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Evaluating the benefits of Cloud Computing in Small, Medium and Micro-sized Enterprises (SMMEs)

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Abstract

Cloud computing is becoming an essential tool in lowering Information Technology (IT) costs amongst Small, Medium and Micro-sized Enterprises (SMMEs). As such amongst a myriad of challenges, SMMEs are faced with a general lack of resource capability including the lack of Information and Communications Technology (ICT) infrastructure and skills. This further disables the SMMEs ability to compete with big business and industry peers. As such cloud computing offers SMMEs the ability to access high level ICT services either through SaaS (Software-as-a-Service), PaaS (Platform-as-a-Service) or IaaS (Infrastructure-as-a-Service) service delivery models. Cloud computing adoption amongst SMMEs is relevant in the sense that SMMEs can realise the full benefits of reduced capital expenditure, improved access to ICT systems, heightened security of data and low costs for agile development amongst a myriad of cloud computing benefits. The overall intention is to ensure that SMMEs always have access to updated ICT services through the cloud, without having the burden of maintaining ICT infrastructure in-house. Based on this interpretation, this study analysed factors affecting cloud computing adoption amongst SMMEs, by use of a Conceptual Research Model based on the Technology-Organization-Environment (TOE) framework. This was informed by a survey distributed to SMMEs within the Ngaka Modiri Molema and Bojanala Platinum Districts of the North West Province. The results of this study will assist SMMEs to make informed decisions on adopting cloud computing practices in their organisations.

Keywords: SMMEs; Cloud computing; SaaS; PaaS; IaaS; public cloud; private cloud; hybrid cloud; community cloud

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1. Introduction

Business, particularly Small, Medium and Micro-sized Enterprises (SMMEs) are still utilising traditional forms of Information and Communications Technologies (ICT). These SMMEs acting particularly as key economic empowerment vehicles, have similar characteristics in that they are generally small, specialise in one field of work and lack resource availability [1] (SEDA, 2016). However, business no matter how big or small is forced to align itself with current conditions, where its clients/consumers are becoming technologically savvy. Small, Medium and Micro-sized Enterprises (SMMEs) in particular should explore and build their organisations around cloud computing services to realise greater efficiency and effectiveness within their business functions and processes [2] (Kumalo & van der Poll , 2015). Cloud adoption is the affordable choice, as it offers greater flexibility, accessibility, data security and disaster recovery benefits to SMMEs. In addition, it also gives SMMEs a competitive advantage whilst saving money, giving entrepreneurs more time to focus their energy on core business processes and objectives [3] (Mohlameane & Ruxwana, 2014).Small, Medium and Micro-sized Enterprises (SMMEs) as the focus of this study within the South African context, refers to businesses that employ less than 200 people, employ approximately 60% of the work force and contribute approximately 34% of the Gross Domestic Product (GDP). SMMEs play an integral role in the South African economy as drivers of both growth and job creation [1] (SEDA, 2016).

Cloud computing adoption is defined by cost reductions in the Information System (IS). Through this mechanism SMMEs pay for the services they use, and are able to justify the flow of capital and operational expenditure. Through scalability SMMEs can tailor make their IT needs at different points of the SMMEs life-cycle, and respond to IT needs that are needed for specific projects. Accessibility and flexibility, allows SMMEs the ability to utilize their information needs anywhere through simple end-user programs. Innovation is another critical cost saving mechanism to SMMEs, as it ensures that service providers are the ones taking up the costs for Research and Development (R&D) which results to an overall access to improved resources [4] (Chovancová, L.Vokorokos, & Chovanec, 2015). This study seeks to answer the main research question, as to what the main factors influencing the adoption of cloud computing services amongst SMMEs in districts of the North West Province. This paper is structured as follows: Section 2 Literature Review, Section 3 Research Methodology, Section 4 Results and Section 5 Conclusion.

