



# Cloud Computing Adoption Guidelines in a South African Higher Education Institution



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## **ABSTRACT**

Global technology is advancing rapidly, particularly within higher education institutions, where remaining competitive in teaching and learning is paramount. Embracing cloud computing offers numerous benefits that higher education institutions could leverage to enhance their operations. However, this requires a paradigm shift in one's approach. While many higher education institutions aim to adopt cloud computing, their focus tends to centre on Software as a Service initially, overlooking the broader potential benefits. Cloud computing offers scalability solutions that could drive down costs and increase flexibility, allowing higher education institutions to concentrate on their core educational missions. Nevertheless, challenges persist, hindering widespread adoption, especially among smaller institutions.

The primary objective of this study focused on cloud computing adoption guidelines in a South African higher education institution. Through comprehensive research, various barriers to adoption have been identified. Moreover, this study sheds light on the benefits of cloud computing, particularly evident during times such as the COVID-19 pandemic, where it enhanced teaching and learning experiences significantly. Some higher education institutions have already embraced certain cloud computing services, such as Microsoft applications through Software as a Service models.

Employing an interpretative research approach, this study engaged information technology technical staff and information technology governance within a higher education institution. Data collection was primarily conducted through interviews, with content analysis serving as the primary research method. Utilising a case study approach, the interview questions were informed by an extensive literature review, structuring the investigation process. Qualitative methods were used to gather insights from information technology governance and information technology technical staff, with data being carefully analysed, coded, and categorised to identify emerging patterns and themes. Through this process, this study found barriers and challenges confirmed by extant literature on cloud computing. The development of cloud computing guidelines aimed at facilitating cloud computing adoption in South African higher education institution.

The key findings of this study outline the guidelines for cloud computing adoption in higher education institutions. The guidelines incorporate participant insights on optimizing cloud computing adoption. Factors extracted including technological, environmental, governance, financial, organizational factors, and challenges, guide the guidelines' formulation. Recommendations include evaluating data protection, upskilling information technology staff, prioritizing security, aligning with higher education institution policies, awareness on cloud

computing benefits, assessing financial impacts, fostering a learning culture, and addressing challenges such as trust, costs and support. It emphasizes the importance of service level agreement with service providers, vendor selection, intellectual property considerations, and staff training to ensure successful cloud computing adoption aligned with higher education institution digital migration strategies.

**Keywords:** Cloud computing, cloud computing characteristics, cloud computing models, guidelines, higher education institution

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## DECLARATION

I, Robert Azwidowi, declare that **Cloud Computing Adoption Guidelines in a South African Higher Education Institution**, is entirely my own work that I have submitted for the Master of Computer Science programme at North-West University and has not been presented to any other institution. Furthermore, I have appropriately cited and acknowledged all references used in the dissertation.

Signature: .....

Date: .....

## ABBREVIATIONS

API	Application Programming Interface
CC	Cloud Computing
CS	Case study
EO	Empirical objectives
FNAS-REC	Faculty of Natural and Agricultural Science Research Ethics Committee
HEI	Higher Education Institution
IAAS	Infrastructure as a Service
ICT	Information Communication Technology
IT	Information Technology
NHMRC	National Health and Medical Research Council
NIST	National Institute of Standards and Technology
NWU	North-West University
NWU-RDGC	North-West University Research Data Gatekeeper Committee
PAAS	Platform as a Service
SAAS	Software as a Service
SANReN	South African National Education and Research Network
SLA	Service level agreement
TO	Theoretical objectives
TVET	Technical Vocational Education and Training colleges

### A note on abbreviations

This list of abbreviations helps readers understand the content of this dissertation. When a concept is first mentioned in each chapter, its full definition is provided in brackets with the abbreviation, followed by the abbreviated form.

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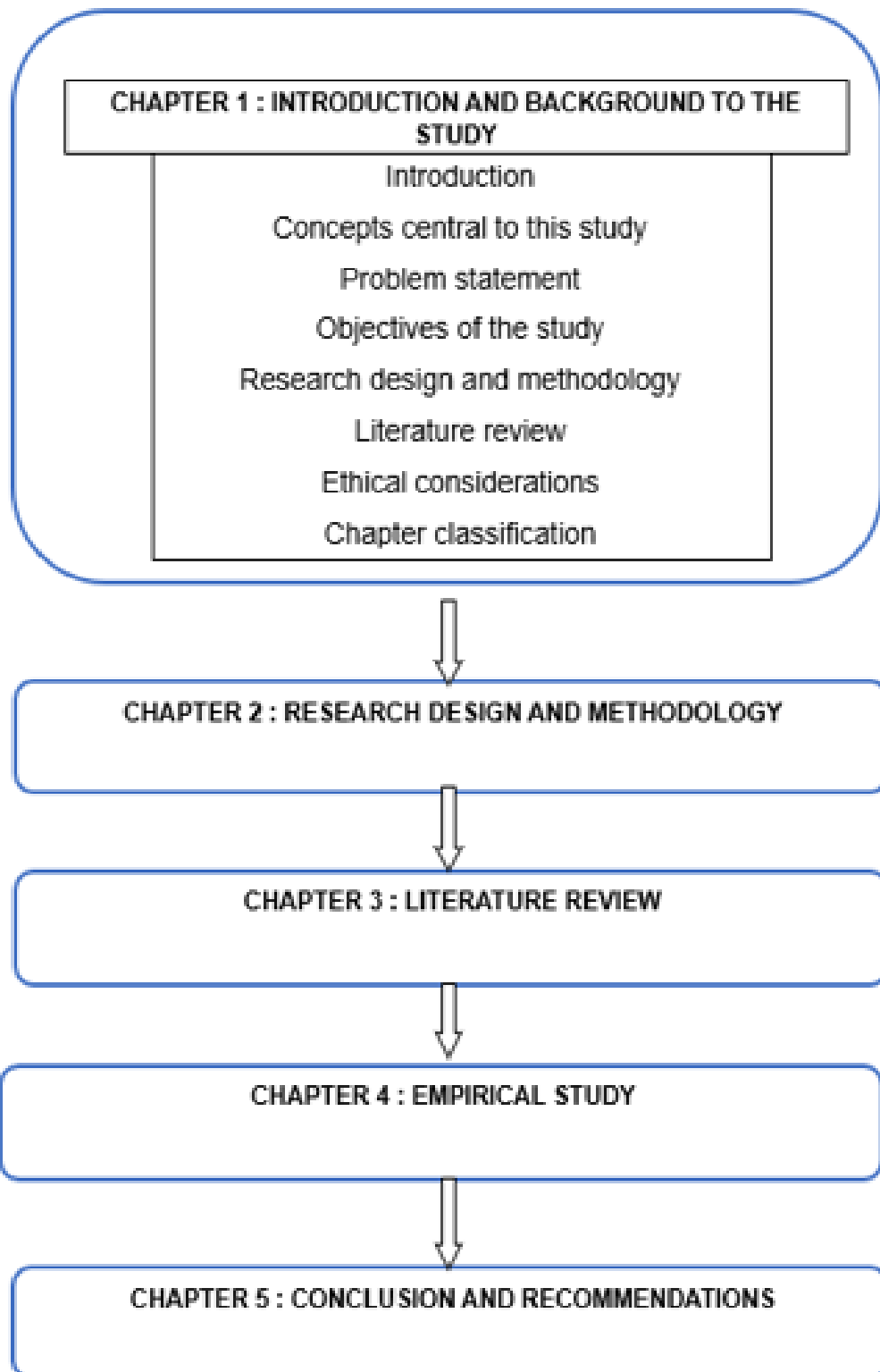
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## CHAPTER 1: INTRODUCTION AND BACKGROUND TO THE STUDY

