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An assessment of resource utilization from traditional on premise computing to cloud computing in SMMES in Zimbabwe

by

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Abstract

This study investigates small and medium enterprises in Zimbabwe's IT sector to determine their perceptions of the benefits and limitations of cloud computing vs traditional on-premise computing, and to determine the viability of the cloud computing technology model in meeting the business goals of IT SMEs and ascertain how cloud computing and traditional computing security were perceived in order for I.T SMES to meet their business objectives. The findings revealed that respondents were IT consultants, IT managers, executive managers, middle managers, company owners, employees with IT expertise or knowledge, and IT specialists from each selected IT SME.Employees were the primary users of computing devices for the IT SMEs that participated in the study, followed by clients. According to the findings, IT SMEs operated in three sectors: computer/IT, mobile business, and digital solution. These organizations ranged in age from one to ten years.According to the research findings, 50% of respondents used cloud computing and 50% used traditional on-premise computing. The findings also revealed that 80% of traditional computing planned to use cloud computing, compared to 20% who did not plan to use cloud computing. According to the findings, traditional users were more likely to use SaaS than other cloud services.Users identified the following factors as important benefits in cloud computing: cost-efficiency, ease of implementation, scalability, time and cost savings, sustainability, customization, and virtualization.The findings revealed the following concerns and limitations in cloud computing: risks, availability, security issues, regulatory requirements, awareness, performance, impact of security, impact of challenges, impact of availability, trust and transparency, shared technology issues, disaster recovery, service level agreement, virtualization, and policy integration.

Keywords : Cloud computing , Traditional on-premise computing ,Cloud adoption , Service models

Declaration Page

I declare that this dissertation is my original work except where sources have been cited and acknowledged. The work has never been submitted, nor will it ever be submitted to another university for the award of a degree

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Dedication

This study is dedicated to my parents. From them I have the gift of Life and Education; the greatest gifts parents can give to their children.

This work is also dedicated to my siblings Tatenda , Hazel ,Chelsea , Lione and Jayden. Thank you for the encouragement when my levels of motivation ran low.

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Acronyms and abbreviations

CC	Cloud Computing
CSP	Cloud Service Provider
SMMES	Small Medium and Micro sized Enterprises
ICT	Information and Communications Technology
PaaS	Platform-as-a-Service
SaaS	Software as a Service
IaaS	Infrastructure as a Service

Chapter 1

1.1 Introduction

Traditional forms of Information and Communications Technology (ICT) were still used by businesses, particularly Small, Medium, and Micro-sized Enterprises (SMMEs) (ICT). These SMMEs, which were particularly important economic empowerment vehicles, share characteristics in that they were generally small, specialize in one field of work, and lack resource availability [1]. (SEDA, 2016). However, businesses of all sizes were being forced to adapt to changing market conditions as their clients/consumers become more technologically savvy. Small, Medium and Micro sized Enterprises (SMMEs) in particular should investigate and build their businesses around cloud computing services in order to achieve greater efficiency and effectiveness in their business functions and processes [2]. (Kumalo & van der Poll, 2015).

Cloud adoption is the most cost-effective option because it provides SMMEs with greater flexibility, accessibility, data security, and disaster recovery benefits. Furthermore, it provides SMMEs with a competitive advantage while saving money, allowing entrepreneurs to devote more time to core business processes and objectives. Mohlameane and Ruxwana (2014) Small, Medium, and Micro-sized Enterprises (SMMEs), the focus of this study in the Southern African context, refer to businesses that employ less than 200 people, employ approximately 60% of the labour force, and contribute approximately 34% of the GDP (GDP).

Cost savings in the information system define cloud computing adoption (IS). SMMEs can justify the flow of capital and operational expenditure by using this mechanism to pay for the services they use. Scalability allows SMMEs to tailor their IT needs at various stages of their life cycle, as well as respond to IT needs for specific projects. Accessibility and flexibility enable SMMEs to use their information needs from anywhere using simple end-user programs. Innovation is another important cost-cutting mechanism for SMMEs because it ensures that service providers bear the costs of R&D, resulting in increased access to resources [4] (Chovancová, L.Vokorokos, & Chovanec, 2015).

1.2 Background

Cloud computing is the provision of computer resources and IT infrastructure such as servers, storage, databases, networking, software analytics and intelligence over the internet ("the cloud"). Because cloud computing uses the internet to deliver these services, it does not have to be constrained by physical infrastructure, the same way a physical data centre is. Though complementary in purpose, data centres antagonize cloud computing in that the owner assumes full responsibility of all the facets of the datacentre from hardware, location, human recourses. Whereas cloud computing propounds a shared responsibility model in which the owner is responsible only for the data stored in the cloud, the devices that are allowed to connect to your cloud and the accounts / identities of the people, services and devices within your organization. The physical data centre, network and hosts are all taken care of by the cloud provider. A cloud provider is a company that assumes the responsibility of providing cloud services to consumers; example of cloud providers are Microsoft, AWS and Google Cloud.

With cloud computing being such a hotcake, it is easy to get caught in the euphoria and ignore the facts surrounding it. This research aims to explore resource utilization from traditional datacentres in Zimbabwe to the cloud, focusing mainly on the following attributes

- · Cost.
- · Speed.
- · High availability.
- · Productivity.
- · Performance.
- · Reliability.
- · Policy management
- · Security.

So as to establish a factual blueprint through which cloud adoption can be achieved and promoted in Zimbabwe; put simply, is cloud adoption worth it?

1.3 Statement of the problem

Cloud computing is gaining traction in the market, and this trend is expected to continue, but it is still in its early stages and far from mature. As a result, it is unclear whether Cloud-related concerns are justified in the long run, and whether total cost of ownership (TCO) is advantageous to customers when compared to owning the systems. Doubt is instilled by those with a vested interest in an old computing model versus the new. As a result, one of the top concerns that decision-makers, who are clients of IT services, have about the Cloud is the integration of risks and costs.

It was critical to conduct this research for the following reasons:

- There is a high likelihood that SMEs in Zimbabwe's IT sector will continue to use legacy systems with little knowledge of how to improve their business processes.
- There was a good chance that SMEs in Zimbabwe's IT sector will continue to lack the knowledge needed to improve their business processes in order to compete or gain a competitive advantage.
- There was a high likelihood that SMEs in Zimbabwe's IT sector will be unable to maximize profit on new technologies while also playing a meaningful role in aligning IT with their business processes.

1.3 Justification/ rationale

The researcher's passion for contemporary cloud computing advances and its globalization were only two of the many factors that led to the study's selection. The goal of the study is to support IT decision-makers in maximizing cloud computing while concentrating on their core businesses. The study was chosen by the researcher to learn more about how non-users view the advantages, problems, and restrictions of traditional on-premise computing and the cloud.

The unfavourable effects of not doing such a study include; Since there was insufficient information on cloud computing for IT SMEs in Zimbabwe, it's possible that they won't be able to achieve all of their business goals. In Zimbabwe, the likelihood of IT SMEs not upgrading beyond their current legacy technologies may still be higher.

1.4 Research Objectives

1. To ascertain IT SMEs' perceptions of the benefits of cloud computing technology versus traditional on-premises computing.
2. To evaluate IT SMEs' perceptions of the limitations and challenges of cloud computing versus traditional on-premises computing.
3. To determine the viability of the cloud computing technology model in meeting the business goals of IT SMEs.
4. To determine how the security of cloud computing and traditional computing was perceived in order for I.T SMES to meet their business objectives

1.4.1 Research Questions

1. What are the perceived benefits of cloud computing technology compared to traditional on-premises computing among IT SMEs?

2. How do IT SMEs perceive the limitations and challenges of cloud computing compared to traditional on-premises computing?

3. Is the cloud computing technology model viable in meeting the business goals of IT SMEs?

4. How was the security of cloud computing and traditional computing perceived by IT SMEs in relation to meeting their business objectives

1.5 Significance of study

The primary goal of the study was to assess the resource allocation of traditional on-premise computing and cloud computing in small and medium enterprises in the IT sector, as well as their perceptions of the benefits and risks associated with both computing methods.

1.5.1 Assumptions

- Public cloud is much more cost effective than private cloud.

- The cloud is less expensive than traditional on-premise computing.

1.6 Limitations of the research

1. A limitation was the use of the mixed-research method, as well as the method's complexity. Measures were taken to ensure that the method was appropriate for this study, taking into account previous studies on cloud computing versus traditional on-premise computing.
2. Another limitation of this study was the lack of other methods for collecting, analysing, and interpreting data. Measures were taken to ensure that only methods capable of producing reliable results were used for the purposes of this study.
3. Another limitation of this study was the use of the conceptual framework. There could be other relevant constructs that were not considered in this study.

1.7 Delimitations of the research

In the project, we primarily compared the utilization of resources by Cloud Computing and traditional on-premises for SMMES to determine which was a better option. We also considered some disadvantages and risks. One ambiguous factor, for example, was that many scholars are debating was the risk management issues associated with implementing a cloud computing service. We were unable to provide specific information on which services fit better into which industries in this paper. However, in the conclusion section, we made recommendations to the companies we studied in order for them to benefit from a cloud transition and reduce their costs. These recommendations can be applied to other similar IT firms. As a result, it was the company's responsibility to select the best services according to their needs.

Chapter 2

2.1 Literature review

Cloud computing is not a novel idea in the field of information systems. Instead, it is an evolutionary concept derived from grid computing, which sought to solve complex problems through parallel computing. This was followed in the 1960s by utility computing, which provided computing solutions as a metered service. Finally, in the early 2000s, Software-as-a-Service (SaaS) was introduced, allowing end users to subscribe to web services. Gustafson and Norgren (2012) The National Institute of Standards and Technology defines cloud computing best. (NIST) (Alshamaileh, 2013). (Alshamaileh, 2013). This definition highlights six (6) key factors that characterize the concept of cloud computing: cloud computing is defined as an on-demand self-service, it depicts an aspect of multi-tenancy and resource pooling, it promotes rapid elasticity and ubiquitous access, it is a measurable/payable service, and it encourages resiliency. Second, cloud computing is linked to three major service/delivery models: Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS), and Infrastructure-as-a-Service (IaaS), and provides a cost-effective alternative to traditional Information Technology department outfits. Finally, cloud computing is made up of four deployment models that encompass the cloud's underlying structure. Public, private, community, and hybrid clouds are among the deployment models available. In essence, cloud deployment models represent the different types of cloud environments that cloud customers and organizations can choose from and are distinguished by ownership, size, and access. Ambrose, Dagland, and Athley (2009)

Cloud computing services

According to the National Institute of Standards and Technology (NIST), cloud computing is made up of three service models that encompass the cloud's underlying structure. These main service/delivery models include Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS), and Infrastructure-as-a-Service (IaaS) and offer a more cost-effective alternative to the traditional models. 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

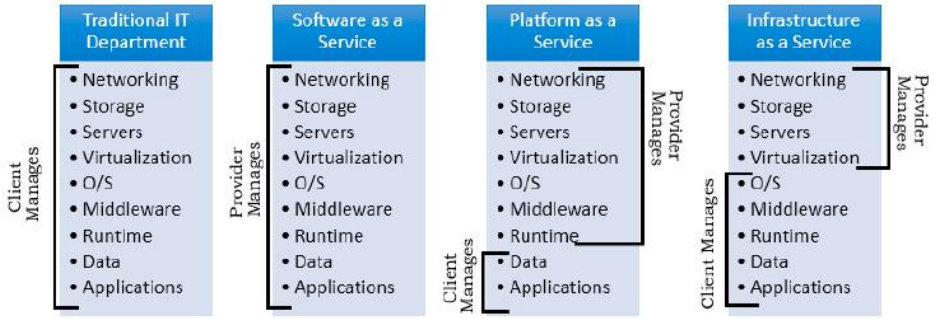

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Figure 1 Traditional IT outfit versus the cloud adapted from [13] (Dufrasne, et al., 2015)

The most basic type of cloud computing service/delivery model available is software-as-a-service (SaaS), which is used without realisation. SaaS was created with end users in mind, allowing them to interact with web-based applications over the internet without having to install software on their computers. To access a specific service, the cloud customer logs into a web service using a web browser [8] Vaskovich, 2015). Platform-as-a-Service (PaaS) is a cloud service/delivery model designed specifically for application developers. Application developers can use PaaS to develop, test, deploy, host, and maintain web applications and software over the internet without installing base software on their computers.