2. Literature review

Cloud computing is by no means a new concept in the field of information systems. Instead, it is an evolutionary concept which stems its roots from grid computing, which sought to solve intricate problems with parallel computing. This was followed by utility computing in the 1960s which offered computing solutions as a metered service and finally Software-as-a-Service (SaaS) during early 2000 where end-users could subscribe to web services [5] (Gustafson & Orrgren, 2012). Cloud computing is best defined by the National Institute of Standards and Technology (NIST) [6] (Alshamaileh, 2013). Through this definition six (6) key factors stand out that characterise the concept of cloud computing, where cloud computing is outlined as an on-demand self-service, portrays an aspect of multi-tenancy and resource pooling, promotes rapid elasticity and ubiquitous access, is a measurable/payable service and encourages resiliency. Secondly, cloud computing is coupled with three main service /delivery models comprising of Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS) and Infrastructure-as-a-Service (IaaS) and provide an alternative cost effective solution compared to the traditional Information Technology department outfits. Lastly cloud computing comprises of four deployment models which encompass the underlying structure of the cloud. These deployment models include public, private, community and hybrid clouds. In essence, cloud deployment models typically represent the types of cloud environments, cloud customers and organizations can opt for and are distinguishable via ownership, size and access [7] (Ambrose, Dagland, & Athley, 2010).

2.1. Cloud computing services

As outlined in the National Institute of Standards and Technology (NIST) definition, cloud computing is composed of three service models which encompass the underlying structure of the cloud. These main service /delivery models comprise of Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS) and Infrastructure-as-a-Service (IaaS) and provide an alternative cost effective solution compared to the traditional Information Technology department. Figure

1 outlines the types of responsibilities afforded to either the cloud customer or cloud service provider, in a traditional IT Department and in a SaaS, PaaS and IaaS setting.

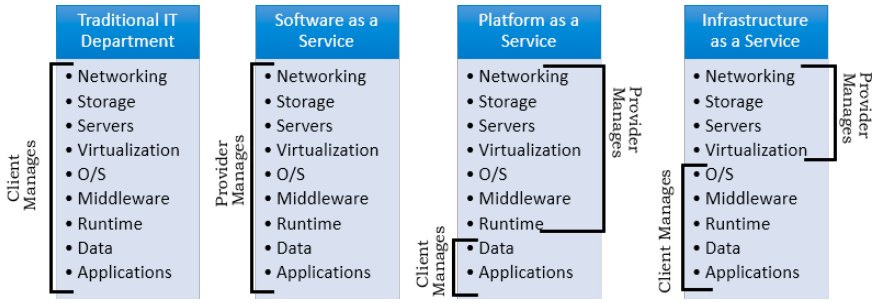

Figure 1 - Traditional IT outfit versus the cloud adapted from[13] (Dufrasne, et al., 2015)

Software-as-a-Service (SaaS) is the most basic type of cloud computing service/delivery model available, and is utilised without realisation. SaaS was developed with the needs of end users in mind, and allows end users the ability to interact with web-based applications over the internet without having to install applications on their computers. What the cloud customer does to access a particular service is to log into a web service via a web browser [8] (Vaskovich, 2015).Platform-as-a-Service (PaaS) is a cloud service/delivery model developed with application developers in mind. With PaaS, application developers have the ability to develop, test, deploy, host and maintain web applications and software's through platforms over the internet without installing base software's on their computers. Due to the high costs associated with buying developmental software's, PaaS provides a cheaper alternative, as the disadvantages of directly owing such software is passed on to cloud service providers, in addition cloud customers have the ability to enjoy benefits of elasticity, efficiency and workload management [9] (Gorelik, 2013). Infrastructure-as-a-Service (IaaS) is a cloud service/delivery model developed with the needs of network architects and organizations that seek to outsource their Information Technology infrastructure in mind. This move is particularly triggered by a cloud customers need to drastically reduce Information Technology expenses whilst remaining highly competitive in their respective industry. In addition to this, IaaS exposes a cloud customer to expensive technologies outside the reach of the cloud customer and a simplified, cost effective management of Information Technology infrastructure which allows cloud customers the ability to rent/utilise a service that best suits the needs of the cloud customer [9] (Gorelik, 2013).