### 1.1 INTRODUCTION

Cloud computing (CC) has significantly transformed processes in higher education, playing a pivotal role in delivering services to higher education institution (HEI). Students, teachers, administrators, and other stakeholders in HEI stand to gain from the promising new features offered by CC (Ali, 2020:413). Cloud computing enhances the sustainability of HEI by reducing information technology (IT) expenses and enhancing operational efficiency, thereby bolstering their long-term viability (Qasem, Asadi, *et al.*, 2020). A growing model of cloud computing enables institutions to access computing resources directly from the cloud as a service (Moloja & Ruhode, 2020:1262).

McCrea (2009:54) mentions that CC provides universities with more possibilities to enhance teaching, learning and research, rather than focusing on complex information communication technology (ICT) configurations and software integration systems.

Cloud computing has emerged as an innovative paradigm where companies and organisations enhance their ICT investment, making these resources quickly accessible (Singh & Bhisikar, 2013:37). Cloud computing refers to the services and the program applications that are delivered over the Internet (Armbrust *et al.*, 2010:50). Kulkarni (2012:11) mentions that in simple terms, CC means Internet Computing, where the Internet is virtualised as a cloud; hence, the term cloud computing, which means that computing is done through the Internet. Through CC, users can access data anywhere and anytime, if they have an Internet connection.

Universities and companies experience challenges related to managing big data and complex systems, because of a lack of experience in effectively using ICT. Hussein and Khalid (2016:52) state that CC enables cost-effective data sharing over the Internet, as well as big storage of data. According to Rajan (2013:38), CC changes the way in which recent ICT infrastructure manages and presents consumable services such as platforms, applications and infrastructure.

Section 1.2 focuses on the concepts central to this study that include CC and its characteristics, CC models, guidelines, and HEIs. The problem statement is discussed in section 1.3. Section 1.4 focuses on the objectives of this study that include primary objectives, theoretical objectives and the empirical objectives. Section 1.5 focuses on the research design and methodology and includes the research paradigm, empirical research, data collection and

the evaluation methods. Section 1.6 refers briefly to the literature review, while Section 1.7 explains ethical considerations. The last section 1.8 outlines the chapter classification.

## **1.2 CONCEPTS CENTRAL TO THIS STUDY**

The key concepts of this study included the following: cloud computing (CC) and its characteristics, guidelines, and higher education institutions (HEIs). Each concept is introduced below and discussed in detail in the literature review of this study.

### **1.2.1 Cloud computing and its characteristics**

This section provides a description of CC, which includes definitions, cloud characteristics, cloud models and cloud deployment. The future of ICT application systems is determined by the characteristic of CC (Rashid & Chaturvedi, 2019:423).

#### **1.2.1.1 Cloud computing**

Rashid and Chaturvedi (2019) define CC as “storing and accessing data and programs over the Internet instead of using our computer hard drive”. They mention that the cloud is a metaphor for Internet. CC is a way of delivering computing services over the Internet and because of its capabilities to be incorporated into education processes, it can bring wider benefits, such as the improvement of the quality of higher education across HEIs.

#### **1.2.1.2 Characteristics of cloud computing**

A considerable number of scholars (Aldossary & Allen, 2016:485; Mell & Grance, 2011) describe the characteristics of CC in the same way. For instance, the National Institute Standard of Technology (NIST) identifies the following four characteristics of CC, namely on-demand self-service, broad network access, resource pooling, and rapid elasticity (Aldossary & Allen, 2016:485; Mell & Grance, 2011). Kaur (2020:920) adds one to this list, namely measured service.

### **1.2.2 Cloud computing models**

Businesses and organisations are able to benefit from the cloud models, which improve efficiency and reduce cost (Rashid & Chaturvedi, 2019). The CC models bring numerous benefits, for example Software as a Service (SaaS), which provides pay-per-use services to customers over the Internet; implying that you pay only for what you consume (Singh & Bhisikar, 2013:38).

### 1.2.2.1 The cloud deployment model

Felter (2021) states that cloud deployment may be described as a way in which the cloud platform executes, how it is hosted and who can access it. He further explains that all CC deployment models work on the same proposition by virtualising the servers into components that result in enhanced data processing and storage capacity (Felter, 2021).

Alam (2020:111) states that during CC implementations, application models are deployed. He further mentions that there are four deployment models, including public cloud, private cloud, hybrid cloud and community cloud. Tavbulatova *et al.* (2020:1) posit that a cloud deployment model represents four types of cloud environments, including private clouds, public clouds, hybrid clouds and community clouds, all of which may be differentiated by ownership, as illustrated in Table 1.1.

**Table 1.1: Four types of cloud deployment models**

Ownership	Public Cloud	Private Cloud	Hybrid Cloud	Community Cloud
Performance	Owned by customers	Owned by single organisation	Owned partially by both service provider and consumer	Owned by two or more organisations having the same goal
Used by	Anyone can access	Few people can access	Medium accessibility	Depend upon the number of cooperatives
Reliability	Medium	Highest	Moderato	High
Maintenance cost	Lowest	Highest	Moderate	High
Security	Less	Highest	Medium	High
Example	Amazon	Microsoft Azure	Rackspace Hybrid cloud	Microsoft government community cloud

### 1.2.2.2 The cloud service models

According to Rashid and Chaturvedi (2019:423), there are three common CC service models, namely SaaS, Platform as a Service (PaaS), and Infrastructure as a Service (IaaS).