Due to the high costs associated with purchasing development software, PaaS provides a less expensive alternative because the disadvantages of directly owning such software are passed on to cloud service providers; additionally, cloud customers can enjoy benefits such as elasticity, efficiency, and workload management [9]. Gorelik (2013) Infrastructure-as-a-Service (IaaS) is a cloud service/delivery model designed with network architects and organizations seeking to outsource their IT infrastructure in mind. This shift is being driven primarily by cloud customers' desire to drastically reduce Information Technology costs while remaining highly competitive in their respective industries. Furthermore, IaaS exposes a cloud customer to expensive technologies that are out of reach for the cloud customer, as well as a simplified, cost-effective management of Information Technology infrastructure, allowing cloud customers to rent/use a service that best suits their needs [9]. Gorelik (2013)

An Overview of Traditional On-Premise

Traditional On-premise IT infrastructure includes systems, hardware applications, and software applications. With an on-premise system, you have complete control over your

servers and can personally oversee system maintenance. Until cloud computing gradually took over, on-premise systems were the standard method. The local storage and physical maintenance of systems is one of the major differences between cloud computing and on-premise computing.

If a company opts for a Traditional on-premise system, it is responsible for installing in-house servers and related hardware. The company will also need to hire IT staff to keep the infrastructure running smoothly and prevent system failures that could lead to data breaches and data losses. Traditional On-premise software, also known as "Shrink-wrap software," requires a license per server, after which the servers are completely the responsibility of the company, including management and security. Businesses, on the other hand, can request after-sales technical support from their vendors.

Traditional on-premise systems are ideal if your company requires customizable hardware or systems that can be built to your specifications. On-premise systems, on the other hand, have less scalability. Because you do not need internet access or connectivity to access your required software when using on-premise, there is less opportunity for time waste.

Key Differences of Traditional On-Premise vs. Cloud

As previously stated, there are several fundamental differences between an on-premises and a cloud environment. Which path is best for your company is entirely dependent on your requirements and what you're looking for in a solution.

Deployment

On-premises: Resources are deployed in-house and within an enterprise's IT infrastructure in an on-premises environment. An enterprise is in charge of maintaining the solution and all of its associated processes.

While there are various types of cloud computing (such as public cloud, private cloud, and hybrid cloud), in a public cloud computing environment, resources are hosted on the premises of the service provider, but enterprises can access and use as much as they want at any given time.

Cost

Enterprises that deploy software on-premises are responsible for the ongoing costs of server hardware, power consumption, and space.

Cloud computing: Businesses that choose to use a cloud computing model only pay for the resources they use, with no maintenance or upkeep costs, and the price adjusts up or down depending on how much is consumed.

Control

On-premises: In an on-premises environment, businesses keep all of their data and have complete control over what happens to it, for better or worse. Because of this, companies in highly regulated industries with additional privacy concerns are more likely to be hesitant to jump into the cloud before others.

Cloud computing: In a cloud computing environment, many companies - and vendors - have struggled with the issue of data ownership. Because data and encryption keys are stored by your third-party provider, you may be unable to access that data if the unexpected occurs and there is downtime.

Security

On-premises: Companies with highly sensitive information, such as the government and banking industries, require the security and privacy that an on-premises environment provides. Despite the cloud's promise, security is a primary concern for many industries, so an on-premises environment, despite some drawbacks and a higher price tag, makes more sense.

Cloud: Security concerns continue to be the most significant impediment to cloud computing deployment. Many publicized cloud breaches have occurred, and IT departments around the world are concerned. Security threats range from employee personal information such as login credentials to intellectual property theft.

Compliance

On the Property: Regardless of the industry, many businesses nowadays operate under some kind of regulatory oversight. Although the Family Educational Rights

and Privacy Act (FERPA), which incorporates comprehensive student records, and other governmental and industry rules are among the others, HIPAA, which protects private health information, is arguably the most well-known. It is crucial for businesses who are subject to these requirements to maintain compliance and to always be aware of where their data is.

Cloud: Enterprises that do choose a cloud computing model must do their due diligence and ensure that their third-party provider is up to code and in fact compliant with all of the different regulatory mandates within their industry. Sensitive data must be secured, and customers, partners, and employees must have their privacy ensured.

Key similarities between the Traditional On premises and Cloud

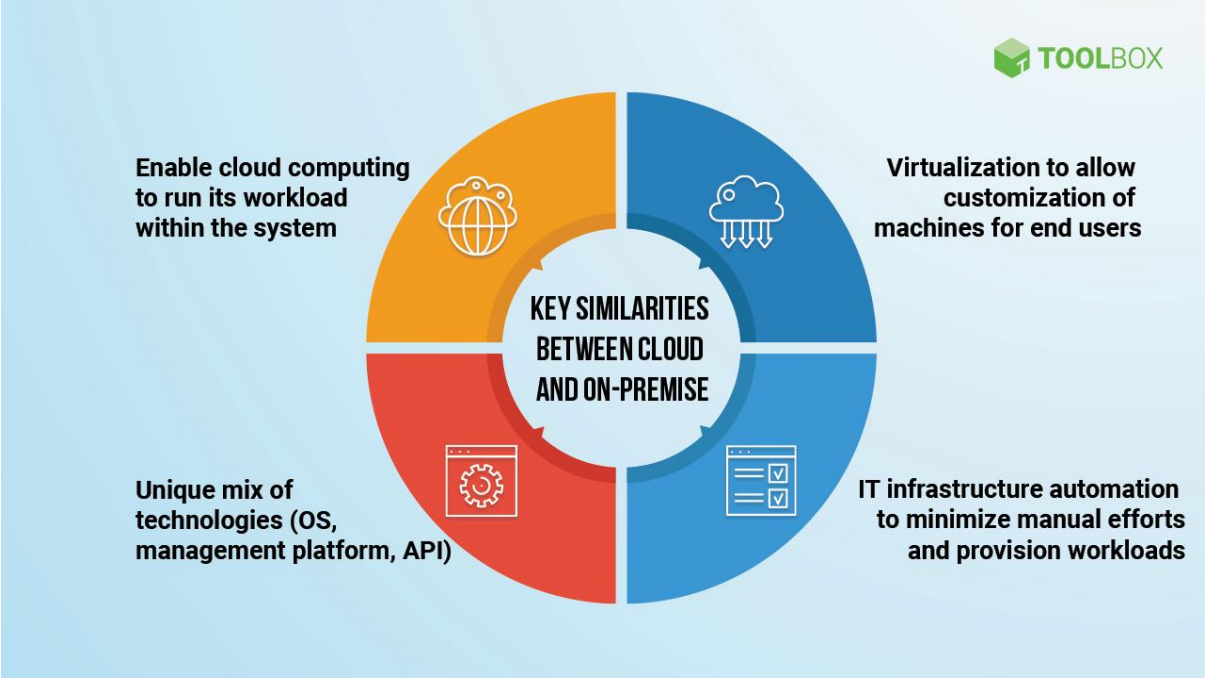

Figure 2 **Key similarities between the Traditional On premises and Cloud**

On-premise solutions deal with infrastructure at organizational premises or on-site, whereas the cloud manages infrastructure over the network. However, creating agile IT infrastructure is the key objective of both of these solutions in order to save organizational expenses and maintenance demands. Small businesses have found the cloud to be more economical and convenient since it provides flexible

and agile integrations at reasonable prices. Nevertheless, there are some parallels between the two strategies.

Cloud Advantages

1. Cost-Effective

The affordability of cloud computing systems is a big benefit. Businesses should not be concerned about maintenance and upgrade costs when using cloud computing systems; they should only be concerned about the subscription cycle.

With cloud computing, a company can avoid the trouble of maintaining physical infrastructure, which can break down and result in data loss or theft. The company saves thousands of dollars as a result.

2. Accessibility

Systems for cloud computing make it simple and hassle-free to access software, data, and services online. Use any device to instantly access the applications you desire.

Due to their ease of access to cloud storage and ability to readily share information within themselves, this accessibility also aids in boosting group cooperation, which boosts productivity.

3. Easy Installation

Cloud computing is simple to implement and can be set up in a matter of hours, unlike on-premise systems that require considerable installation time. A skilled service provider can quickly install cloud computing systems on your servers, saving your company a ton of time.

On-Premise Advantages

On-premise systems were widely used for several advantages:

1. Absolute Control

With on-premise, you have complete control over the data, hardware systems, and software. You can even closely observe the upkeep procedures. You also get to decide which upgrades to make.

2. No External Factors

On-premise systems can save you a ton of time when it comes to accessing the software because internet connectivity and other outside factors are not relevant in this case.

2.2Theoretical framework

The Conceptual Research Model of this study as 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).

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

2.3 Relevance of the Theoretical Frame to the Study

According to Fenerlicht (2010), cloud computing adoption is perceived as a distinct scenario when compared to other traditional innovation adoption and diffusion models. It has been discovered that cloud services are provided to businesses by a third party known as a cloud service provider.

Cloud computing, like other conventional innovations, has three key players: cloud-based services, cloud computing users (clients), and cloud service providers (Dargha, 2009). The use of cloud computing resources is influenced by three key factors: cloud computing technology characteristics as a technological context, firm or organization characteristics as an organizational context, and third-party characteristics as an environmental context (Louw, 2013).

Previous studies on technology adoption have identified a gap in that they have only identified the technological determinants of cloud computing (Low et al., 2011). As a result, the TOE conceptual framework will be useful in explaining the adoption and use of cloud computing by SMEs in Zimbabwe's IT sector.

