frameworks are crucial steps towards promoting successful cloud adoption in the public sector of these countries.

3.3. Perceived Benefits of Cloud Computing

This section addresses the question: What are the perceived benefits of cloud computing adoption in the public sector?

The main benefits that were noted in the data are as follows:

Table 5. Respondents perceptions of the benefits of Cloud Computing

Benefits	Main Findings	Sample Respondents' Quotations
Enhanced security	The data supported the notion that cloud computing offers enhanced security features, controls, protection, etc. than the local hardware or traditional data centres that are hosted in-house. Furthermore, it was indicated that cloud computing offers physical security as it is hosted by the service providers that are required to adhere to the government legal prescripts.	Participant 14 further indicated that the "*issues of security will be improved because there are people who are trained and more specialist in providing these services*".
Scalability	The scalability was identified as a benefit for cloud adoption in the public sector. Furthermore, it was found that cloud computing offers high hardware specifications, several systems that meet requirements and highly skilled resources.	Participant 12 indicated that "*scalability is also another element which makes them trust the cloud*", while participant 20 was quoted as saying "*I think once your services are in the cloud and if you train everybody on how to use them and how to adopt it, scalability may be realised*".
Improved access to information and mobility	Improved access to information and mobility was identified as a perceived benefit for cloud computing adoption in the SA government. It was concluded that the adoption of cloud computing might improve access to government information and enable information to be accessed anywhere, anytime and with any device.	Participant 11 stipulated that the adoption of cloud computing will result in: "*the systems will be quicker for accessibility at the service points, which is the challenge currently*" while participant 9 shared the same sentiment by indicating that "*the public service can get far more access to information if cloud computing is adopted in the public sector*".
Enhanced integration of systems and interoperability	Enhanced integration of systems, resources, services, and interoperability may be realised as benefits if cloud computing is adopted in government.	Participant 11 indicated that "*Government can easily share critical systems and information and also improve seamless integration across government*". This perspective was supported by Participant 1 who stated that "*integration of systems, eradication of systems that are running in silos*" is one of the benefits for cloud computing adoption.
Centralised and shared resources and services	The centralised and shared resources and services were also identified as perceived benefits for cloud computing adoption. It was concluded that this can also be realised through deploying and consolidation of data centres that are existing in various government institutions by sharing information, systems, and the infrastructure.	Participant 16 was quoted as saying "*That is what cloud computing does. It wants you to have shared services. We have 10 national departments; if we are on the cloud platforms, moving to one common platform, we can combine all our IT.*" Participant 24, stated that "*Government can easily share critical systems and information and also improve seamless integration across government*".
Optimised speed and agility	Agility and enhanced speed were identified as benefits that may be reaped if cloud computing is adopted in the public sector. Moreover, this benefit was supported on the basis that the development and implementation of systems may be done quickly when using cloud computing. Cloud computing can respond quickly to new requirements for systems that are required to be developed and implemented.	Participant 15 was quoted saying that "*effectiveness is the benefit for cloud adoption because it will allow the department to deploy applications quicker*", is a benefit for cloud computing adoption.
Improved service delivery	Enhanced service delivery was also supported as a benefit of adopting cloud computing in government. The automation of processes and reduced queues may be realised if the cloud is adopted in the public sector.	Participant 16 stipulated that "*I think that a lot of people's lives can be improved. One is the delivery. It can improve efficiency by eliminating queueing systems when we put automation*". Furthermore, Participant 7 shared the view that "*service delivery improvement and efficiencies may be realised. You can implement mainly service delivery improvement*" while Participant 25 alluded to the sentiment that