### 1.2.3 Guidelines

Craig *et al.* (2011:1) mention that by applying theory and practice, guidelines can help intervention program implementers to ensure that their interventions are implemented and evaluated effectively. It is generally believed that guidelines can make it easier to give consistent and efficient care and that they can bridge the gap between what scientists do and what is supported by scientific evidence (Eccles & Mason, 2001:1).

Gopalakrishna *et al.* (2013:14) state that by using the best available evidence, guideline panels develop recommendations. The evidence provided by panels is often graded in this process. It can reduce bias and provide transparency in the process of developing guidelines when the evidence is evaluated systematically, and recommendations are developed in this way. Guideline developers and target audiences both benefit from this. Thus, evidence and recommendations have been graded according to their quality and strength (Gopalakrishna *et al.*, 2013:14). Clifton and Petrosino (2016) state that across all fields of practice, policy, and resource allocation, guidelines have a significant impact. Therefore, guideline documents should include recommendations based on objective evidence assessments. Thorough literature reviews and using rigorous methods to evaluate evidence help to reduce scientific bias. In this way, they improve the chances that high-quality, relevant evidence will be considered. Clifton and Petrosino (2016) further stated that evaluating scientific evidence is only one aspect of guideline development.

To achieve a desired outcome, guidelines define the procedures that need to be followed (Howard & Jenson, 1999:285). There are nine basic key principles that the researcher will adopt on the development of the guidelines (NHMRC, 2000:1). The National Health and Medical Research Council (NHMRC) of Australia recommends the following guideline principles:

- *Principle one:* The focus should be on outcomes when developing guidelines.
- *Principle two:* Resource constraints should be considered when developing guidelines.
- *Principle three:* It is important that guidelines are based on the best scientific evidence and that their recommendations are described as strong.
- *Principle four:* To synthesize the evidence, one of the most valid methods should be used.
- *Principle five:* Consumers must be involved in the guideline development process.
- *Principle six:* Flexibility and adaptability should be key characteristics of guidelines.
- *Principle seven:* A target audience is considered when developing guidelines for dissemination and implementation.
- *Principle eight:* Guidelines should be evaluated for their implementation and impact.
- *Principle nine:* A regular review of guidelines is necessary.

Therefore, the purpose of this study was to develop guidelines for the adoption of CC in HEIs in South Africa. The key principles identified above guided the development process. The main purpose of this study was to establish guidelines to provide a practical ethical framework for

the adoption of CC at HEIs. In this study guidelines were developed that will assist HEIs to adopt CC.

#### **1.2.4 Higher education institutions**

Higher education institutions play a major role in the growth of the community (Alharthi *et al.*, 2015:2). The South African higher education system has key challenges that they faced, as outlined in the White Paper (Jaffer *et al.*, 2007:132):

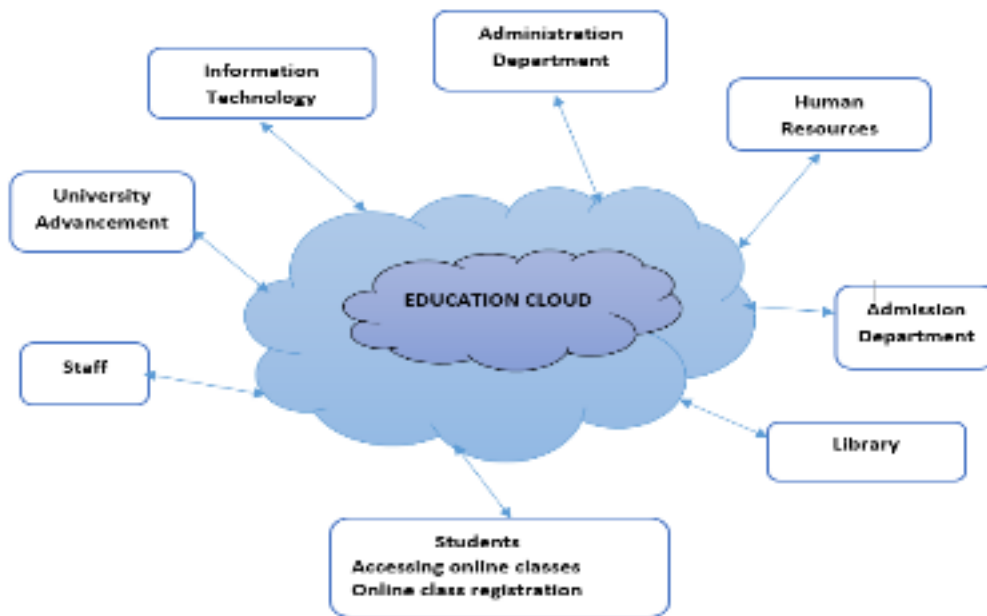
“to redress past inequalities and to transform the higher education system to serve a new social order, to meet pressing national needs, and to respond to new realities and opportunities”.

There are many challenges that affect the adoption of CC in HEIs to allow its significant and fast growth (Attaran *et al.*, 2017:27). Cloud computing is faced with common challenges which are: data protection, data recovery and reliability management, capability, and regulatory and compliance restrictions (Rashid & Chaturvedi, 2019:422). However, they add that HEIs are faced with other challenges, such as the rapid development of technology, political issues, and non-traditional demand.

The higher education sector experiences the challenge of limited data storage, which can be easily solved by implementing CC (Yadav, 2014:3110). Higher education institutions should weigh the advantages and disadvantages associated with new technologies, because of limited budgets (Pardeshi, 2014b:591). These challenges make the higher education sector an attractive area of research (Elrehail *et al.*, 2018:55).

The adoption of CC in HEIs will maximise the benefits of faster deployment of software and reduce the demand for infrastructure and highly skilled ICT staff (Akanke, 2018:6). Higher education institutions can benefit from using CC, as stakeholders will be able to access the service via the Internet, as has been proven during the COVID-19 pandemic-induced lockdown.

To mitigate the disruptions to the academic year, cloud services enable students to register online and attend classes virtually (Chen *et al.*, 2020:1). Higher education institutions use SaaS computing model applications, such as Microsoft Office 365 and Google Apps for e-mails and to create documents and spreadsheets (Attaran & Woods, 2019:499). In the context of HEIs, CC can be incorporated into the learning management system, thus simplifying the teaching and learning process (Attaran & Woods, 2019). Figure 1.1 presents all the HEIs-stakeholders that can be inter-connected using CC (Abdulkareem & Ismaila, 2017).



**Figure 1.1: Education cloud stakeholders**

Mary and Rose (2020:5476) state that in the world of education, cloud-based learning is a new technology, which provides, creates, and distributes information at any time, at any location. Many HEIs across the world have already embraced CC. The authors further identify the following characteristics of CC in higher education: data storage, sharing, worldwide access and collaborative interaction.