2.2. Cloud computing deployment models

As outlined in the National Institute of Standards and Technology (NIST) definition, cloud computing is also composed of four deployment models which encompass the underlying structure of the cloud. These deployment models as outlined in Figure 2 comprise of public, private, community and hybrid clouds. In essence, cloud deployment models typically represent the types of cloud environments cloud customers and organizations can opt for, and are distinguishable via ownership, size and access as outlined below:

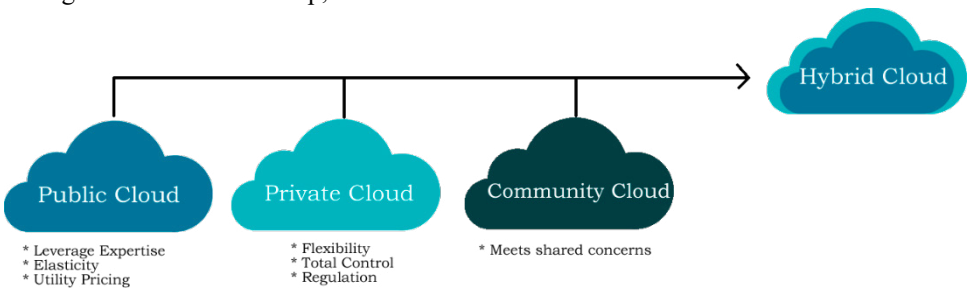

Figure 2 - Cloud deployment models adapted from [10] (Ramsaran, 2014)

A public cloud is a cloud environment that is publicly offered to many cloud customers without restriction by a cloud service provider. In such an environment, the cloud service on offer in a public cloud is often provisioned through a SaaS, PaaS or IaaS setting. Figure 2 clearly outlines this depiction of public clouds, were a public cloud service provider like Google would make its Software-as-a-Service (SaaS) offering like Gmail available to a wide range of cloud customers [7] (Ambrose, Dagland, & Athley, 2010).A private cloud is a cloud environment that can take two scenarios. In the first scenario, the private cloud can be deployed exclusively within a single organization and the private cloud is maintained and controlled by the cloud service provider. In the second scenario the private cloud is deployed exclusively within a single organization and the private cloud is maintained and controlled by the organization. In both scenarios, the private cloud is utilised privately in a controlled environment by a single organization [7] (Ambrose, Dagland, & Athley, 2010). A community cloud is a cloud environment where access is limited to organizations and cloud customers that share the same objectives. This type of cloud can be jointly maintained and managed by members of the community, or by a separate cloud service provider that provisions its service offering to accommodate a community cloud. An example of a community cloud could be a banking community cloud, where access is granted only to banks and financial institutions as they bounded by the same objectives [7] (Ambrose, Dagland, & Athley, 2010). A hybrid cloud is a cloud environment that is a combination of one or more cloud deployment models. This could either be in the form of a combination of a public and private cloud. This cloud environment is often the solution cloud customers and organizations opt for, as they can store sensitive data on a private cloud for security purposes, whilst storing less sensitive data on a public cloud[7] (Ambrose, Dagland, & Athley, 2010).

2.3. Theoretical framework

The Conceptual Research Model of this study as outlined in Figure 3, is based on the Technological-Organisational-Environmental (TOE) framework as the core structure of the framework. In essence, the TOE framework seeks to analyse the effects of Information Technology (IT) innovations within the organisation. This is achieved by analysing the direct effects, the technological context (analysis of existing technologies versus the impact of adopting new technologies and the overall effect on the organisation), organisational context (analysing the effects of how organisational culture, size and management support have on adoption) and environmental contexts (analysis of the micro and macro environmental effects have on adoption) have in adopting and implementing technological innovations within the organisation [11] (Larsen, Allen, Vance , & Eargle, Welcome to the Theories Used in IS Research Wiki, 2015).