Summary

Chapter two presented a literature review of cloud computing and traditional on premise to establish the need for this study. There was a need to use a more comprehensive definition of cloud computing and on-premise computing in order to provide a direction for this study. A number of services in cloud computing were highlighted although their development keeps on expanding on daily basis. A comprehensive list of cloud computing and on-premise benefits is provided in this literature to create awareness in the adoption and usage process.

Chapter 3

3.1 INTRODUCTION

This section provided a concise and clear description of the study's methodology. The study employed a mixed methods approach. Mixed methods research is defined by Johnson, Onwuegbuzie, and Turner (2007) as being a type of research in which the researcher combines quantitative and qualitative research techniques, methods, approaches, concepts, or language into a single study or group of related studies

As a result of the limitations of both quantitative and qualitative methods, mixed methods research has evolved (Venkatesh, 2013). Mixed research has emerged as an option, providing richer insights into the phenomenon under investigation, expanding the body of knowledge, and providing the potential for robust research (Caruth, 2013).

3.2 The Research Design

The study collected data using both qualitative and quantitative methods. The qualitative data technique was regarded as a methodical mode of investigation into complex social structures, interactions, or processes.

Bhattacherjee (2012) and Saunders et al. (2009) are two examples. According to Bhattacherjee (2012), the technique is applicable to textual data rather than quantitative or numeric data. The technique makes sense of the phenomenon in its socio-historic context by using subjective interpretations of the actors involved (Bhattacherjee, 2012).

3.3 Population and Sampling

The study focused on IT SMEs in Zimbabwe. The study identified one decision-maker from each selected IT SME, including IT managers, IT middle managers, IT specialists, executive managers, consultants, and employees with IT knowledge and skills. These decision-makers

from each IT SME were chosen because they have an impact on the alignment of IT business goals and their perspectives constantly shaped the organization's direction.

3.3.1 Sampling techniques and population

The sample for this study was selected using an online resource in order to compile a list of SMEs that satisfied the criteria set in this study, namely:

- Have a small market share.
- Be managed by an owner.
- Be independent.
- Be the size of the firm in terms of its contributions as compared to other firms in the country.

Respondent segments	population	selected sample	usable sample
I.T Managers	5	3	2
I.T Specialists	20	18	10
I.T Consultants	50	30	10
Total	75	51	32

Table 1- SAMPLING

3.4 Data Collection Instruments

Interviews

The decision to use interviews as a research instrument was influenced by the need to learn more about the topic under investigation. According to Saunders et al. (2009), interviews are typically associated with qualitative research, and the instrument presents its benefits and drawbacks.

When employing interviews for this research, the researcher considered both their advantages and disadvantages. It was possible to receive further, more detailed information. The interviewer can make the interview method produce any almost ideal sample of the general population by using her skills to overcome any resistance from the responder. There was always the option to rearrange questions, particularly in the case of instructional interviews, so there was more flexibility under this approach. Also, simple to collect under this approach was personal information. To minimize misunderstandings regarding questions, the language of the interview was adjusted to the interviewee's aptitude or educational level.

However, there were certain flaws in the interviewing techniques as well. Among the most significant flaws mentioned are the following:

It was an extremely expensive strategy, particularly when large groups and a geographically diverse sample were used. The challenge of monitoring and control of interviews still existed, as did the possibility of interviewer and respondent prejudice. As a result, the data may have turned out to be insufficient for some respondents, such as CEOs or members of high-income groups who were difficult to reach using this strategy. This approach took a bit longer, especially because the sample size was high and calls to the respondents were required.

Questionnaires

Associated with quantitative research, questionnaires were intended to capture responses in a standardized manner. This method of data collection was quite popular. Sedgety (2007) notes that a questionnaire was a method being adopted by private individuals, research workers, and even by governments. A questionnaire consists of several questions printed or typed in a definite order on a form or set of forms. Blaxter (1998) notes that questionnaires are modelled to the respondents who are expected to read and understand the questions and write down the reply in the space provided or meant for the questionnaire itself. In this case, the researcher constructed 10 questionnaires with 15 questions in each copy thus, she sent the forms to the respondents and asked them in kind to answer them and collected them later for data analysis purposes

However, there are advantages of using questionnaires. There was low cost even when the universe was large and widely spread geographically. It is free from the bias of the

interviewer; answers are in the respondents' own words. Respondents had adequate time to give well-thought-out answers. Respondents who were not easily approachable were also reached conveniently. Large samples can be made use of and thus the results can be made more reliable.

The disadvantages of questionnaires are that there was a low rate of return of the dully filled in questionnaires gives a bias to the no response was indeterminate. It can be used only when respondents are educated and cooperating. The control over questionnaires may be lost once it is sent. It was difficult to know whether willing respondents are truly representatives. There is no room for probing or clarification. People may give the same answer but with different meanings. Validity can be reduced by respondents' inability or unwillingness to give information

To overcome these challenges the researcher followed the questionnaire designing guidelines such as the need to avoid ambiguity, the wording should never give clues about preferred responses, and also the need to carry out a pilot study to assess how effective the questionnaire was in producing the intended results. Since the questionnaires were going to be given to I.T consultants during work hours and collected by end of the day there was going to be a challenge concerning low returns

Before using this method, the researcher was willing to conduct a pilot study for testing questionnaire

3.5 Pilot Study

Given the study's complexity, a pilot study was required before the administration of the research instruments and data collection. All research instruments, including interviews and questionnaires, were tested to improve the standard and effectiveness of the instruments. The pilot study was carried out in two stages: first, the pilot interview schedule was implemented, followed by the pilot questionnaires.

3.6 Data collection procedure

This study collected data using both primary and secondary sources. Questionnaire interviews were used to collect primary data from I.T managers and consultants working in I.T SMEs in Zimbabwe. Face-to-face interviews were held. In addition to primary sources, the study relied on secondary data from the internet, journals, textbooks, and existing environmental literature to obtain information on resource utilization. The use of these data sources allowed the study to obtain useful historical and current information.

3.7 Analysis and Organization of Data

All gathered data was summarised, analysed, and presented in the form of tables and graphs (descriptive analysis). The analysis will be made quantitatively and qualitatively. Variables were key elements in the research. Variables are anything that can affect or change the results of a study. I.T professionals were the key participants in the research and they were be categorized according to their position in the organization and how both cloud and on-premise computing affects them. These variables were useful in analysing the causal effects of one variable to another as far as the impact of resource utilization in cloud computing and traditional on-premise was concerned

3.8 Ethical Consideration

The researcher considered the following ethical issues and made it clear that they were to be strictly adhere to throughout the research. To ensure that research was carried out in a way that was in the best interests of all participants and third parties, the researcher asked for permission at every stage of the process whenever it involved other people. They also ensured that they obtain informed consent and followed the restrictions and limits imposed on them in terms of information passing.

As was the case, the researcher first provides the best solutions for the protection of participants who requested privacy in order to keep them safe. It was also to be seen that they ensured the confidentiality of any research data that the owners did not want disclosed. All participants' needs were met honestly and without deception.

People's rights were to be respected regardless of age, race, or gender. Business personnel who provided information for this study may have been well-known individuals, and their positions were to be well recognized while ensuring that their dignity was maintained. Some

information holders may have been vulnerable individuals, and this was also considered. The researcher's primary goal was to protect the identities of all participants while avoiding any form of cohesion.

3.9 Summary

This chapter focused on the research design which deals with plans and procedure to do with sampling data collection using various techniques such as interviews, observation and questionnaires. This chapter also looked at organization of data and ought to employ tables and bar graphs for data interpretation. Ethical issues in research such as informed consent and confidentiality have been selected to be used in the research for protection of participants.

computing, as well as to assess the extent to which cloud computing services are used. This chapter discusses the study's qualitative findings and quantitative analysis. The qualitative findings and quantitative analysis are an important part of this study because they help to establish the main categories/themes relating to the respondents' perspectives

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Chapter 4

DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 Introduction

The research aims to investigate the perceptions of IT SMEs regarding the benefits and limitations of cloud computing technology compared to traditional on-premises computing. Additionally, the study seeks to determine the viability of the cloud computing model in meeting the business objectives of IT SMEs, as well as assess the perceived security levels of cloud computing and traditional computing in helping IT SMEs achieve their business goals.

COMPANY SIZE	PERCENTAGE
0-50	12.5%
50-250	37.5%
250 >	50%
TOTAL	100
Business sector	
Computer, IT	60%
Mobile	15%
Digital Solutions	25%
TOTAL	100%
Role In Company	
CIO	0%
IT manager	25%
Cloud architect	0%
Team leader	12.5%
Prefer not say	25%
Software developer	0%
CTO	0%

CEO	0%
Total	100%
Solution used	
Public cloud (owned and managed by an unrelated business)	12.5%
Private Cloud (owned and managed internally)	37.5%
Hybrid cloud (some services hosted internally and some hosted in the public cloud)	50%

Table 4.1.0 Shows the socio-demographic characteristics of the participants (SMEs).

Table 4.1.0 shows the respondents' and organizations' backgrounds. This category's theme codes include: role in the organization, business sector or process, size of the organization, duration in business, and specific software used or loaded.

Interview Success Rate

The interview method was used to collect data from I.T. firms in Zimbabwe. Figure 4.1 presents the data collection success rate based on the use of the interview method.

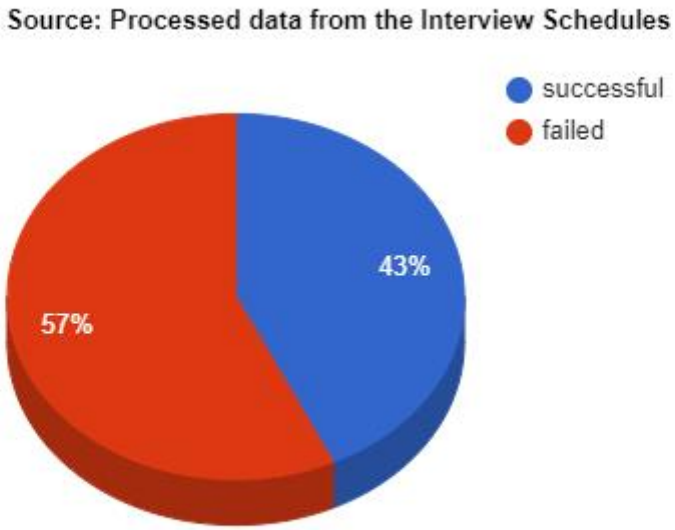

Figure 4.1

Figure 4.1 shows that from the 11 interviews scheduled with the managers, only 4 were conducted, giving a response rate of 43%.

Questionnaire response rate

The pilot interviews

Three people participated in the pilot interview. A formal meeting was scheduled with the organization's managers or decision-makers.

Changes become apparent after administering the interview instrument. The schedule for the pilot interview did not provide enough information about business processes, computing device types used in the organization, or primary users of computing devices in the organization.