### 1.3 PROBLEM STATEMENT

Rapid changes in IT are affecting the teaching and learning process in the higher education context. Higher education institutions are experiencing problems regarding IT storage infrastructure and affordable education services due to a yearly increase in the number of students and staff. Although CC became an important platform to drive digital innovation in HEIs to improve the quality of education (Al-Shqeerat *et al.*, 2017:22), the rate of cloud adoption in HEIs is very slow, particularly in developing countries (Qasem, Asadi, *et al.*, 2020:1047).

Arkorful (2019:5) cites that HEIs are no different when it comes to adoption considerations. From student registration to accessing research data, data traffic has increased exponentially in recent years. Educating, researching, and innovating require tremendous amounts of IT support. As a result, scalability challenges at HEIs can be easily addressed via CC by IT staff or system administrators (Arkorful, 2019:5). To handle the growing demand for data and control costs, it is necessary to find smarter ways. Mitrovic (2017:2) mentions that IT staff experience less stress because of the effective use of CC. In large companies and HEIs, IT systems are typically developed and maintained internally. It is the responsibility of IT

departments to manage the control and support of IT services. Therefore, there is a need to focus on adoption guidelines of CC in HEIs. Higher education institutions stand to gain significantly by embracing the CC model for specific tasks. Through resource sharing, including expensive hardware, software, and technical expertise among multiple institutions, IT costs can be minimized. This maximizes resource utilisation and distributes delivery costs effectively (Moloja & Ruhode, 2020:1262). Krauss and Van der Schyff (2014:41) suggest that to utilise CC effectively, there should be trust between the cloud provider and the organisation.

According to this study conducted by Krauss and Van der Schyff (2014:41), the issue of adopting CC in HEIs in South Africa was raised with the South African National Education and Research Network (SANReN) by the Department of Arts, Culture, Science and Technology in 2003. SANReN is an organisation that provides the broadband connectivity in all public universities and Technical Vocational Education and Training colleges (TVETs) in South Africa. The final approval for implementation came in 2006, but the actual implementation only started in 2011. The main focus of adopting CC was to ensure that South African universities were abreast with other global institutions of higher education (Krauss & Van der Schyff, 2014:41).

The adoption of CC in HEIs in South Africa has been insufficiently investigated although cloud adoption awareness in South Africa has seen some growth, yet actual adoption faces constraints, despite the operations of major global cloud providers like Microsoft, Amazon, and Google in the market (Adendorff & Smuts, 2019). Moloja and Ruhode (2020:1262) also attest to this by mentioning that South Africa currently has 26 public universities that are spread across the country. They further mention that only a few universities have adopted some of the CC services and models. Cloud computing has received significant attention from many industries as a promising paradigm. Globally, CC has been adopted by many business domains due to its rapid growth (Ali, 2020:413).

The research on CC primarily focuses on security, since security concerns hinder the use of cloud computing in HEIs. Cloud adoption is slow in HEIs, especially in developing countries, likely due to a lack of clear guidelines and successful adoption examples. Research on cloud adoption in HEIs, particularly in developing nations is limited (Al-Sharafi *et al.*, 2021). Therefore, CC adoption in Higher Education aims to fill these knowledge gaps.

This clearly shows that there is still a need to investigate and conduct in-depth research into the guideline's adoption of CC in higher education in South Africa.

Therefore, the research problem in this study was to develop adoption guidelines for CC in South African HEIs. To achieve the objective of this study, the overarching question need to be answered:

- What would a set of CC adoption guidelines include?

This will be supported by the following sub-questions:

- What are the benefits of CC in HEI?
- What are the challenges faced by HEI?
- What are the recommendations to enhance the adoption of CC in HEI?

#### **1.4 OBJECTIVES OF THIS STUDY**

The following were objectives of this study:

##### **1.4.1 Primary objective**

The primary objective of this study was to develop adoption guidelines of cloud computing in South Africa higher education institutions.

##### **1.4.2 Theoretical objectives**

- T01: To clarify interpretive research as an appropriate methodology for this study.
- T02: To elucidate CC by focusing on the CC models and its characteristics.
- T03: To pave the way in which HEIs can improve their process about the CC adoption.
- T04: To create a mutual understanding regarding the development of guidelines.
- T05: To extract a comprehensive list of guidelines from literature.

##### **1.4.3 Empirical objectives**

- E01: To extract adoption guidelines from the literature review on how HEI can facilitate CC adoption.
- E02: To extract adoption guidelines on how HEI can facilitate CC adoption from data gathered and analysed – to make sense of it.
- E03: To incorporate adoption guidelines based on the perceptions and experiences of the participants into guidelines extracted from literature on how HEI can facilitate CC adoption.

## **1.5 RESEARCH DESIGN AND METHODOLOGY**

This study included literature reviews and an empirical study. The interpretive research paradigm was applied to the empirical portion of this study.

### **1.5.1 Appropriate theory of this study**

This study focused on the formal logic format. The deductive approach of this study involves utilising pre-established themes identified through a review of literature, along with a theoretical framework constructed through engagement with literature. Additionally, the inductive aspect entails extracting themes directly from the data gathered from the participants (Proudfoot, 2023:311). Research questions were developed based on the literature review that were answered through a hybrid inductive and deductive analysis of the qualitative data as it was gathered through the interviews. Therefore, the hybrid inductive and deductive theory was appropriate for this study. The researcher started with the premise, data that were collected from the IT governance and IT staff through the interviews and subsequently organizing this data into emerging themes.

### **1.5.2 Research paradigm**

An American philosopher, Kuhn (1962:158), was the first scholar to use the word paradigm, which in simple terms mean a philosophical way of thinking. He then mentions, “the philosophy and sociology of science cannot be practiced independently of each other”. A research paradigm is concerned with the quest for knowledge. This means that a researcher starts with positive assumptions on how to seek knowledge to be able to address a problem.

Positivism is grounded in the philosophical stance of a natural scientist that is focused on the reality which is observable within the society (Alharahsheh & Pius, 2020:41). The positivist approach is focused on the natural sciences, where it seeks information that is based on experiments and observation (Abdulkareem & Ismaila, 2017:28; Roth & Mehta, 2002:133). Positivism relates to the accuracy of data without the influence or bias of humans – it mainly focuses on the facts. Positivism has its philosophy based on the natural sciences (Abdulkareem & Ismaila, 2017:28; Roth & Mehta, 2002:133).