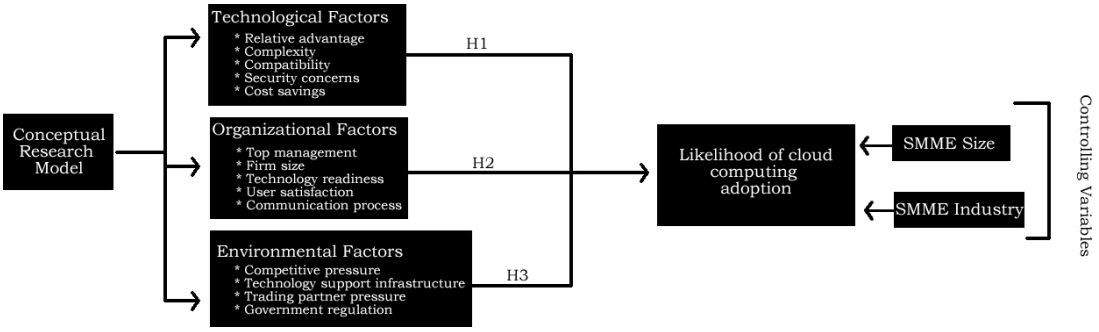

Figure 3 - Conceptual Research Model based on TOE framework

As such from the perspective of the Conceptual Research Model based on the Technological-Organisational-Environmental (TOE) framework, the aim is to analyse technological innovations that affect cloud computing adoption internally and externally from the organisation. Second to that is to analyse organisational attributes that affect cloud computing adoption and lastly to analyse how environmental factors affect cloud computing adoption from a micro-macro perspective. In addition to this two (2) controlling variables have been selected, being SMME

Size and Industry to give emphasis into the likelihood to adopt cloud computing practices amongst SMMEs. Table 1 outlines the studies hypothesis.

Table 1 – Study Hypothesis

Technological factors	**Organizational factors**	**Environmental factors**
• Relative advantage *H1 (a) – Relative advantage affects cloud computing adoption positively.*	• Top management support *H2 (a) - Top management has a positive effect on cloud computing adoption*	• Competitive pressure *H3 (a) – Competitive pressure plays a positive role towards cloud computing adoption*
• Complexity *H1 (b) – Complexity of cloud computing services affects cloud computing adoption negatively.*	• Firm size *H2 (b) - Firm size has a positive effect on cloud computing adoption*	• Technology support infrastructure *H3 (b) - Technology support infrastructure does not influence cloud computing adoption*
• Compatibility *H1 (c) – Compatibility issues affect cloud computing adoption positively.*	• Technology readiness *H2 (c) - Technology readiness has a positive effect on cloud computing adoption*	• Trading partner pressure *H3 (c) - Trading partner pressure has a positive effect of cloud computing adoption*
• Security concerns *H1 (d) – Security concerns affect cloud computing adoption negatively*	• User satisfaction *H2 (d) - User satisfaction plays a significant positive role in cloud computing adoption*	• Government regulation *H3 (d) - Government regulation has a positive effect on cloud computing adoption*
• Cost savings *H1 (e) – Cost savings affect cloud computing adoption positively*	• Communication processes and channels *H2 (e) – Communication processes and channels influence cloud computing adoption positively*	

3. Research Methodology

This section outlines the research philosophy, approach, strategy, method, the data analysis and a collection strategy that was employed in answering the research question in a systematic way. The study takes on an epistemological-positivist philosophy through deductive means [6] (Alshamaileh, 2013). The study employed a quantitative method survey to constitute its research strategy. Due to convenience sampling, 111 SMME's from Ngaka Modiri Molema and Bojanala Platinum Districts of the North West Province took part in this study. Epistemology as such becomes the appropriate philosophy of this study in the sense that we are concerned with the creation of acceptable knowledge in this field of cloud computing as it relates to Small, Medium and Micro-sized Enterprises (SMME's). In addition to this, positivism becomes an appropriate tool, as knowledge will be attained in a scientific manner through hypothesis testing base the TOE Framework (Table 1).

The adopted research strategy revolves around a survey. A survey constitutes as part of the deductive approach, which was used to distribute, collect and analyse data. This research strategy allows us the ability to have enhanced control over the research process, by gathering large quantities of data in an economical way. The surveys will be distributed to a particular segment of the society, utilising objective questions that are close ended [12] (Ramothibe, 2012). As a result, this study used quantitative research method and close-ended questions based on a cross-sectional study. Google Forms (web-based software tool) online survey was used to collect data from Small, Medium and Micro-sized Enterprises (SMME's) in the North West Province. The constructs used in this study have been utilised in prior studies on cloud computing adoption amongst Small, Medium and Micro-sized Enterprises (SMME's) worldwide. As such a Cronbach's Alpha test was conducted, to test the reliability of 14 constructs amongst themselves using SPSS 24. The researcher took ethical considerations during the study.

4. Research Results

The data collection process commenced from July 2017 to October 2017, and during that process, 340 surveys were distributed to SMMEs using Google Forms. Out of that, only 111 SMMEs took part in fully completing surveys submitted online through Google Forms. The objective was to establish whether or not the independent variables significantly affect the likelihood of cloud computing adoption by SMMEs. This presents demographic characteristics of the respondents preceded the three (3) constructs namely the technological, organizational and environmental

context constructs regression tests. Table 2 outlines the multiple regression tests done to analyse the independent variables.