Another significant change that resulted from the pilot interview was the absence of follow-up questions to a number of critical interview questions. According to the pilot findings, questions about cloud computing challenges, security issues, and availability issues were not adequately addressed. There was a need for more information in this regard.

The pilot questionnaire

Four people participated in the pilot questionnaire. The final research instruments were modified after the survey was administered. There was a need to add employees with IT knowledge or expertise in the section of the respondents' current position to ensure that not just any employee answered the survey, and this should be aligned with the criteria set in the selection of respondents.

Another significant change brought about by the pilot study's administration was the need to expand cloud computing services. The previous questionnaire did not provide respondents with enough information to choose from among the cloud computing services. A list of examples describing services for SaaS, IaaS, and PaaS was added.

4.2 Data Presentation and Analysis

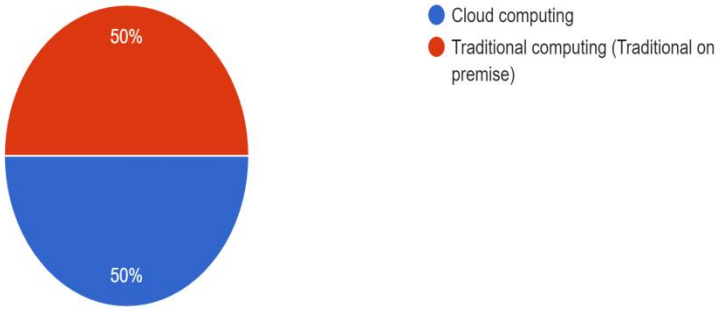

Figure 4.2 -Adoption levels of cloud computing

The graph above (Fig. 4.2) depicts the percentage of respondents who used cloud computing in their business operations. According to the findings, 50% of respondents used cloud computing and 50% used traditional computing. According to the research findings, an equal number of respondents used cloud computing for their business operations. The findings were significant in determining the number of Zimbabwean IT SMEs that have adopted cloud computing. Despite the fact that most businesses in Zimbabwe are still using traditional computing, most have expressed an interest in moving to cloud computing. The cloud computing discussion could not be expanded because it was still necessary to identify the types of cloud services used by respondents.

Lack of adoption of cloud computing / Adoption of Traditional Computing

This theme code addresses the use of traditional computing versus the lack of use of cloud computing services. According to the findings, 50% of respondents did not use cloud services. The findings of this theme code and possible reasons for not using cloud computing will be discussed further below.

The following section discusses the levels of adoption of cloud computing services by users. The figure below represents the levels of adoption of cloud computing by users.

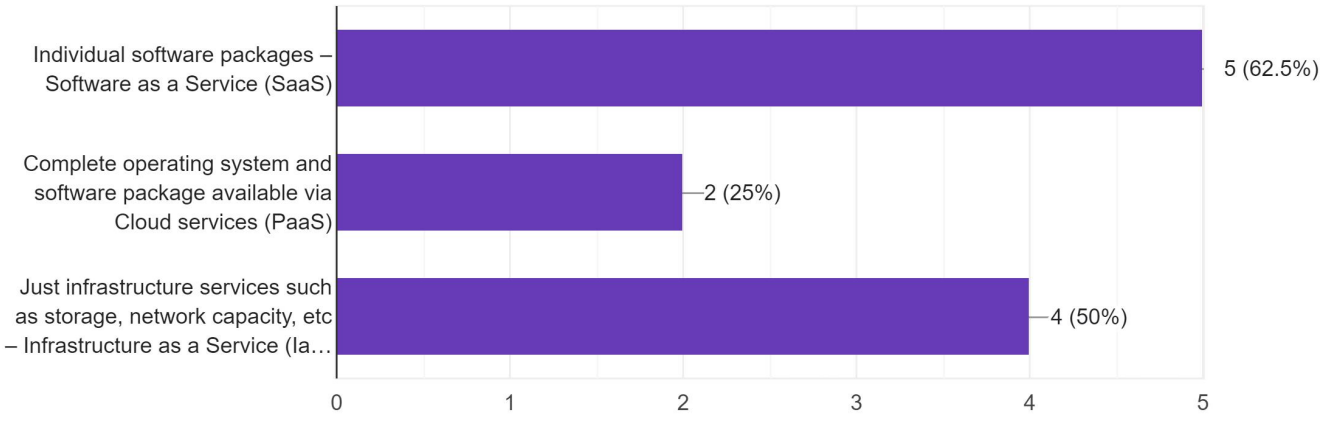

Figure 4.3

According to the findings in Fig 4.3, 62.5% of users used SaaS, while the remaining users did not. Brown and Madden (2012) provided extensive information on the adoption and use of SaaS among SMEs. These findings were also discussed in a section of the literature review by Erol et al. (2012) and Tredger (2013), who argued that SMEs were considering the use of these readily available cloud services for business operations. It was necessary to evaluate the services used in the adoption of SaaS among cloud computing users.

According to the findings, 50.0% of users used IaaS, while 50.0% did not. Despite the fact that the findings indicated a negligible level of IaaS adoption among SMEs, these findings were discussed in the literature review. According to Avram (2014), adoption and usage of IaaS were deemed to be lower than those of SaaS.

According to Awa et al. (2012), the adoption and usage of cloud services should be dependent on the level of technological change and business transformation. Furthermore, Avram (2014) reported that organizations shifted to IaaS after becoming acquainted with SaaS usage. Other services, he explained, could be implemented in the process depending on the level of transformational needs required.

This theme delves into the use and adoption of PaaS. The provider gains control of the system software and computing resources through the service (Singh and Seenham, 2013). According to the findings, 25% of respondents used this service. The review of literature discussed the low levels of adoption and usage of PaaS among SMEs. According to the literature, the lack of adoption or non-use of PaaS among SMEs could be due to a lack of transformation needs or business processes in the organization (Matuszak and Lamoureux, 2013). According to Awa et al. (2012), the low adoption rate of PaaS by SMEs may be explained by users' lack of knowledge about the service and its benefits.

According to the Deloitte 2012 report, the slow adoption or lack thereof was not only an African phenomenon but also an international phenomenon. This literature supported the research findings.

This section discussed the use and adoption of cloud computing services by SMEs in Zimbabwe's IT sector. The findings provided additional information on the various types of organisations organizations to adopt and use cloud computing. According to the research findings, respondents used IaaS in the form of Dropbox and Google Drive. According to the findings of the study, IaaS adoption was lower than that of SaaS.

The research findings on these two services, namely, SaaS and IaaS, provided enough evidence to assess the usage and adoption levels by SMEs in the IT sector. According to the research findings, only a few respondents used PaaS. The literature has extensively reported on SMEs' lack of or low adoption of PaaS services. Arpaci et al. (2012) attributed the lack of adoption of this service to a lack of awareness, competency, or IT skills in cloud computing technologies. According to the literature, the level of transformation required by the business could also be a factor in determining whether or not to adopt some of these services. According to Matuszak and Lamoureux (2013), organizations that did not yet see the need for additional business transformations or upgrades were hesitant to use or adopt some of these cloud services.

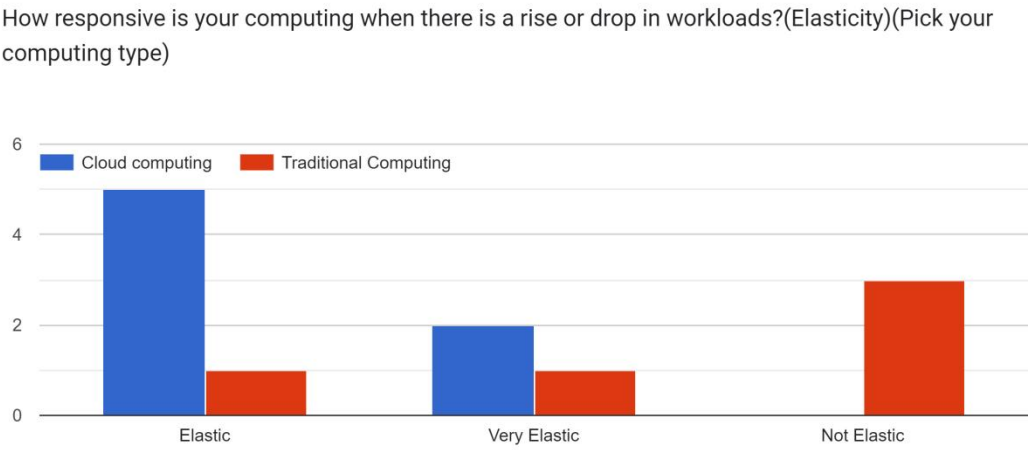

Figure 4.3.1

Fig 4.3.1

In terms of actual utilization, elasticity was a major concern, especially for organizations that are still using traditional computing, as shown in Fig. 4.3.1. The 3 companies struggled with elasticity due to the use of traditional computing and claimed that they could not meet dynamic changes in resource needs, which can increase or decrease. However, those with cloud computing were able to meet the sudden up-and-down surge in the workload for a short period of time.

Scalability provides a greater ability to manage IT resources and accommodate growth as in by meeting their needs. The findings could also imply that respondents regarded the theme's high level of customization and flexibility in the cloud as an important contribution to the long-term viability of their businesses.

Traditional IT infrastructure can only use hardware that is on-premises. When one's processing power or storage space runs out, the only option is to rent or buy another server. Furthermore, if they decide to expand the team, they will need to buy more computers as well as software licenses to go with them. not to mention that the IT department will have to manually implement the changes.

Figure 4.4. 1

Fig. 4.4.1 shows that organizations have reduced the upfront capital and operational costs associated with technology implementation and maintenance. They reported that the cost of cloud computing implementation and maintenance has been drastically reduced, and that cost savings have increased as a result of cloud computing adoption and usage when compared to traditional computing. Furthermore, Erolet et al. (2012) contend that cost-efficiency enables SMEs to compete both nationally and internationally, which many SMEs are unable to do due to the high initial costs and capital required to run their businesses. With traditional computing, an organization had to fully replace old equipment, which was worth thousands of dollars, with new equipment to keep up with the competitors. Of which most of the companies in Zimbabwe would rather work with the old equipment than replace it.