Benefits	Main Findings	Sample Respondents' Quotations
		"*improved service delivery to the public may be realised as a result of high availability of the cloud platform*".
Cost savings	The cost savings received a high level of occurrences from the respondents concerning the benefits realised for cloud computing. The adoption of the cloud can shift financial investments from Capex to Opex and decrease capital expenditure.	Participant 17, stated the following: *"Instead of buying the hardware or infrastructure, you choose to go to the public cloud. The money that you need to invest in the hardware or infrastructure, could consider to reinvest it to broadband connectivity if you adopt the cloud model. You shift costs from capital investment to operational investment."*
High availability	High availability of government systems was identified as a benefit that may be reaped if the cloud is adopted.	Participant 23 stipulated that there will be "*improved service delivery to the public as a result of the high availability of the cloud platform*".
		Participant 18 as he indicated that "*the other thing that would be a clear benefit is the reachability, availability because if you have this hyperscale or logical initiatives that these data centres will bring, you can almost be assured on time that the systems will always be available and that they will be easy to scale into the right direction*".
Improved disaster recovery	Cloud computing offers more enhanced disaster recovery services. Moreover, it offers the reduction of restoration and costs of operation.	The participants expressed different perspectives around this subject area. They listed disaster recovery as one of the benefits that may be realised when adopting cloud computing in the public sector.
Energy efficiency	South Africa is currently facing power outages due to cable theft and load shedding. However, cloud computing remains a mitigation strategy for resolving this challenge.	Participant 12: "*Cloud computing should form an integral part of green IT strategy as it enables energy efficiency."* Participant 2: "*It will reduce energy consumption and save the government a lot of money."*
Green IT	Green IT benefits may be reaped if the cloud is adopted in the public sector. The consolidation of data centres that are existing in various government departments may lessen carbon emissions, footprints, reduce the costs of electricity used and improve energy efficiency.	Participant 26: *This offers an improvement to green IT as the cloud service better utilises the resources, thereby improving the green footprint of such a service compared to the implementation of standalone on-premise equipment.*" Participant 16: *Cloud computing is a strategy that truly embraces shared services in a sense that you eliminate carbon emission from building your own data centres. It allows us to reduce the number of data centres that we have. Building a data centre alone requires you to buy physical hardware that will eliminate carbon emissions."*

The benefits associated with cost savings, centralised and shared resources, and services have been extensively covered and supported by the existing literature. Countries like the United Kingdom (UK) have successfully realised these advantages through the consolidation of data centers and the sharing of resources and services across government departments. This practice has proven to be effective in achieving substantial cost reductions. In alignment with this approach, the Japanese government has implemented the "Kasumigaseki Cloud" computing infrastructure for consolidating all government data centers and other IT resources. This strategic initiative was aimed at reduing costs but also for making a valuable contribution towards greener and more ecologically pleasant IT operations. Japan has witnessed notable benefits in terms of increased standardisation and centralization by centralising and standardising IT resources within their government. However, it is important to note that the literature on this specific initiative is limited. Nevertheless, the adoption of cloud computing holds significant potential for additional advantages, including high availability, improved disaster recovery, enhanced service delivery, and increased speed and agility. To fully realise these benefits, further research and investigation are needed to explore the implications of cloud computing adoption in the relevant context.

3.4. Perceived Readiness for Cloud Computing

This section addresses the question: What is the perceived readiness for cloud computing adoption in the public sector?

Based on the feedback provided by the participants, the SA government in this case study was assessed as not fully cloud-ready. The areas where the country was identified as ready for cloud computing are at the national and provincial government departments. The areas situated at the local government or in remote areas such as the clinics and schools are not cloud-ready. The findings for perceived readiness for cloud computing adoption in government showed that the country is not comprehensively ready for adopting cloud computing. The majority of the respondents argue that the country is not ready. This is due to the lack of a national cloud

computing policy, cloud standards and the strategy for fully adopting the cloud. The reasons for not being cloud-ready are essentially about the shortage of broadband network in rural areas, skills shortage, and absence of a national cloud computing policy for the country. Several views of the respondents are shared below:

Table 6. Respondents perceptions that government is not cloud ready

Participants	Sample Respondents'' Quotations
Participant 18	*"Connectivity and infrastructure are a problem and the ability to invest financially in the transformation agenda. The country is not ready, but I think we are getting there slowly."*
Participant 8	*"Not ready, the cloud can only exist on a proper infrastructure."*
Participant 16	*"We are not ready, we don't have connected facilities, services and so the clinics at most, there's are no computers in most of them. If there is a computer, then it is a standalone computer."*
Participant 10	*"We do not have the bandwidth; I think we are still not 100% ready.*
Participant 24	*"The infrastructure is still at its infant stage."*
Participant 25	*"My department is not ready for cloud computing, either private or public. There is a huge gap in skills to deal with cloud computing."*
Participant 7	*"I would say our readiness is quite low because our infrastructure is old and not cloud-ready. The lack of robust broadband infrastructure. I do not think we are ready. We need to get the basics first, like the broadband infrastructure."*
Participant 9	*"When it comes to the smaller towns in rural areas, we are not ready."*
Participant 4	*"We are far from being ready."*
Participant 13	*"From a readiness point of view, specifically concerning the network and we do have an issue. We need to relook at the structure of our internet access as well. Thirdly, probably there is an issue on the bandwidth currently."*
Participant 17	*"Generally, as a public service, the level of readiness for cloud computing is low as it requires connectivity to access the services. There are skills shortage for managing the cloud services."*