Interpretivism is subjective, and its concern is with the variables and factors that are related to context; it reflects humans as different from physical phenomena (Alharahsheh & Pius, 2020:41). Rashid *et al.* (2019:4) say that through the eyes of participants, the researcher has multiple views of a research problem. They further mention that an interpretivist does not view the world in an objective light. Interpretivism is dependent on a constructivist ontology

(Alharahsheh & Pius, 2020), which is concerned with human existence in the world, and how humans are able to acquire knowledge (Moon & Blackman, 2017).

Klein and Myers (1999:265) describe critical social theory as a paradigm that starts with the premise that people engage in two different types of activities, which are social interaction and work. In work, everyone and everything can be seen as an object that needs to be manipulated, which means it can also be controlled and predicated. Social interaction is quite different from work, and this deals with mutual understanding in a communicative relation, which means people need to share their views and have others to agree to those views but that does not mean that manipulations does not occur, it alters the way in which the participants relate to each other.

There are numerous explanations of critical social theory; however, one of the most cited is that of Myers and Avison (2002:7), and they define critical social theory in the following way:

“Critical researchers assume that social reality is historically constituted and that it is produced and reproduced by people. Although people can consciously act to change their social and economic circumstances, critical researchers recognize that their ability to do so is constrained by various forms of social, cultural and political domination.”

Vom Brocke *et al.* (2020:1) define design science research as a paradigm that seeks to enhance human knowledge by creating an innovative artefact in order to solve a particular problem. Design science research paradigm has its root focus in engineering and artificial science. Its aim is to produce knowledge on how things can be re-arranged or designed; usually by a human agency, to accomplish a desired set of goals or achievement (Vom Brocke *et al.*, 2020:1). Hevner and Chatterjee (2010:9) explain design science research as a paradigm which is concerned with the design of an artefact that will be able to resolve its exact problem. This has been supported by Johannesson and Perjons (2014:7), who mention that design science research is a scientific study that is used by people to develop or create an artefact with the aim of solving a practical problem.

The four paradigms, which are positivism, interpretivism, critical social theory and design science research, were explained which helps the researcher to choose the suitable paradigm for this study. The positivism paradigm was not applicable for this study because there would be no testing of a hypothesis of this study by using quantitative methods. Critical social theory was not suitable to this study because it gathers knowledge in which participants express their own views, a self-understanding and self-reflecting process that provides criticism of the existing social knowledge. Design science research was not applicable for this

study because this study did not aim to design an artefact to solve the problem. The appropriate paradigm for this study was interpretivism as this study focused on the development of adoption guidelines of CC in HEIs in South Africa. To achieve this, the researcher interacted with the participants. Thus, the research approach to be used in this study was the interpretive paradigm because it is compatible with qualitative methods.

### **1.5.3 Empirical research**

According to Myers and Avison (2002:21), a research design is the plan of action of the whole qualitative research project that should involve various components of a research project, such as research method, data collection techniques, analysis techniques, and publishing your findings. As established in the previous section, the empirical study of this research was done in the interpretive research paradigm. The empirical objective was to develop adoption guidelines of CC in HEIs in South Africa. For this reason, IT governance and IT technical staff were interviewed in terms of their technological background knowledge and experience regarding CC. Interviews were used to gather qualitative data. The collected data were analysed and discussed.

#### **1.5.3.1 Research Method**

The researcher applied case studies (CSs) as a research method in this study. According to Yin (2009:4), a case study (CS) is a research method that can be used in different situations, which helps to enhance our knowledge of organisational, individual, group, political and another related phenomena. He further explains that using the CS approach helps to understand the complexities of such social phenomena. According to Feagin *et al.* (1991), a CS is defined as “an in-depth, multifaceted investigation, using qualitative research methods, of a single social phenomenon”. They further mention that a CS allows the researcher to investigate not only the complexities of life in which the specific groups of people are implicated, but it also has an impact on the beliefs and complex decisions of social interaction. A CS does not intend to generalise its focus of this study on the entire organisation, but rather focuses on the particular issue to help the researcher to understand the complex real-life activities of a problem in depth (Noor, 2008:1602).

A CS has been defined as a research method that focuses on:

“... the complexity and uniqueness of a particular project, policy, institution, program or system in a real life context, it can be research based, inclusive of different methods and is evidence-led” (Thomas, 2021:10).

Rashid *et al.* (2019:5) explain that a CS often consists of empirical material collected from detailed investigations over a period of time in order to define a case that will provide the analysis of the context and processes that are involved in a phenomenon. Thomas (2021:3) continues by saying that a CS is a method that provides the complexity of life in the form of inquiry that elevates a view of life.

The researcher focused on the development of the adoption guidelines of CC in higher HEIs in South Africa, therefore the focus was on the development of adoption guidelines. According to Yin (2003:360), in CSs are more relevant when there is little knowledge about the topic that has been studied, and this study will be answering the how and why questions. Answering the how and why questions allows the researcher to focus on human behavioural attributes, interactions and actions (Rashid *et al.*, 2019). Hafiz (2008:546) mentions that while considering what the research question will be, it is very important to consider what the case will be. For instance, if this study focuses on the development of adoption guidelines of CC at HEIs, the researcher should be able to answer why and how questions that are related to the adoption of CC, and as such determine the relevant data to be collected during interviews.

Many social scientists have the view that CSs may be implemented in three different ways, including descriptive CS for surveys and history, exploratory CS for investigations, and explanatory CS implemented through experiments (Yin, 2009:6). In addition, the CS focuses on primary research and should not be used to test or describe propositions. Typically, CSs are the favoured approach when exploring how or why questions, especially in situations where the investigator lacks control over events, and the emphasis is on examining a contemporary phenomenon within a real-life context (Yin, 2012:4). These explanatory CSs can also be supplemented by exploratory and descriptive variants. Regardless of the chosen type, researchers must meticulously plan and execute CSs to address conventional criticisms associated with this method (Yin, 2012:3).

In descriptive research, questions can be answered such as *who, what, when, where, and how*. It is both creative and analytical (Holmes *et al.*, 2024:51). The researcher used the descriptive CS, this study analysis methods focus more on describing rather than analysing data, since this study focuses on developing adoption guidelines of CC in HEIs. This study utilises descriptive analysis methods to investigate viewpoints of IT governance and IT technical staff on the adoption of CC within HEIs. Qualitative description requires researchers to clearly explain their disciplinary background, why they are interested in the topic, and their assumptions (Bradshaw *et al.*, 2017).

According to Myers and Avison (2002:4), research methods can be categorised into qualitative and quantitative. Positivist study methods include experimental, survey and numerical

methods. It can be used in research where this study needs to quantify the problem by generating numerical data that can be transformed into statistics (DeFranzo, 2020). Qualitative research normally falls into the interpretative paradigm, whose key aim is to clarify the subjective details that may originate from social action (Abdulkareem & Ismaila, 2017). In a qualitative research study data have to be collected in order to allow a better understanding of the participant's perspective (Gelo *et al.*, 2008). Qualitative research methods include case studies, interviews, questionnaires and observations (Myers & Avison, 2002:4).