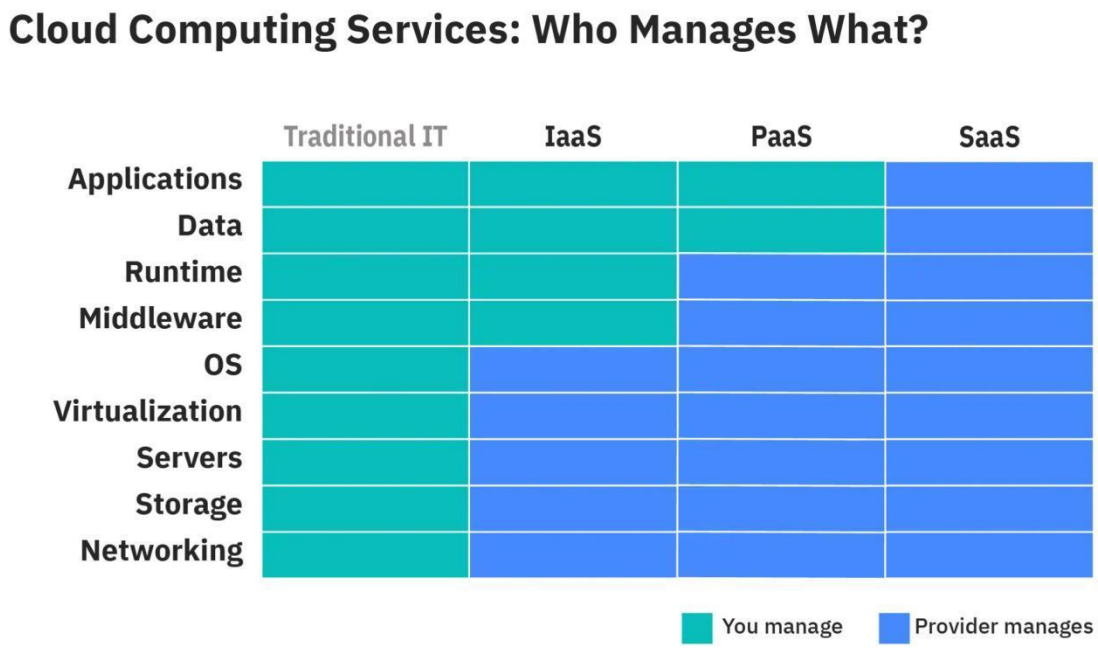

Figure 4.4. 2

Greater mobility can be defined as the ability to move and adjust resources to meet the needs of customers. The research findings could imply that respondents perceived this benefit when, according to Ogwel (2013), organizations that adopted cloud computing also established this theme as a benefit.

Cloud computing appears to be lagging behind, as the security metrics of a cloud-based facility are less promising than one might expect. During the research findings, many organizations sided with this because anyone with an internet connection and possible access to your cloud with valid credentials can take the reins, compromising your presence on the internet and the data on which you rely so heavily.

Traditional IT security typically entails an on-site IT team managing and maintaining physical, on-premises computing components involved with network security and data storage. Its processes aid in the security and monitoring of any unauthorized access, malicious software, or other threats attempting to exploit your data, resources, and applications via the local network and on-site servers.

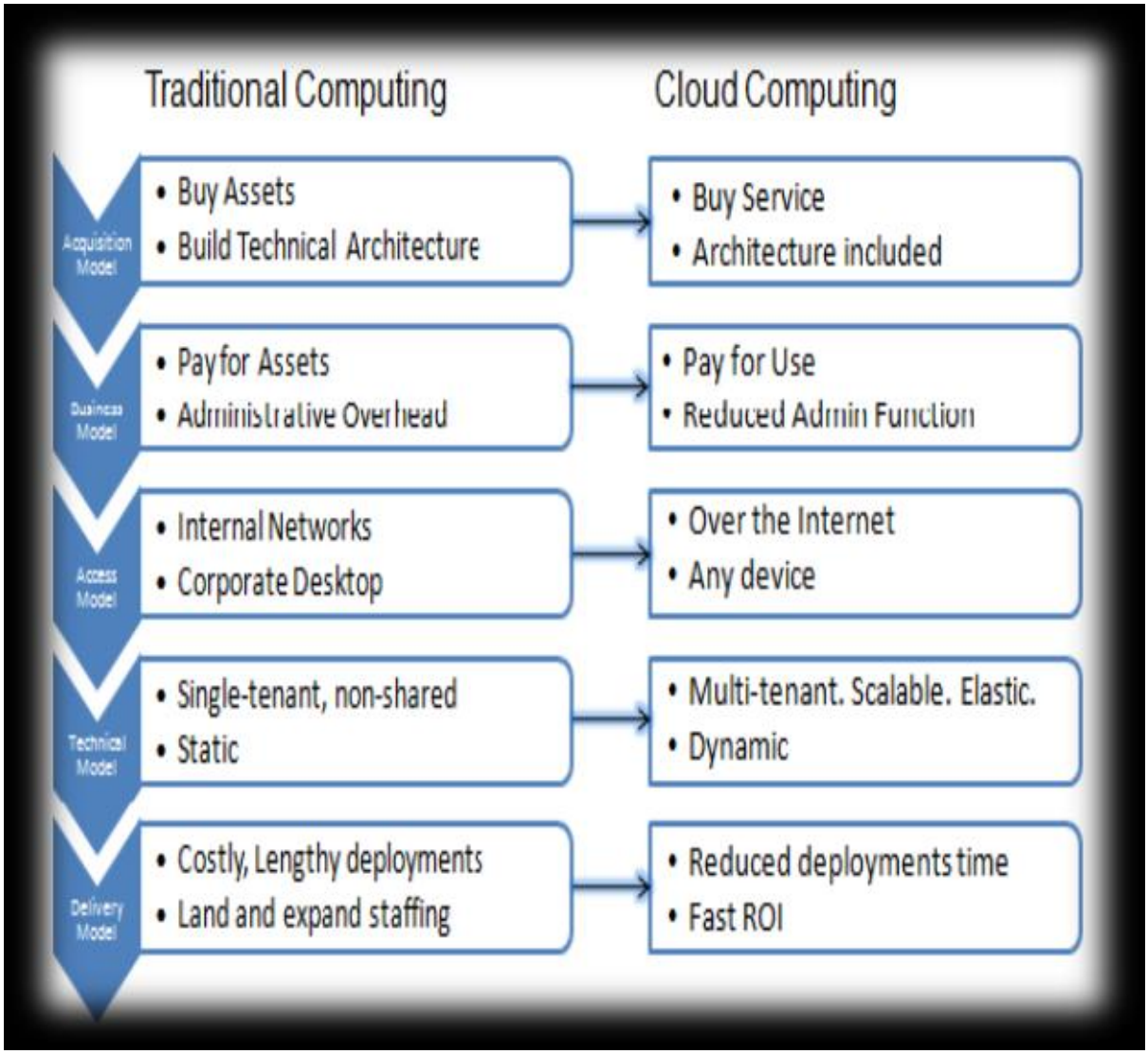

Figure 4.4. 3

Benefits and usefulness of using cloud computing and Traditional computing

	Cloud computing	Traditional Computing	Others (neither agree or disagreed)
Awareness	50%	50%	0%
Cost efficiency	60%	10%	20%
Cost savings	70%	5%	20%

Flexibility	70%	15%	15%
Greater mobility	85%	3%	22%
Customisation	85%	10%	5%
Maintenance/low implementation	80%	5.4%	14.6%
Scalability	88%	4%	8%
Agility	75%	19%	6%
Sustainability	67%	20%	13%
Virtualisation	75%	20%	5%
High performance	80%	15%	5%
Better IT resource management	75%	10%	15%
Improved automation	75%	10%	15%
Improved security	80%	20%	0%

Table 4.5 1: shows the benefits and usefulness of cloud computing and traditional computing

Awareness

This section discusses awareness as a benefit of cloud computing. Awareness was regarded as an important aspect of cloud computing because it represents factors related to skills, competency level, and technological know-how in terms of cloud computing adoption and usage. According to the literature, respondents' decisions to use and adopt cloud computing were heavily influenced by their level of awareness, as discussed by Arpaci et al. (2012). According to Awa et al. (2012), there was a link between technology awareness and usage, which should result in the greatest benefit to the organization. The research findings revealed that organisations that were aware of cloud computing were in a better position to relate to its benefits as compared to organisations that were not

Cost

One of the most important adoption factors motivating SMEs to migrate IT resources to cloud services was cost. The utility and scalability of cloud computing provide enormous economic benefits to SMEs when provisioning, renting, or hiring IT services. SMEs have limited IT resources, making it difficult for them to have a functioning ICT department in-house; however, cloud adoption allows them to deploy applications and data with no upfront cost. It will also eliminate capital expenditures for hardware, software, licensing, and personnel to maintain the data centre (Armbrust et al., 2010; Garg and Buyya, 2020). According to Benlian and Hess (2011), "cost advantages are the strongest driver influencing IT executives' perceptions of SaaS opportunities" (Benlian and Hess, 2011).

According to the findings, 60% of respondents strongly agreed that cost-efficiency was a benefit, and 30% agreed that cost-efficiency was a benefit of traditional computing. The findings revealed a significant difference between cloud computing users' and traditional computing users' perceptions of cost-efficiency as a benefit. Cloud users were more likely than traditional users to believe that cost efficiency was a significant benefit of cloud computing.

The literature discussed and supported the findings on cost-efficiency as a benefit. Cowhey and Kleiman (2013) reported that the adoption and use of cloud computing technologies have resulted in increased cost savings and massive cost reductions. They also stated that cost-efficiency was mentioned as a benefit by organizations that used cloud computing.

Flexibility

Flexibility refers to a variety of computing capacities and resources that can be added or removed as needed by customers (Youssef, 2012). This was discussed and supported in the literature. Carroll et al. (2011) and Zabalza et al. (2012) reported extensively on the importance of flexibility in the cloud, claiming that organizations that adopted this technology had also established this theme as a benefit. According to the research findings, respondents viewed this theme as a benefit because they valued the specific characteristic that the theme provided in supporting and meeting their business goals. The findings may also imply that respondents found the theme useful in assisting them in the deployment and maintenance of IT resources in cloud computing versus traditional computing.

In the case of traditional IT infrastructure, respondents reviewed that they could only use the hardware on premises. When they run out of processing power or storage space, the only option was to rent or buy a new server. Furthermore, if they decide to expand their team, there was we need to buy more computers as well as software licenses to go with them. not to mention that the IT department will have to manually implement the changes.

Customisation

Customization allows for the reconfiguration of IT resources and infrastructures to meet the needs of customers (Carroll et al., 2011). According to Carroll et al. (2011), Youssef (2012), and Zalbaza et al. (2012), this respondents' theme was an important benefit and characteristic of cloud computing. They also claimed that organizations that used cloud computing had established this benefit.

According to the findings on customization, 85% of respondents strongly agreed that customization was a benefit of cloud computing, 3% agreed that customization was a benefit of traditional computing, and 22.0% agreed that customization was neither a benefit nor a disadvantage. According to the findings, there was a significant difference in perceptions of customization as a benefit between cloud users and non-users. cloud Users believed that customization was a significant advantage of cloud computing over traditional computing. This literature supports these findings. Customization was mentioned as a benefit by Carroll et al. (2011), Youssef (2012), and Zabalza et al. (2012). They emphasized that customization was an important feature of cloud computing. They reported that businesses that used cloud computing cited customizations having as a benefit.