4.1. Demographic Characteristics

Figure 4 outlines a cross tabulation between the presence of IT departments within SMME's and their corresponding industries. As such based on this it is clear that 7% of SMME's in the Finance, ICT, Legal and Business services industry, 3% of SMME's in the Manufacturing industry, 3% of SMME's in the Retail, Motor Trade and Repair Services industry, 1% of SMME's in the Transportation industry and 1% of SMME's in the Wholesale Trade, Commercial Agents and Allied Services industry have dedicated Information Technology (IT) departments to support business processes and functions. The remaining 86% of SMME's that took part in the study do not have dedicated Information Technology departments.

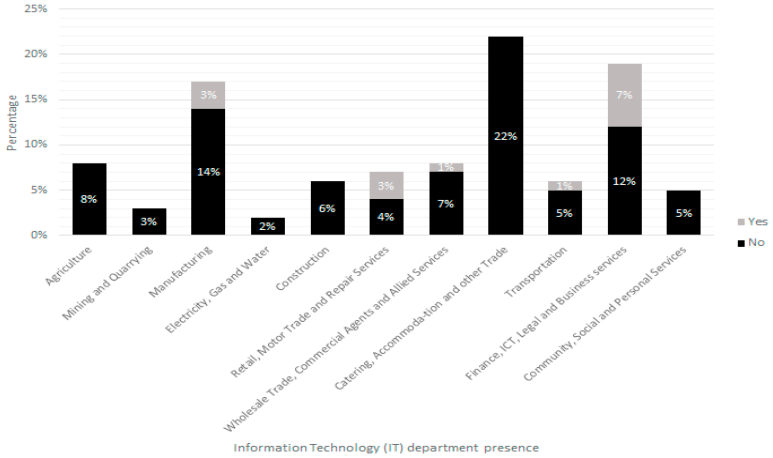

Figure 4- IT department presence

4.2. Regression Analysis

The regression test analysis was conducted, where the control variables are SMME Size (Q2) and SMME Industry (Q3). These two (2) control variables will be computed to serve as dependent variables to test regression against the variables in the three (3) contexts which are independent variables.

4.2.1 Multiple regression analysis conclusion on hypothesis testing

Table 2 indicates that the linear regression test explains 47.7% of the variance in the overall data. In addition, the F-test in the linear regression indicated that there was a linear relationship between the variables with $F = 2.023$ and 110 degrees of freedom.

Table 2 - ANOVA test

Model		Sum of Squares	df	Mean Square	R	R^2	Adjusted R^2	F	Sig.
1	Regression	278.189	14	19.871	.477[a]	.228	.115	2.023	.024[b]
	Residual	942.910	96	9.822					
	Total	1221.099	110						
a. Dependent Variable: AdoptionIndustrySize									
b. Predictors: (Constant), H3dGovernmentRegulation, H1dSecurityConcerns, H1aRelativeAdvantage, H3bTechnologySupportInfrustructure, H2bFirmSize, H1bComplexity, H2eCommunicationProcess, H1eCostSavings, H3cTradingPartnerPressure, H2dUserSatisfaction, H2aTopManagment, H2cTechnologyReadiness, H3aCompetitivePressure, H1cCompatability									

The multiple regression tests were done to analyse the independent variables. The objective was to establish whether or not the independent variables significantly affect the likelihood of cloud computing adoption by SMME's.

Table 3 - Coefficients test

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	6.182	1.470		4.206	.000
	H1aRelativeAdvantage	.884	.437	.262	2.022	.046
	H1bComplexity	.382	.295	.138	1.295	.198
	H1cCompatability	.200	.464	.063	.432	.667
	H1dSecurityConcerns	-.080	.321	-.025	-.250	.803
	H1eCostSavings	1.591	.566	.292	2.809	.006
	H2aTopManagment	-.180	.428	-.051	-.421	.675
	H2bFirmSize	-.132	.284	-.045	-.463	.645
	H2cTechnologyReadiness	-.319	.460	-.097	-.695	.489
	H2dUserSatisfaction	-.399	.253	-.195	-1.579	.118
	H2eCommunicationProcess	.406	.498	.086	.815	.417
	H3aCompetitivePressure	.144	.249	.081	.577	.565
	H3bTechnologySupportInfrustructure	-.346	.879	-.041	-.394	.695
	H3cTradingPartnerPressure	-.190	.446	-.047	-.427	.670
	H3dGovernmentRegulation	.195	.409	.054	.477	.634
a. Dependent Variable: AdoptionIndustrySize						