The researcher focused on the CC adoption guidelines in HEIs. Selected IT staff and IT governance from one HEI were interviewed, therefore the CS methodology guided the researcher to investigate the problem in depth, and particularly focus on the adoption guidelines of CC in HEIs.

### **1.5.3.2 Data collection**

Paradis *et al.* (2016) mention that collection of data is very important because it explains how the information collected is used; they further mention that there are five types of data collection, which are surveys, interviews, focus groups, observations and content or textual analyses.

According to Sargeant (2012:1), data collection is an approach which is frequently used by qualitative researchers. Qualitative research focuses on an individual or group of people who can be interviewed or observed. Interviews are commonly utilised in interpretive studies as a primary method for accessing the interpretations of informants within the field (Walsham, 2006:323). Interviews are used to collect data that can question a selection of participants from this study and can be analysed across the qualitative approaches used. The saturation of data needs to align with the research questions, theoretical orientation, and analytical framework employed. Nonetheless, it is important to establish a reasonable limit to its application to maintain the coherence and effectiveness of saturation without stretching its conceptualisation (Saunders *et al.*, 2018). As mentioned earlier, qualitative research is synonymous with the interpretative paradigm and its key aim is to clarify the subjective details that may originate from social action (Abdulkareem & Ismaila, 2017). According to Alsaawi (2014:149-151), there are different types of interviews, which are: structured interviews, unstructured interviews, semi-structured interviews and focus group interviews.

For this study, semi-structured interviews were selected as the method of choice to gather data. Semi-structured interviews allow researcher to ask detailed questions while ensuring important topics are covered. Semi-structured interviews encourage participants to freely

share their thoughts and experiences, leading to richer qualitative data (Adeoye-Olatunde & Olenik, 2021:1362; Kallio *et al.*, 2016:2960).

### **1.5.3.3 Participants**

This study was conducted in South Africa, with a particular focus on one HEI. The participants of this study included IT governance and technical IT staff from one HEI in South Africa. South African universities are categorised into three types: traditional universities, which are academic in focus, universities of technology (previously known as technikons), with a vocational focus, and comprehensive universities that offer a combination of both types of qualifications. The university that was the focus of this study has three distinct campuses aligned in offering academic courses. This study focused on one university campus.

IT governance was selected because the adoption of CC will have an impact, which may be positive or negative, on teaching and learning. In addition, the IT staff corporately responsible for the actual implementation of CC was interviewed.

The number of participants was determined by the saturation of data gathered through the interviews (Mason, 2010). The participants were selected voluntarily, both male and female. Informed consent letters were distributed to participants, in time and for them to familiarise themselves with this study and understand the aim of study.

### **1.5.3.4 Data analysis**

The phenomenon of this study was facilitated and understood by using qualitative research to obtain results from participants and interpret the collected data (Sargeant, 2012:2). Data collected throughout this study would be meaningless if it was not analysed. Data collected through interviews were analysed using the interpretative approach.

Medelyan (2020) mentions that coding is the process of organising qualitative data that help to identify relationships and different themes among them. Furthermore, he mentions that group response, the feedback you receive from a small group of selected participants who contributed to a discussion, is always based on the themes, not on wording. This means a group response with the same themes should be under the same code, but they might not use the exact same wording.

There are five different types of qualitative data analysis, which are content analysis, narrative analysis, discourse analysis, framework analysis and grounded theory (Medelyan, 2020). Prasad (2008:1) defines content analysis as a study of communication content that can be described by a scientific study. Mayring (2004:173) mentions that the main objective of

qualitative content analysis is to record all communications that have been obtained. The researcher used qualitative content analysis.

Qualitative content analysis has been defined as:

“a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns” (Hsieh & Shannon, 2005:1278).

Zhang and Wildemuth (2005:2) mention that qualitative content analysis starts on the early stages of data collections as it will be able to address the research questions. They further explain that qualitative content analysis should have different steps that the researcher should follow. The researcher followed the following steps to conduct content analysis, which have been mentioned by (Zhang & Wildemuth, 2005:3-5):

1. Prepare the data.
2. Define the unit of analysis.
3. Develop categories and a coding scheme.
4. Test coding scheme on a sample of text.
5. Code all the text.
6. Assess your coding consistency.
7. Draw conclusions from the coded data.
8. Report your methods and findings.

#### **1.5.3.5 Evaluation of the method**

In a study conducted by Klein and Myers (1999a:72), they mention that in order to confirm the quality of this study, the following principles for an interpretive research study should be followed:

##### **The fundamental principle of hermeneutic circle**

This principle suggests that there is a fundamentals process of interpretation with the aim to determine the objective this study. This first principle gave guidance to the other six principles for a better understanding of this study material (Klein & Myers, 1999:79). This principle of human understanding is fundamental to all the other principles. The understanding is achieved when the researcher iterates between the participants, and as more participants are interviewed, the better the understanding about the aim of the research will be.

### **The principle of contextualisation**

The principle of contextualisation focuses on (Gadamer, 1976) insight cited by Klein and Myers (1999:73) and mentions that:

“... there is an inevitable difference in understanding between the interpreter and the author of a text that is created by the historical distance between them”.

Here the data must be understood in a context of why or how it is gathered and from whom, then in this study the findings may be understood, for example why guidelines can affect the adoption of CC in one HEI and why adoption affects its stakeholders.

### **The principle of interaction between the researchers and the subjects**

This principle requires critical thinking on research materials that involves the participants' interactions with the researcher. The understanding needs to be established between the researcher and the participants. It further states that in an interpretative research approach both the participants and the researcher could be seen as an analyst and interpreter (Klein & Myers, 1999:74).

During the interviews, a clear understanding should be established that the aim of this study is to develop adoption guidelines of CC in HEIs, unlike using assumptions. In this study, the researcher had to be focused on one HEI and made sure that the empirical work was guided by the participants, not the researcher's own views.

### **The principle of abstraction and generalisation**

The researcher must be sensitive with the bias inputs, but only focus on the outcome of the data. Klein and Myers (1999:75) mentions that the principles of abstraction with its philosophy says that:

“... the validity of the inferences drawn from one or more cases does not depend on the representativeness of cases in a statistical sense, but on the plausibility and cogency of the logical reasoning used in describing the results from the cases, and in drawing conclusions from them”.

The researcher must be a fair judge and should refrain from being biased and using false inputs, but only focus on what emerges from the data.