There were a few opposing views as outlined below:

Table 7. Perceptions that government is cloud ready

Participants	Sample Respondents'' Quotations
Participant 32	*"High level of readiness, adequate bandwidth exists."*
Participant 30	*My department infrastructure is ready since we are already implementing cloud computing solutions in our department.*
Participant 26	*"The department has the infrastructure to implement the cloud. However, specific upgrades might still be necessary. This would include a possible increase in bandwidth, from the office as well as staff working from home."*
Participant 9	*"We are ready in the major metropolitans and the major towns."*

The perspectives provided show that government is cloud-ready in certain government departments, although the bandwidth rate remains an overarching an issue. Most of the participants shared their concern with broadband coverage, which has not yet reached all the rural areas, remote areas, clinics, schools, etc. The high data costs were also noted as the reason why the SA government is not yet ready for cloud computing adoption. The shortage of skills was also identified as the reason why the SA public sector is rated as not being ready for cloud computing adoption.

The adoption of cloud computing in countries such as Ethiopia has been noted to progress at a slow pace, potentially attributable to the level of readiness for embracing this technology;. Developed countries like the United States, United Kingdom, Japan, and New Zealand have been regarded as having a favorable state of readiness in comparison to developing nations like Ethiopia and South Africa. The discrepancy in cloud computing adoption rates between the identified developed and developing countries could be attributed to various factors. The developed nations often possess more advanced technological infrastructures, including robust internet connectivity and reliable data centers, which serve as fundamental prerequisites for adopting cloud computing. In contrast, the developing countries may face infrastructure limitations and challenges, such as inadequate internet connectivity, limited access to electricity, and insufficient resources to establish and maintain data centers.

Addressing the slow pace of cloud computing adoption in developing countries like Ethiopia and South Africa requires a multifaceted approach. It entails improving technological infrastructure, expanding

internet connectivity, promoting digital literacy programs, and providing financial support and incentives for organizations and individuals to embrace cloud solutions. Collaborative efforts between government, the private sector, and international organisations can help bridge the readiness gap and facilitate the adoption of cloud computing in developing nations.

3.5. Recommendations

Considering the lessons from the data and literature, we offer the following guidelines for consideration when adopting cloud computing in the public sector. These guidelines relate to the themes of Security, skills development , infrastructure, legislation, policy and implementation approaches as outlined below:

Security- The security control measures for the protection of data and information hosted on cloud computing must be put in place. It is recommended that a cybersecurity strategy and framework with the relevant and best practices adhering and complying with the global security standards be developed and implemented. The development and implementation of the cloud standard and policy also need to be accelerated as this is deemed critical for ensuring that government consume cloud services in a secured environment.

Skills- The digital skills for the development programme or strategy that encompasses all the emerging technologies that form an integral part of the 4IR, including cloud computing, needs to be developed. It is suggested that an education programme be considered that incorporates the digital technologies that form an integral part of 4IR, including cloud computing. The upskilling of resources in managing cloud services is a necessity. The approach for conducting awareness and empowering staff, management and the executive is of much importance. Platforms such as the TV, mobile phones, etc. may be employed for educating the citizens about these new technologies.

Broadband and bandwidth- The rollout of broadband across the country needs to be expedited. The SA Connect policy and strategy to be used as a driver for accelerating the implementation of broadband and high-speed bandwidth to all areas in South Africa. However, rural, and remote areas are to be prioritised. The aspect of access to the broadband network at a cheaper or zero-rated data is recommended for accessing critical government and any other essential services.

Private cloud for government- The roadmap for implementing a private cloud for the government is recommended. The private cloud for government services should not be a service that is outsourced to cloud service providers. It was suggested that the private cloud may offer highly scalable services, enhanced security, and enhanced services for government entities. There is a need to benchmark with other countries that have a private cloud for the government such as Japan, the United Kingdom and other developing countries. The private cloud architecture for the government may be developed, which should adhere to the applicable legal prescripts. It also recommended that a programme for shared IT resources, services and the infrastructure be developed and implemented.