4.3. Research Results

Based on Table 4, it is clear that hypothesis 1 and 3 are supported, and that the technological and environmental contexts played a positive pivotal role, while hypothesis 2 was rejected because the organisational context played a negative pivotal role in the adoption of cloud computing services amongst SMMEs.

Table 4 - Hypothesis testing results

Technological context		
Hypothesis	**Weights**	**Support/Reject**
H1 (a) – Relative advantage affects cloud computing adoption positively.	β = 0.262, t = 2.022, p = 0.046	Supported
H1 (b) – Complexity of cloud computing services affects cloud computing adoption negatively.	β = 0.138, t = 1.295, p = 0.198	Supported
H1 (c) – Compatibility issues affect cloud computing adoption positively	β = 0.063, t = 0.432, p = 0.667	Supported
H1 (d) – Security concerns affect cloud computing adoption negatively	β = -0.025, t = -0.250, p = 0.803	Supported
H1 (e) – Cost savings affect cloud computing adoption positively	β = 0.292, t = 2.809, p = 0.006	Supported
Organisational context		
Hypothesis	**Weights**	**Support/Reject**
H2 (a) - Top management has a positive effect on cloud computing adoption	β = -0.051, t = -0.421, p = 0.675	Rejected
H2 (b) - Firm size has a positive effect on cloud computing adoption	β = -0.045, t = -0.463, p = 0.645	Rejected
H2 (c) - Technology readiness has a positive effect on cloud computing adoption	β = -0.097, t = -0.695, p = 0.489	Rejected
H2 (d) - User satisfaction plays a significant positive role in cloud computing adoption	β = -0.195, t = -1.579, p = 0.118	Rejected
H2 (e) – Communication processes and channels influence cloud computing adoption positively	β = 0.086, t = 0.815, p = 0.417	Supported
Environmental context		
Hypothesis	**Weights**	**Support/Reject**
H3 (a) – Competitive pressure plays a positive role towards cloud computing adoption	β = 0.081, t = 0.577, p = 0.565	Supported
H3 (b) - Technology support infrastructure does not influence cloud computing adoption	β = -0.041, t = -0.394, p = 0.695	Supported
H3 (c) - Trading partner pressure has a positive effect of cloud computing adoption	β = -0.047, t = -0.427, p = 0.670	Supported
H3 (d) - Government regulation has a positive effect on cloud computing adoption	β = 0.054, t = 0.477, p = 0.634	Supported

5. Discussion and Conclusion

The primary objective of this study is set on evaluating the benefits of cloud computing in Small, Medium and Micro-sized Enterprises (SMMEs) in the Ngaka Modiri Molema and Bojanala Platinum Districts of the North West Province. As such to achieve this objective, the following sub-objectives were used. In order to realise the sub-objectives, a Conceptual Research Model based on the Technology-Organization-Environment (TOE) framework was utilised, centred around three (3) constructs, namely the technological, organizational and environmental constructs. Based on the results, technological context has a positive significant effect on the adoption of cloud computing practices. In addition, an analysis of the organizational context revealed that the organizational context had a negative and non-significant effect on the adoption of cloud computing practices. Lastly, an analysis of the environmental context revealed that the environmental context had a positive and significant effect on the adoption of cloud computing practices amongst SMMEs.

This study contributes to our knowledge on cloud computing adoption amongst Small, Medium and Micro-sized Enterprises (SMMEs), and used different attributes from previous studies to analyse the independent variables technology, organization and environmental contexts and their overall relation to the dependent variable adoption. Lastly this research can be used by cloud service providers and Small, Medium and Micro-sized Enterprise (SMME) business owners in their pursuit to adopt cloud computing practices within the North West Province context. Future research can be done at a large scale and longitudinal instead of cross-sectional.

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