The research findings could imply that respondents perceived this theme as a significant benefit due to the remarkable feature that the theme possesses in cloud computing. Furthermore, respondents may have perceived opportunities to view this theme as a benefit because it provides the most sustainable ways to reconfigure IT resources to achieve organizational goals. Cloud computing, as a technology enabler, provides flexible ways to rearrange resources in a cost-effective manner as opposed to traditional computing, which makes customization an impossible task.

Maintenance

Lower-implementation findings show that 80.0% of respondents strongly agreed that lower-implementation was a benefit of cloud computing, 5.4% agreed with lower-implementation

as a benefit of traditional computing, and 14.6% did not agree or disagree with lower-implementation as a benefit.

This literature discussed and supported these findings. According to Cowhey and Kleeman (2013), there was a significant reduction in up-front capital and operational costs associated with the implementation and maintenance of IT resources. Furthermore, Avram (2014) stated that the cost of implementing and maintaining IT resources aided SMEs in becoming competitive at both the national and international levels. He went on to argue that lower-implementation contributed significantly to high business competitiveness, something that was never possible in-house.

Scalability

The findings on scalability as a benefit show that 88% of users strongly agreed that scalability was a benefit of cloud computing, 4% agreed that scalability was a benefit of traditional computing, and 8% agreed that scalability was neither a benefit nor a disadvantage. The findings revealed a significant difference in cloud users' and traditional users' perceptions of scalability as a benefit. According to the findings, scalability was a significant advantage of cloud computing over traditional computing. The literature review discussed the research findings. Scalability was mentioned extensively by Brohi and Bamiah (2011) as a benefit. They emphasized the importance of the ability to scale on-demand that scalability provides in cloud computing.

Sustainability

Carroll et al. (2011) defined sustainability as a possibility of an organisation to continue using its services and resources to their higher availability in cloud computing According to the findings on sustainability, 67% of respondents strongly agreed that sustainability was a benefit of Cloud computing, 20.0% agreed that sustainability was a benefit of traditional computing, and 13% agreed that sustainability was neither a benefit nor a disadvantage. According to the findings, there was a significant difference in perceptions of sustainability as a benefit between cloud and traditional computing users. Cloud users were more likely than non-users to believe that sustainability was a significant benefit of cloud computing. The literature review discussed these findings. Sustainability as a benefit in cloud computing was extensively covered by Zabalza et al. (2012). They claimed that organizations that used cloud computing cited sustainability as a benefit over those that did notice

Limitations of using cloud computing vs Traditional computing

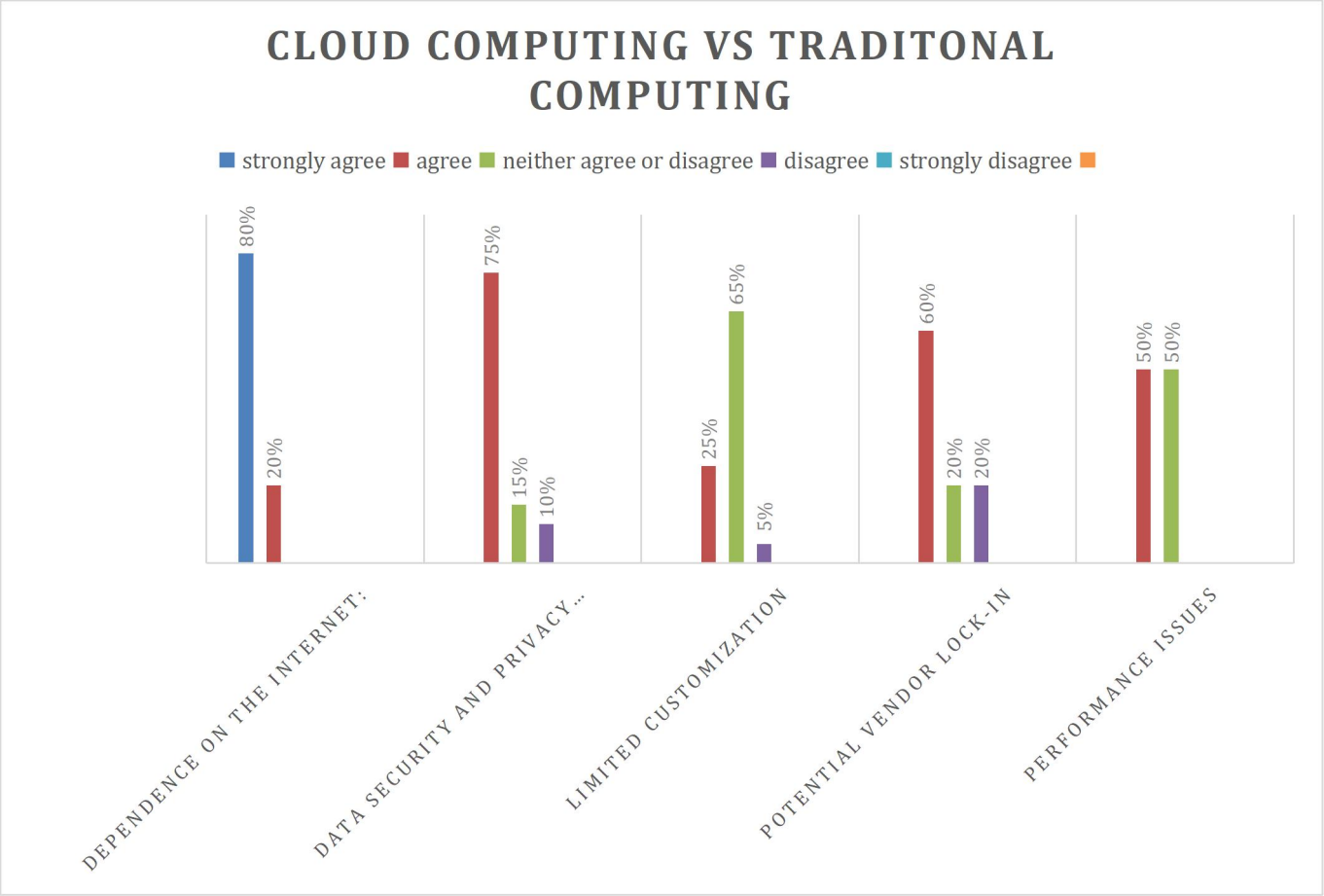

Figure 4.6 1

Dependence on the internet : All of the businesses that used cloud computing substantially relied on an internet connection, and any internet outage had an impact on users' access to cloud-based data and apps. 80% of those who agreed with this statement highlighted how Zimbabwe's high loadshedding levels resulted in lost productivity and economic disruptions. Furthermore, they argued that individuals that have traditional on-premises computers are currently in a superior position. When the power was cut off in some parts of Harare, the network also appeared to have shut down, indicating no work would be done on that specific region. As a result, contracts are being lost more frequently because the organization cannot fulfill deadlines.

Data security and privacy : Despite the fact that cloud providers provide robust security measures, 75% of IT SMEs were concerned about the security and privacy of their data in the cloud. They are concerned about unauthorized access to data, data breaches, and data loss. However, no cases have been raised concerning this issue, so we have 15% who are indifferent and 10% who disagree that cloud security is a concern. In most interviews, it was mentioned that organizations who employed the traditional on premise computing provided physical security and that in order to access data, one had to have both physical and technological(biometric) clearance provided by the organization.

Limited customization : Given that 25% of IT SMEs have limited control over the underlying infrastructure and software, cloud computing services may not be as customizable as one might hope. This may limit their ability to tailor applications and services to their unique business requirements. This was mostly for companies that used the SaaS model. They had to make do with what the cloud service provider provided. The Paas models were used by 65% of those who could not agree or disagree, indicating that they had some level of control and could customize their services. The remaining 5% used IaaS, which allowed them to access underlying infrastructure and customize their applications, but it was an expensive move on their part.

Potential vendor lock-in:When using a specific cloud provider's services, 60% of IT SMEs experienced vendor lock-in, making it difficult to switch providers if they became dissatisfied or if the provider's pricing changed. The cost of implementing these services has led to some reluctance to join the cloud.

Performance issues :Cloud computing services may experience performance issues due to latency, network bandwidth, or server load in some cases. This had an impact on the user experience and productivity of IT SMEs. This was also a case of network and zesa shutdown, which had a significant impact on Zimbabwe's IT SMEs. Furthermore, when these service providers introduce a new use case, IT SMEs must quickly learn how to use it and attempt to shift workloads on time because the previous use case become outdated and servers wont accommodate it.

Security issues in the Cloud computing

Traditional security issues, availability issues, and third-party data control issues are the three categories of data security issues. Traditional security issues are based on network outages and computer attacks such as viruses, worms, and cookies. Cloud service providers' vulnerability, authorization and authentication, and an expanded network attack surface are traditional security concerns. Availability, safeguard against single-point failure or denial of service (DOS). Third Party Data Control, the transparent data was held by a third party. It raises a number of security and data privacy concerns. Auditability, due diligence, and contractual obligations are all part of it.Additional data security issues associated with cloud computing include side channel attacks, denial of service attacks, and mobile device attacks. Insider and Organized Crime Cheat, Data Analysis and Cheap Data Enhanced authentication requirements and cost-effective availability When virtual machines are involved in data transmission, side channel attacks occur. It only affects virtual platforms. Data leakage across virtual machine instances was caused by side channel attacks. The main concern with a Denial of Service attack was availability. Major DOS attacks are associated with the Network layer within Multi-Tenant cloud Infrastructure, hypervisor, and shared resource consumption. Mobile device attacks are more likely to target mobile devices such as smartphones, laptops, and desktop computers. In general, the majority of mobile devices lack security features.

Security issues in service models

SaaS, PaaS, and IaaS are the three service models or delivery models used in cloud computing. This provides various services such as application platform, software, and infrastructure resources. Each delivery model has its own set of security concerns. The various types of security issues in delivery models are described in Table.4.6.

Security Issues	Affected Delivery Models			Solutions
	SaaS	PaaS	IaaS	
Offensive use of cloud computing	No	Yes	Yes	Strong authentication and monitoring
Data Interruption	Yes	Yes	No	High data protection
Malicious Insiders	Yes	Yes	Yes	Cloud Transparency for management and security
Denial Of Service (DOS)	No	Yes	Yes	Cloud Service provider delivers reliability and availability
Service hijacking	Yes	Yes	Yes	Provide security polices and activity monitoring
Privacy breaks	Yes	No	No	Provide communication protection
Data loss and data leakage	Yes	Yes	Yes	Use only secure API's, encryption algorithms and apply backup polices.
Shared Technology Issues	No	No	Yes	Use Access Control mechanism

Figure 4.6 2

and breaches caused by security flaws in the application. The challenges of the Software as a Service delivery model include data location, data disposal, data integrity, data confidentiality, authorization and authentication, network attacks, and data availability.

a. Location of Data

Data segregation and data location are in the cloud, and it provides shared cloud and data location resources.