Cloud adoption approach- It is recommended that a readiness assessment model be developed and employed as a guideline for assessing the level of readiness for cloud adoption in all government institutions before considering its implementation. The government may consider adopting the hybrid approach for cloud adoption, enabling access to services that may not be offered by the private cloud for the government, such as the transversal systems will be migrated to the public cloud. Moreover, the government may make progress with the implementation of a private cloud while leveraging the services offered by reputable commercial cloud service providers.

Cloud policy, strategy and framework- The national cloud policy for the government was identified as a necessity for cloud computing. Although there may be bits and pieces of policies, strategies, and frameworks, the need for a more integrated view became prominent for cloud computing adoption. The overarching countrywide cloud strategy was also flagged as critical for successful implementation and adoption of cloud computing in government. It is recommended that the existing frameworks be revised to accommodate cloud computing.

Compliance to government legislation and regulation- There is a need to develop compliance controls, procedures, checklists and measures to be used for cloud computing implementation or adoption. It is recommended that the procurement of cloud computing services be centralised and clear guidelines for adhering to the legal prescripts of government be developed. The development and implementation of the cloud must be standardised.

Budget and financial resources- The National Treasury may develop and provide direction concerning the costing model that may be used for budgeting and managing the billing of cloud services in government.

Research and innovation- The country needs to invest in building capacity concerning cloud computing, which forms an integral part of 4IR. Various government entities can also drive IT research and

innovation concerning these 4IR technologies. They may consider collaborating with higher education instistutions for research projects.

Green IT- An integrated green IT strategy for the government consisting of 4IR technologies such as cloud computing needs to be developed. The strategy should have the benefits realisation of green IT. Cloud computing should form an integral part of that strategy as an enabler for green IT.

4.   CONCLUSION
4.1 Concluding Remarks
The main aim of this study was to determine how cloud computing may be adopted in the public sector considering the slow rate of adoption that has been noted. The study elucidated the factors that influence cloud computing adoption in the public sector in the South African context. The findings add to the extant literature. The key enablers for cloud computing adoption are security, IT infrastructure readiness, skills and the national cloud policy, strategy and framework, research and innovation for 4th Industrial Revolution, skills, knowledge and understanding, budget and financial resources, trust, leadership and management support. The major barriers for cloud computing include the security concerns, lack of ICT infrastructure, budget and financial constraints, governance, lack of cloud policy, framework, standard and strategy, legislation and regulations contradictions, energy limitation, shortage of skills, understanding and knowledge, lack of an overarching nation-wide cloud computing policy and compatibility. The main benefits identified for cloud computing adoption are concerning the cost savings, scalability, improved access to information and mobility, enhanced integration of systems and interoperability, centralised and shared resources and services, optimised speed and agility, improved service delivery, high availability, improved disaster recovery, energy efficiency and green IT.

The study found that South Africa is currently not fully ready for cloud computing adoption, especially in the rural and remote areas. This is due to a lack of IT infrastructure such as broadband coverage in rural areas, the bandwidth speed is low and there is poor internet coverage in remote areas. Most national and provincial governments were found to be cloud-ready. While others are busy upgrading their infrastructure, others are experiencing challenges with poor latency for bandwidth. Another common reason for South Africa not being cloud-ready is because of the high cost of data charged for internet access.

4.2. Limitations and Future Research
The study notes some limitations. Data was collected from 33 respondents thus there may be limited generalisability. However the study serves to provide insights into the expriences and lessons from various public sector respondents on the challenges faced with adopting cloud computing. Additionally, data was predominantly collected at the national and provincial level. Future studies may focus on collecting more data from the state owned entities and local government perspective. The study was also exploratory, qualitative and interpretivist in nature and relied on thematic data analysis informed by the TOE and DOI frameworks. As such future research may consider a mixed method approach and expanding the sample size for data collection. This may also consider a quantitative survey and include statistical analysis.