### **The principle of dialogical reasoning**

The researcher needs to understand and analyse preferred the research approach, that will be able to identify the weakness and strength of the favourite philosophy of this study (Klein & Myers, 1999:79).

The researcher needs to be sensitive to the underlying theories as per the research design, that means the theoretical and the actual findings would not be the same. It is the researcher's responsibility to interpret the findings appropriately.

### **The principle of multiple interpretations**

The researcher must be sensitive and able to examine the outcome of study that may be influenced by the social context from different perceptions of different participants. Data from participants should not be ignored because of their background; all information is important in order to identify possible supporting factors and contradictions that can be influenced (Klein & Myers, 1999:77).

This principle is similar to multiple witness accounts, even if all tell it as they saw it. Participants may have different perceptions, for example every participant may have their own perception and experience about CC.

### **The principle of suspicion**

The researcher must always be aware of the fact that some of the participants may be biased towards the research study. Some of the participants' findings might be invalid and this may affect the findings if included (Klein & Myers, 1999:77).

#### **1.5.4 Delimitations to this study**

This study intended to develop adoption guidelines of CC in HEIs in South Africa. South Africa has 26 public HEIs, but this study was conducted at only one HEI in South Africa, focusing on only one campus. South African universities are categorised into three types, which are traditional universities, comprehensive universities, and universities of technology. The university as subject of this study is a traditional university, with three diverse campuses. The outcome of this study can therefore not be generalised to all HEIs in South Africa and not to other countries. Especially newly launched universities, and universities that are located in rural areas may have different experiences regarding CC.

In addition to the above, the lack of utilisation of CC in HEIs, and specifically the university as subject of this study, may limit this study.

### **1.5.5 Expected contribution to knowledge**

The focus of this study was to develop adoption guidelines of CC in HEIs in South Africa which the South African HEIs sector should take into consideration when adopting cloud services.

The guidelines are essential in understanding of CC; to facilitate the adoption of CC. This will enhance teaching and learning through an online platform, for example file sharing, increased data storage and reduced cost. There is little research on the CC adoptions; therefore, the findings of this study will contribute towards the academic literature of CC adoption in South African HEIs.

## **1.6 LITERATURE REVIEW**

According to Ishtiaq (2019:40), a literature review must have a central position in this study and should find a gap in research done previously. The literature review chapter provides a description of what other scholars and researchers have published about a specific topic that the researcher focuses on (Taylor & Procter, 2008). The literature review was conducted using various publications, journal articles, relevant textbooks, and the online academic databases. Journals were used through the North-West University library system, such as EBSCOhost, Google Scholar and SA publishers. The keywords used were:

- Cloud computing: “cloud computing in higher education institutions”, “cloud computing models”.
- Technology in higher education: “technology in higher education”, and “benefits of cloud computing”.

## **1.7 ETHICAL CONSIDERATIONS**

Bell and Bryman (2007:71) identify the following most important principles related to ethical considerations:

- Research participants should not be subjected to harm or threat.
- The participants' dignity needs to be respected.
- Participants should provide a full consent before they take part in this study.
- Confidentiality of the research data has to be ensured at all times.
- Anonymity of individuals and organisations who are participating in this study must be ensured.
- Bias, misleading information and misrepresentation of primary data findings must always be avoided.
- Honesty and transparency in relation to the research should be observed accordingly.

- Exaggeration about the objective of the research should be avoided.

The researcher informed the participants that their responses would be treated with the utmost confidentiality. In addition, the identities of the participants and organisations will remain anonymous. The respondents were informed of their right to withdraw from this study at any time.

## 1.8 CHAPTER CLASSIFICATION

This study comprises the following chapters:

**Chapter 1 - Introduction and background to this study:** The focus is on the background to this study, the problem and research questions and its objectives. The chapter provides an overall detailed background of this study on CC.

**Chapter 2 - Research design and methodology:** The focus is on research design and the methodology used in this study. The chapter discusses the paradigms pertaining to Information Systems, applicable research methodologies, with the focus on interpretivism as the adopted approach to this study, as well as outline to the process of data collection from participants, which includes an HEI's IT governance and technical IT staff, and the data analysis.

**Chapter 3 - Literature review:** This chapter focus on the literature review and key concepts related to this study. The chapter investigate previous research on the adoption guidelines of CC in HEIs. By analysing previous studies, the researcher was able to extract relevant guidelines. This focus allowed the researcher to compare and establish the findings of other scholars in the field of CC adoption in HEIs.

**Chapter 4 - Results and findings:** The focus is on the discussion of the results and findings of this study. It provides the process used in data gathering, its review and the presentation of the interview results. The researcher formulates guidelines from the empirical data. The results were obtained by analysing the collected data using an interpretative method with the intention to provide adoption guidelines of CC to HEI IT practitioners.

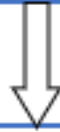
**Chapter 5 - Conclusion and recommendations:** The focus is on the conclusion and recommendations of this study. This chapter presents a complete overview of this study and gives recommendations emanating from this study on how this research may be conducted in the future.

## **1.9 SUMMARY**

Chapter 1 provided a comprehensive overview of the research, including its background and research objectives. It explains the significant motivations driving the need for this study and outlines the research approach. The introduction also offers a clear definition of cloud computing, the problem statement, and the research questions of this study. Additionally, this chapter outlines the layout of the subsequent chapters in this study.

The next chapter presents the research design and methodology of this study.

**CHAPTER 1 : INTRODUCTION AND BACKGROUND TO THE STUDY**



**CHAPTER 2: RESEARCH DESIGN AND METHODOLOGY**

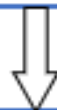
Introduction  
Research Paradigms  
Research Methodology  
Research Design



**CHAPTER 3 : LITERATURE REVIEW**



**CHAPTER 4 : EMPIRICAL STUDY**



**CHAPTER 5 : CONCLUSION AND RECOMMENDATIONS**

## **CHAPTER 2: RESEARCH DESIGN AND METHODOLOGY**

### **2.1 INTRODUCTION**

The purpose of this study was to develop guidelines for the adoption of cloud computing (CC) in a South African higher education institution (HEI). The aim of this chapter is to present to the reader, in more detail, the research design used to guide this study. This chapter focuses on achieving the main goal by addressing the first theoretical objective. This chapter examines a variety of philosophical assumptions based on the interpretive paradigm with the aim to focus on the theoretical objective (T01). Researchers who use interpretive paradigms are theoretically able to view the world through the participants' eyes, perceptions and experiences by considering the views of various scholars. Interpretive paradigm investigators construct their understanding from gathered data after using the experiences they have accumulated in seeking answers to research questions (Thanh, 2015:24).