Cloud providers are required to disclose information. Natural disasters such as flooding, extreme weather, and earthquakes can compromise the security of customer data.

b. Data Disposal

Data disposal refers to the storage of multiple copies of a single piece of data in the cloud. It results in high data availability, but it was also a major issue with cloud computing data storage. Because there are more copies of data in the cloud, deleting operations are more difficult for cloud customers.

c. Integrity of Data

Data integrity was the fundamental requirement of data security because it means protecting information from unauthorized changes or deletion. CSP(Cloud service provider) includes

mechanisms to ensure data integrity.Data Integrity also ensures data consistency, completeness, and wholeness.

d. Confidentiality of Data

Data confidentiality entails allowing authorized users and systems access to data. In the absence of strong authentication, illegal access occurs. Because the cloud provider should not access any user's data, cloud storage requires confidentiality. Customers should be given guarantees, and data security policies, practices, and procedures should be implemented in cloud users.

e. Authentication and Authorization

Mash-Up authorization explains how attackers can extract data from data sources or leak data. Sometimes, centralized access control techniques are not appropriate for all types of customer data. Because it only supports limited cloud hosting of applications and data, increased authentication demands allow only thin clients to access cloud data.

f. Attacks on the network

Cloud storage stores a large set of customer data, making it vulnerable to social networking attacks. A pair of interconnected relationships between customers, suppliers, cloud providers, and vendors. It alludes to data loss.

Security issues in Iaas

Customers who use IaaS must handle all security concerns because the CSP only provides VMs, storage, and networking; the rest was up to the customer. Customers are responsible for installing, monitoring, and operating all software components on their own.

Because many tenants share the same physical hardware in the form of virtual machines, virtualization technologies are used to create VMs at the IaaS level.

The most critical issues in IaaS are data visibility and resource isolation in shared hardware. Other critical issues include guest VM data confidentiality and denial of service attacks by another guest VM.

Security in Paas

Users can use intermediate equipment to create their program and deliver it to customers via servers and the internet. The user has control over the applications that run in the cloud

environment, but not over the hardware, network substructure, or operating systems. PaaS has major issues with validation, anonymous signups, and service fraud.

Solutions to these issues

Among the three delivery models and service models, cloud computing security faces both logical and physical security challenges. Cloud service provider (CSP) should be delivers an appropriate strong encryption procedure to protect the cloud\storage information. For cloud security, declarations, best practices, and privacy contracts should be delivered to cloud storage users. For the sake of security, cloud providers must improve their information-security governance. Cloud transparency was important in cloud security because it ensures transparency within SLAs.SLA was a legal agreement between clients and service providers that allows cloud providers to gain the trust of their clients. CPABE is a technique for maintaining data confidentiality while transmitting and storing data. A flexible and effective distribution authentication protocol is a major concern for cloud storage data security. These protocols rely on data reliability and availability.

Cloud Computing From SMEs Perspective

The survey attempted to investigate SMEs' needs and concerns regarding cloud computing services. The study looked into the factors that encouraged or hampered SMEs' adoption of cloud computing services.

A quantitative online survey questionnaire approach was used in the methodology. The target audience consisted of SMEs located in Zimbabwe. Participants ranged from IT decision-makers to managers within their respective businesses. Participants in the group came from various sizes of organizations as well as the IT sector. The survey invited 20 SMEs to participate. The questionnaire was completed by a total of ten SMEs. This results in a satisfactory response rate of 50% for this type of survey, where response rates below 15% are suspect. Table 4.1.0 above showed us the socio demographic of SMEs in Zimbabwe

Why Should Small and Medium-Sized Enterprises Use Cloud Computing Services?

Cloud computing provides a new path to business agility and a faster time to market by providing cloud-enabled resources such as IT infrastructure as a service, software platforms,

and business applications that are ready to use. All of these services are available on-demand and provide support for new business requirements much faster than acquiring, installing, configuring, and operating IT resources in-house. Clearly, this was an appealing proposition for organizations where upfront costs for Information and Communication Technology (ICT) are a concern, particularly SMEs.

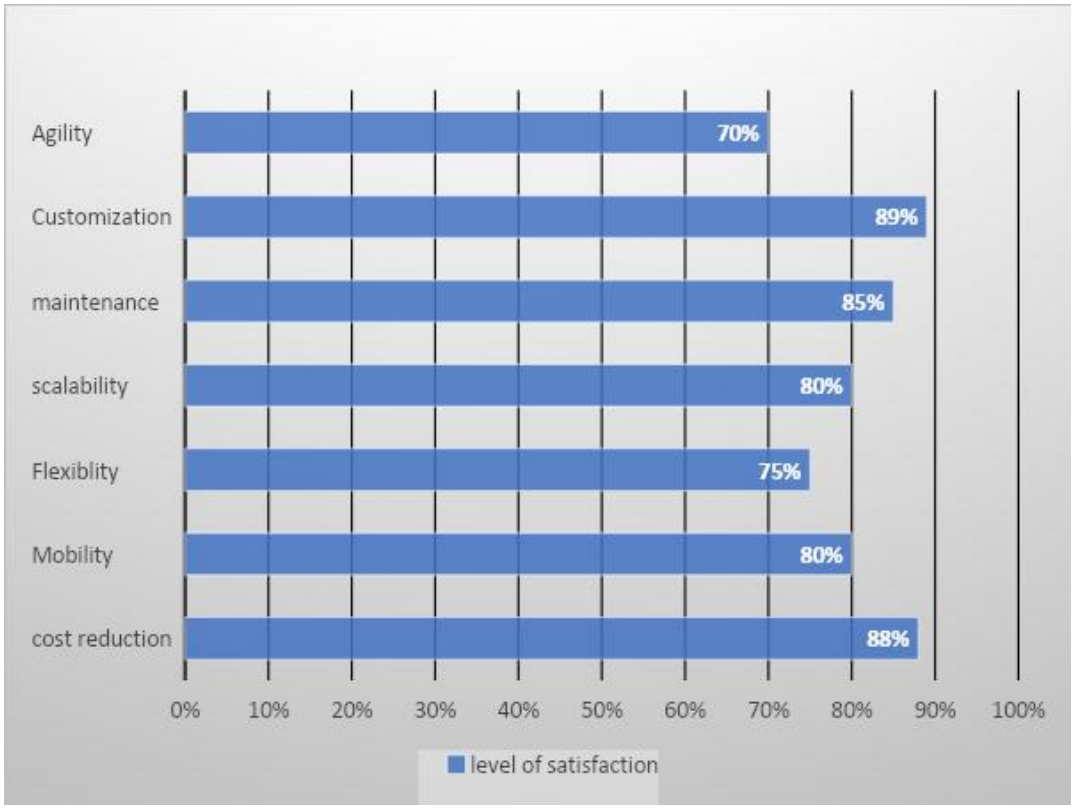

Figure 4.6 3 *(*the reasons behind using cloud computing*)*

Business agility was essential for commercial success, and the current economic downturn has highlighted its significance for SMEs. To survive, SMEs must reduce time-to-market. As a result, if "the cloud" was used appropriately within an overall IT strategy, it can provide a real competitive advantage, improve business performance, and help the organization control the cost of IT resources . Cloud computing can also supply the IT resources needed for scalable business expansion. The cloud was capable of providing a degree of flexibility for IT resources, allowing organizations to adapt to changing business demands. Furthermore, the cloud has a quick implementation time and was simple to upgrade.Cloud services would also eliminate the need for costly equipment to be housed on the company's premises. Furthermore, cloud computing allows SMEs to focus on innovation and new business creation, increasing productivity without the need for frequent updates to IT resources, servers, and software licenses.

The survey asked, "What were the reasons behind using cloud computing?" in order to observe the motivations of SMEs for adopting cloud-based services. Figure 1 depicts an analysis of the reasons provided by the SMEs.

Conclusion

The cloud computing concept was briefly discussed. A survey of 20 SMEs revealed their reasons for and concerns about using cloud computing services. According to the survey results, SMEs are very interested in cloud computing because it allows them to reduce costs, improve accessibility, flexibility, and scalability. These advantages are viewed as key motivators for SMEs to adopt cloud computing services. However, the rapid growth of corporate data in the cloud has raised concerns about security, vendor lock-in, and complications with data privacy and protection. As a result, cloud computing adoption has been slowly increasing. These issues must be addressed in order to persuade more SMEs to migrate their systems to the cloud.The privacy challenge for cloud-based software architects requires the design of a service that reduces security risks while ensuring legal compliance. In other words, data security should be prioritized during the design process of any cloud service. Existing security measures such as perimeter defense on VMs, data encryption, backups, and incorporating cryptographic protocols such as TLS, SSL, and WSS can be improved. Furthermore, implementing a standardized cloud service framework will enable seamless cloud service integration between different vendor platforms.Cloud users would be able to switch from one provider to another as a result of this. Cloud computing was still a new technological venture for SMEs, but reaping its full benefits requires good business sense and appropriate steps. Cloud computing adoption will increase as security, data privacy, interpretability, and portability standards improve.

CHAPTER 5

5.1 Introduction

This chapter summaries the research problem, research methodology and the major findings of the study. Conclusions are drawn from the findings. The researcher then gives recommendations on which computing type I.T SMEs in Zimbabwe should adopt

5.2 Discussion

The extent to which computing resources, such as CPU, memory, storage, and network bandwidth, are used efficiently and effectively in a cloud computing environment was referred to as resource utilization.

Cloud computing providers typically provide a variety of service levels, which dictate the amount of resources allocated to a user and charge users based on how much of these resources are used. As a result, optimizing resource utilization was critical for both users and providers in order to achieve cost efficiency and avoid resource waste.

There are several techniques for optimizing resource utilization in cloud computing, including:

1. Virtualization: By allowing multiple applications to run on a single physical server, virtual machines (VMs) or containers can help to maximize resource utilization.

2. Load balancing: By distributing workloads across multiple servers, load balancing can aid in the prevention of resource bottlenecks and the optimization of resource usage.

3. Auto-scaling: This technique automatically adjusts the amount of resources allocated to an application based on its usage, ensuring efficient resource allocation.

4. Schedule workloads to run during off-peak periods to maximize resource utilization and reduce the need for additional resources during peak periods.

5. Resource pooling was a technique that combines multiple resources into a single resource pool that can be dynamically allocated to different applications based on their needs, resulting in more efficient resource utilization.

Overall, by implementing these techniques, businesses can ensure that they are making the best use of their cloud computing resources, resulting in improved cost efficiency and overall performance.

5.3 Conclusions

Predicting cloud resource utilization was an important issue to handle uncertainty in cloud computing environments. In cloud computing, resources are allocated to user applications accessible from anywhere over the Internet. To handle large number of users, the resources need to be scaled dynamically for efficient utilization, reduced energy consumption, and cost with better Quality of Service (QoS). The focus of this research work was to explore the efficiency of neural networks to predict multi-resource utilization .The hybrid model is capable of training a network for accurate prediction of multivariate resource utilization. The proposed model was validated with comparative experimental results. The results show that the proposed hybrid model yields better accuracy as compared to traditional techniques. It can also be concluded that due to the possibility of rapid and excessive changes in resource utilization, the prediction of multi-variate resource utilization was a challenging task.