REFERENCES
[1]   Vallie, Z. (2018). Treasury defends R587 billion government wage bill 10/04/2018 IOL. [Online]. Available: https://www.iol.co.za/Business-Report/Economy/Treasury-Defends-R587-Billion-Government-Wage-Bill-14332008
[2]   Almarabeh, T., Majdalawi, Y. & Mohammad, H. (2016). Cloud Computing of E-Government. *Communications and Network*, 8, 1-8. doi:10.4236/cn.2016.81001
[3]   Wyld, D. C. (2010). The Cloudy future of government it: Cloud computing and the public sector around the world. *International Journal of Web & Semantic Technology*, 1, 1-20.
[4]   Al-Ruithe, M., Benkhelifa, E. & Hameed, K. (2018). Key issues for embracing cloud computing to adopt a digital transformation: A study of Saudi public sector. *Procedia Computer Science*, 130, 1037-1043.
[5]   Bhisikar, A. (2011). G-Cloud: New paradigm shift for online public services. *International Journal of Computer Applications,* 22, 24-29.
[6]   Vorobeva, I,A., Panov, A,V., Safronov,A,A. and Sazonov, S,I., (2022). Cloud Computing Models for Business. *International Journal of Emerging Technology and Advanced Engineering*, 12(1),163-172.
[7]   Hashim, H. S., Hassan, Z. B. & Hashim, A. S. (2015). Factors influencing the adoption of cloud computing: A comprehensive review. *International Journal of Education and Research*, 3, 295-306.
[8]   Al-Badi, A., Tarhini, A. & Al-Kaaf, W.(2017). Financial incentives for adopting cloud computing in higher educational institutions. *Asian Social Science*, 13, 162-174.
[9]   Makoza, F. (2015). Cloud computing adoption in higher education institutions of Malawi: An exploratory study. *International Journal of Computing & ICT Research*, 9(2).

[10] Mkhatshwa, B., & Mawela, T. (2021). Perceptions of Cloud Computing Risks in the Public Sector. In *International Conference on Innovations in Bio-Inspired Computing and Applications*, 599-611. Springer, Cham.

[11] Muhammad, A. R. (2015). Towards cloud adoption in Africa: The case of Nigeria. *International Journal Of Scientific & Engineering Research*, 6, 657-664.

[12] Nghihalwa, E. N. & Shava, F. B. A. (2018). Secure cloud adoption framework (SCAF) for the Namibian government information technology departments. 2018 *Second world conference on smart trends in systems, security and sustainability* (Worlds4), IEEE, 246-253.

[13] Kundra, V. (2011). Federal cloud computing strategy. Washington D.C: The White House. [Online]. Available: http://www.cio.gov/documents/federal-cloud-computing -strategy.pdf.

[14] Hashemi, S., Monfaredi, K. & Masdari, M. (2013). Using Cloud computing for e-government: challenges and benefits. *International Journal of Computer, Information, Systems and Control Engineering*, 7, 596-603.

[15] Gillwald, A. & Moyo, M. (2017). Modernising the public sector through the cloud. *Research ICT Africa*, 1, 1-53.

[16] Ali, O., Soar, J., Mcclymont, H., Yong, J. & Biswas, J. (2015). Anticipated benefits of cloud computing adoption in Australian regional municipal governments: An exploratory study. *Pacific Asia Conference on Information Systems,* 2015,1-17.

[17] Yeboah-Boateng, E. O., & Cudjoe-Seshie, S. (2013). Cloud computing: The emergence of application service providers (ASPs) in developing economies. *International Journal of Emerging Technology and Advanced Engineering*, 3(5), 703-712.

[18] Liang, Y., Qi, G., Wei, K. & Chen, J. (2017). Exploring the determinant and influence mechanism of e-government cloud adoption in government agencies in China. *Government Information Quarterly*, 34, 481-495.

[19] Rohani, M. B. (2015). An integrated theoretical framework for cloud computing adoption by universities technology transfer offices (TTOS). *Journal of Theoretical and Applied Information Technology*, 79, 415.

[20] Elena, G., & Johnson, C. W. (2015). Factors influencing risk acceptance of cloud computing services in the UK government. *International Journal on Cloud Computing: Services and Architecture (IJCCSA)* , 5,(2), doi: 10.5121/ijccsa.2015.5301

[21] Chang, V. I. (2016). A proposed framework for cloud computing adoption. *International Journal of Organization and Collective Intelligence*, 6(3), 1-17.

[22] Omar, A., Jacques, O., & Gwamaka, M. (2015). Cloud computing adoption for business development: A TOE perspective. In *Proceedings of the 9th IDIA conference* (pp. 463-476).

[23] Tan, M. & Lin, T. T. (2012). Exploring organizational adoption of cloud computing in Singapore. In: *The 19th ITS Biennial conference 2012* "Moving Forward with Future Technologies?: Opening a Platform for All", 1–21.