The potential directions for future research can be to evaluate neural network predictors further in other areas of cloud computing, such as predicting other resources such as disk utilization, cost-effectiveness, network, and reduction in energy consumption for green computing. The proposed framework was evaluated with the Google trace dataset for memory and CPU utilization. It would be constructive to endorse the proposed evolutionary neural network approach further by working on other multi-variate resource utilization datasets.

5.4 Implications

The implications of cloud computing resource utilization can be significant for both cloud providers and users. Here are some of the most important implications:

1. Cost Effectiveness: Cloud service providers bill their customers based on the resources they use. Efficient resource utilization can assist users in lowering cloud infrastructure costs. Similarly, efficient resource utilization can assist cloud providers in optimizing resource allocation and lowering overall infrastructure costs.

2. Performance: Efficient resource utilization can also improve cloud application performance. Applications running on optimized resource configurations can benefit from faster processing times, lower latency, and overall performance improvements.

3. Availability: Efficient resource utilization can also improve cloud application availability. Load balancing, for example, can ensure that workloads are distributed evenly across available resources, lowering the risk of resource overloads and application downtime.

4. Scalability: Efficient resource utilization allows applications to quickly scale up or down based on demand. This can lead to better resource utilization during peak periods and lower costs during low demand periods.

5. Sustainability: Efficient resource utilization can also help to ensure the long-term viability of cloud computing. Organizations can reduce the amount of energy required to power their cloud infrastructure by optimizing resource utilization, resulting in a lower carbon footprint.

In conclusion, efficient resource utilization in cloud computing can result in cost savings, improved performance, increased availability, increased scalability, and more sustainable cloud operations. As a result, it was critical for organizations to implement resource optimization strategies in order to reap these benefits.

5.5 Recommendations

For IT companies in Zimbabwe looking to move from traditional computing to cloud computing, here are a few recommendations they should take note of:

1. Clearly identify the data and processing operations which will be passed to Cloud

A data controller customer must clearly identify the data, processing operations, or services that may be hosted in the cloud before planning to use them.

For each type of processing, the company must determine which types of data are involved, distinguishing between personal data, sensitive data, company strategic data, and data used in business applications.

2. Define your own requirements for technical and legal security

The move to the cloud necessitates a methodical approach to technical and legal security. Unlike traditional outsourcing offers, in which service providers provide a tailored response to a customer-defined specification, many of Cloud's offerings are "standard" for all customers and do not meet a specific specification. However, the customer must define his own requirements and determine whether the proposed offers meet all of them. While the purpose of the cloud was to relieve the customer of certain operational tasks, he must ensure that the service provider adheres to a requirement level that is at least equal to his own.

3. Carry out a risk analysis to identify the security measures essential for the company

A thorough risk analysis was required for businesses to define the appropriate security measures to be demanded of the service provider or implemented within the company.

4. Identify the relevant type of Cloud for the planned processing

On the market, there are several cloud computing service offerings that can be classified into three service models and three deployment models.

The following are the service models:

- SaaS stands for "Software as a Service," which refers to online software provisioning;
- PaaS stands for "Platform as a Service," which refers to online application development platform provisioning;
- IaaS stands for "Infrastructure as a Service," which refers to online computing and storage infrastructure provisioning.

The following are the deployment models:

- "Public" refers to a service that was shared and pooled among many customers;
- "Private" refers to a Cloud that was dedicated to a single customer;

- "Hybrid" refers to a service that was partially in a public Cloud and partially in a private Cloud. In this case, we consider the service to be two interconnected processing types.

5. Choose a service provider offering sufficient guarantees

Customers of Cloud computing services must ensure that they can meet their obligations as data controllers. To do so, they must select service providers who guarantee the implementation of appropriate security and confidentiality measures, as well as who are transparent with their customers about the methods used to provide their services (transfer of data abroad, use of subcontractors, security policy and measures, and so on).

For those operating in the cloud these are a few key notes:

6. Enforce security measures across all clouds and workloads.

The move to the cloud necessitates a methodical approach to technical and legal security. Unlike traditional outsourcing offers, in which service providers provide a tailored response to a customer-defined specification, many Cloud offerings are "standard" for all customers and do not meet a specific specification. However, the customer must define his own requirements and determine whether the proposed offers meet all of the requirements. While the goal of the Cloud was to relieve the customer of certain operational tasks, he must ensure that the service provider adheres to a requirement level that was at least equal to his own.

7. Develop continuous cloud optimization standards.

8. Limit the number of people with access.

9. Set up strong user validation and access management protocols.

10. Audit all identities with access to the cloud.

11. Clearly define who owns which data.

In summary, optimizing resource utilization in cloud computing requires a thorough analysis of computing needs, efficient resource allocation, automation, use of cloud-native technologies, and consideration of hybrid cloud solutions. By implementing these recommendations, organizations can achieve better resource utilization and optimize their cloud computing operations

5.6 Suggestions for Further Research

This study was in the early stages of theoretical concept development, with a preliminary model proposed based on a review of the literature and conceptual reasoning. Further research in this area of study is highly recommended. Cloud computing is a new phenomenon, and few studies on cloud computing adoption in Zimbabwe have been conducted. The researcher proposes that future studies incorporate and combine other adoption theories. The researcher strongly suggests that future studies and other researchers test and confirm the proposed conceptual model in different contexts. It is always recommended that researchers improve the proposed models by adding or removing constructs. It is beneficial in that it provides both researchers and practitioners with a better understanding of cloud computing adoption.

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Appendices

APPENDIX A Questionnaires

I Bianca Kaseke, an Africa University student, is conducting research on the resource utilization of cloud computing and traditional computing in I.T SMES. This counts as part of the requirements for the Honours Degree in Computer Information Systems. You are kindly asked to complete this questionnaire as completely as possible. The information you provide will be used only for the purposes of this study and will be kept strictly confidential. Thank you very much for your help.

1. Name of your organization

2. How would you describe your role in the company?

CIO

.IT manager

.Cloud architect

.Team leader

.Prefer not say

.Software developer

.CTO

.CEO

.Other (please specify)

3. Duration of work in the I.T industry (In Years)

4. Number of employees at your company

.< 50 ☐

50 - 250 ☐

.> 250 ☐

.None of the alternatives ☐

5. What is your level of knowledge about cloud computing?

I know what is cloud computing ☐

I have some knowledge about cloud computing ☐

I have no knowledge on cloud Computing ☐

6. Which type of computing is your organization currently using

Cloud computing ☐

Traditional computing(traditional on premise) ☐

7. Which layer of Cloud applications is currently being used by your company? (Choose all that apply)

.Individual software packages – Software as a Service (SaaS) ☐

.Complete operating system and software package available via Cloud services (PaaS) ☐

.Just infrastructure services such as storage, network capacity, etc – Infrastructure as a Service (IaaS) ☐

8. Based on the answer to question (7) above, how was the migration of the application(s) to the Cloud handled?

.The application(s) was migrated to Cloud environment by our internal technical resources ☐

.The application(s) migration was managed by our internal technical team with help from a consultant ☐

.An outsider (consultant / outsourced company) was engaged to migrate the application(s) ☐

9. Which solution do you see as the most suitable for your organization according to Cloud computing ? ☐

.Public cloud (owned and managed by an unrelated business)

.Private Cloud (owned and managed internally) ☐

.Hybrid cloud (some services hosted internally and some hosted in the public cloud) ☐

Other (please specify). ☐

10. How much does it cost to set up …..

Pick the one you're currently using or if you've use both

I. Traditonal computing

$0-5000 ☐

5000-10000 ☐

11000-20000 ☐

Above 21000 ☐

II. Cloud computing

☐

$0-$20000

$21000-$60000

$65000-$70000

Above $75000

11. On a scale of 1 - 5

How much storage capacity does …….

Cloud computing use (Please explain , in terms of file access and how easy one can create more space including costs involved)

Traditional computing use (Please explain , in terms of file access and how easy one can create more space including costs involved)

12. On a scale of 1 -10

If there is a disruption , how quickly can your organization recover lost data

Cloud computing (time(hours/days))

Traditional computing (time(hours/days))

How responsive is your computing when there is a rise or drop in workloads?(Elasticity)

Cloud computing

Traditional computing

In terms of load balancing , how easy is it to divide/split workloads?

Cloud computing

Traditional computing

APENDIX B Interviews

1. In your own understanding what is the difference between cloud computing and traditional computing?

2. What challenges are you facing with the current computing method your organization is using?
3. In terms of cpu utilization , which computing method do you think organization ought to employ and why?
4. Since the adoption of your computing method , has the company revenue increased or decreased?
5. In terms of costs , how much have you invested in your current computing method? If you can please break down the training costs of employees , equipment bought,and monthly expenses(if there are any) or the overall capital investment
6. Have you gained any competitive advantage in the I.T market ?
7. Do you believe that cloud computing is better than traditional computing?
8. Which security measures have you currently employed to safe keep data?
9. How much went into the securing of data / servers?
10.

APPENDIX C AUREC Approval Letter

AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE (AUREC)

P.O. Box 1320 Mutare, Zimbabwe, Off Nyanga Road, Old Mutare-Tel (+263-20) 60075/60026/61611 Fax: (+263 20) 61785 website: www.africau.edu

Ref: AU2389/22 10 November, 2022

Bianca Tanaka Kaseke
C/O CBPLG
Africa University
Box 1320
MUTARE

RE: AN ASSESSMENT OF RESOURCE UTILIZATION FROM TRADITIONAL ON PREMISE COMPUTING TO CLOUD COMPUTING IN SMMES IN ZIMBABWE

Thank you for the above titled proposal that you submitted to the Africa University Research Ethics Committee for review. Please be advised that AUREC has reviewed and approved your application to conduct the above research.

The approval is based on the following.

a) Research proposal

- **APPROVAL NUMBER** AUREC 2389/22
  This number should be used on all correspondences, consent forms, and appropriate documents.
- **AUREC MEETING DATE** NA
- **APPROVAL DATE** November 10, 2022
- **EXPIRATION DATE** November 10, 2023
- **TYPE OF MEETING** Expedited
  After the expiration date this research may only continue upon renewal. For purposes of renewal, a progress report on a standard AUREC form should be submitted a month before expiration date.
- **SERIOUS ADVERSE EVENTS** All serious problems having to do with subject safety must be reported to AUREC within 3 working days on standard AUREC form.
- **MODIFICATIONS** Prior AUREC approval is required before implementing any changes in the proposal (including changes in the consent documents)
- **TERMINATION OF STUDY** Upon termination of the study a report has to be submitted to AUREC.

Yours Faithfully

MARY CHINZOU
ASSISTANT RESEARCH OFFICER: FOR CHAIRPERSON
AFRICA UNIVERSITY RESEARCH ETHICS COMMITTEE