[24] Mohammed, F., & Ibrahim, O. (2015). Models of adopting cloud computing in the e-government context: a review. *Jurnal Teknologi*, 73(2).

[25] Adendorff, R. & Smuts, H. (2019). Critical success factors for cloud computing adoption in South Africa. a software development lifecycle view, in: *SAICSIT'10 Proceedings of the 2010 Annual Research Conference of the South African Institute of Computer Scientists and Information Technologists*, ACM, 2010, 304–313.

[26] Gangwar, H., Date, H. & Ramaswamy, R. (2015). Understanding the determinants of cloud computing adoption using an integrated TAM-TOE model. *Journal Of Enterprise Information Management*, 28 (1), 107-130.

[27] Alsanea, M. & Wainwright, D. (2014). Identifying the determinants of cloud computing adoption in a government sector–A case study of Saudi organisation. *International Journal of Business and Management Studies*, 6, 29-43.

[28] Alhammadi, A., Stanier, C. & Eardley, A. (2015). The determinants of cloud computing adoption in Saudi Arabia. *Second International Conference on Computer Science and Engineering (CSEN 2015)*, 55-67.

[29] Karim, F. & Rampersad, G. (2017). Cloud computing in education in developing countries. *Computer and Information Science*, 10, 87-96.

[30] Alkhwaldi, A., Kamala, M. A. & Qahwaji, R. S. (2018). Analysis of Cloud-based e-government services acceptance in Jordan: Challenges and barriers. *Journal of Internet Technology and Secured Transactions*, 7(2), 556-568. https://doi.org/10.20533/jitst.2046.3723.2018.0069

[31] Scholtz, B., Govender, J. & Gomez, J. M. (2016). Technical and environmental factors affecting cloud computing adoption in the South African public sector. CO*NF-IRM 2016 Proceedings*, 16. https://aisel.aisnet.org/confirm2016/16

[32] Tweneboah-Koduah, S., Endicott-Popovsky, B. & Tsetse, A. (2014). Barriers to government cloud adoption. *International Journal of Managing Information Technology*, 6, 1-16.

[33] Gill, A. Q., Smith, S., Beydoun, G. & Sugumaran, V. (2014). Agile enterprise architecture: A case of a cloud technology-enabled government enterprise transformation. In *Proceedings of the 19th Pacific Asia Conference on Information Systems (PACIS 2014),* the United States, 1–11.

[34] Gasser, U. & O'brien, D. (2014). Governments and cloud computing: roles, approaches, and policy considerations. *Berkman Center Research Publication, Cambridge*, Mar. 2020. [Online]. Available: http://ssrn.com/abstract=2410270.

[35] Seifu, S. D., Dahiru, A. A., Bass, J. M. & Allison, I. K. (2017). Cloud-Computing: Adoption Issues for Ethiopian public and private enterprises. *The Electronic Journal of Information Systems In Developing Countries*, 78, 1-14.

[36] Rashmi, M. S., & Sahoo, G. (2012). A five-phased approach for the cloud migration. *International journal of emerging technology and advanced engineering*, 2(4), 286-291.

[37] Gao, F. & Sunyaev, A. (2019). Context matters: A review of the determinant factors in the decision to adopt cloud computing in healthcare. *International Journal of Information Management*, 48, 120-138.

[38] Rogers, E. M. (2010). *Diffusion of Innovations*, Simon and Schuster. New York, Free Press.

[39] Erind, H. (2015). The technological, organizational and environmental framework of is innovation adaption in small and medium enterprises. Evidence From Research Over the Last 10 Years. *International Journal of Business and Management*, 3, 1-14.

[40] Yin, R. K. (2009). *Case Study Research* (4th ed.). London: Sage.

[41] DPSA, (2003). The Machinery of government: structure and functions of government. In: Administration, DPSA. (Ed.). South Africa, Pretoria: Department of Public Service and Administration.

[42] DTPS, (2017). National e-government strategy and road map. DTPS (Ed.). Pretoria: Department: Telecommunications and Postal Services.

[43] Irion, K. (2012). Government cloud computing and national data sovereignty. *Policy & Internet*, 4, 40-71.

[44] DPSA (2014). The Batho Pele Vision. Department of Public Service and Adminsitration. [Online]. Available: https://www.dpsa.gov.za/documents/Abridged%20BP%20programme%20July2014.pdf