Information systems paradigms are discussed in this chapter. This study identified research methodologies that are applicable, with interpretivism as the preferred method, as well as outline the steps involved in collecting data from participants. HEI participants include the information technology (IT) governance and IT technical staff. The case study research method, which was appropriate for this study, is discussed in detail in this chapter.

Section 2.2 introduces the research paradigms and provides definitions; it also discusses the different types of paradigms and the suitable paradigm of this study. Section 2.3 explains the research methodology, elaborates the research methods and the case study as an appropriate method for this study. Section 2.4 describes the research design of this study, including the selection of participants, data collection and analysis methods. This section outlines the actual picture of what the researcher did. Section 2.5 is the overall summary of this chapter to summarise the main topic which has been discussed and introduce the reader to the next chapter.

### **2.2 RESEARCH PARADIGMS**

Göktürk (2005:1) mentions that the word paradigm has gained a lot of traction in recent years, it has become increasingly dominant in research. Yet the question remains unanswered: What exactly is paradigm and how did it originate? He elaborates that, in many ways, the meaning of the word has escaped philosophers' laboratories, mostly because it has a vague meaning. According to Saleh *et al.* (2021:22), the word paradigm has been used since the late 15th century, originating from the Greek word *Paradigma*, which means pattern or model. According to the Cambridge Dictionary as cited by (Saleh *et al.*, 2021:22), the word paradigm

means “a model of something, or very clear and typical example of something”. The scientific dictionary also describes it as “the philosophical and theoretical basis of a school of thought or discipline in which theories, laws, and generalizations are formulated and experiments are proposed in support of them”. As Guba and Lincoln (1982:233) mention, a paradigm differs greatly on fundamental issues, much more profound than where the inquiry is conducted. According to the researcher, paradigms are philosophical frameworks used to guide research based on deep understanding, beliefs, and ideas.

Kroeze (2011:4) mentions that paradigm is used in philosophy of science to describe a set of theories that reflects a historical phase in the development of knowledge. Paradigm contains three main elements, namely ontological, epistemological, and methodological (Johannesson & Perjons, 2014:167; Kroeze, 2011:4). Scotland (2012:9) attests to this by saying these assumptions are based on ontology and epistemology for every paradigm.

Rehman and Alharthi (2016:52) cite that positivism, interpretivism, and critical thinking are three types of educational research approaches. Johannesson and Perjons (2014:167) urge that for information systems research in terms of research paradigms, there are two main approaches which are positivism and interpretivism. In addition, they mention additional paradigms which are critical realism and critical theory. Table 2.1 below illustrates the comparison of paradigms within the three philosophical assumptions.

The following paradigms will be discussed.

### **2.2.1 Positivism**

Kaboub (2008:343) says the positivist paradigm was developed in the 19<sup>th</sup> century with Auguste Comte's rejection of metaphysics as well as his claim that science alone reveals the truth about reality. Hiller (2016:105) posts that positivism is founded on the principle that knowledge and learning are based on objectivity.

Positivism's ontological assumption is that reality has objective properties that can be quantified and that are independent of the observer (researcher) and their equipment (Myers, 1997). Positivism epistemology is that scientists believe that science is based on knowledge and is value-free (Carson *et al.*, 2001:5). Methodology assumptions are that experimentation plays a major role in positivism methodology. In hypotheses, the causal relation between phenomena is proposed as propositions or questions (Rehman & Alharthi, 2016:54). Surveys and experiments are quantitative research methods applied to positivism philosophy (Guba & Lincoln, 1994:110).

**Table 2.1: Comparison of the paradigms within ontological, epistemological and methodological (Aliyu et al., 2014:81; Aliyu et al., 2015)**

<b>Analysing Paradigms</b>	<b>Positivism</b>	<b>Interpretivism</b>	<b>Critical Theory</b>	<b>Critical realism</b>
<b>Ontological</b> (Nature of reality)	<p>Established pattern or order based on pre-existing stable patterns.</p> <p>It does not matter when or where reality occurs.</p> <p>It is possible to generalise reality.</p>	<p>Complexity and dynamicity characterise the world.</p> <p>In human interaction and social construction, it is constructed, interpreted, and experienced by people interacting with one another and with wider social systems.</p>	<p>In a society governed by conflicting structures - political, economic, social, cultural, ethnic, and gender.</p> <p>Societal entities constantly influenced by their own internal forces are realities.</p>	<p>A true understanding of reality is only possible through triangulation from numerous sources. (Sobh &amp; Perry, 2006:1195)</p>
<b>Epistemological</b> (Nature of knowledge)	<p>Systematic descriptions of knowledge are possible.</p> <p>The concept of knowledge consists of facts or laws that are based on verified hypotheses.</p>	<p>Observable phenomena are not the only basis for knowledge.</p> <p>Knowledge is constructed not just based on objective beliefs, values, reasons, or understandings</p>	<p>There is a dispersal and distribution of knowledge.</p> <p>Power is derived from knowledge. The lived experience and the social ties that organise it constitute knowledge.</p> <p>Social and economic contexts help us make sense of events.</p>	<p>Results likely true - researcher triangulates perceptions to make sure they are valid.</p> <p>Findings probably true, but mediated by humans; knowledge used to construct theories regarding underlying reality (Wynn Jr &amp; Williams, 2008:3)</p>
(Role of theory)	<p><i>Probabilistic</i> – i.e. occurs in many situations and applies to a large group of people.</p> <p>Accuracy and certainty are key characteristics of knowledge.</p>	<p>People make meaning in their lives in different ways, and knowledge is about how they do this, not just that they do it.</p>		
<b>Methodology</b> (Findings)	<p>Focus on experimental research to verify the hypotheses, e.g. survey research, uses the quantitative methods</p>	<p>Focus on the hermeneutic principles, Uses the following methods: Grounded theory, ethnography, action research, case study</p>	<p>Dialogic/dialectical Critical discourse analysis, critical ethnography action research</p>	<p>Case studies and convergent interviews are the main qualitative methods used (Sobh &amp; Perry, 2006:1195)</p>

### **2.2.2 Interpretivism**

According to Kroeze (2011:2), philosophy of interpretivism emphasises the human construction of reality, which can be understood only subjectively. Humans are only able to perceive an independent, concrete reality through the filters of their sense organs in the absence of an independent and concrete reality. A foundational basis of knowledge is rejected in interpretive research, which casts doubt on its validity. There is no way to compare interpretive research to scientific paradigms (Scotland, 2012:12). Goldkuhl (2012:137) mentions that “Interpretivism is not unified and unequivocal tradition”.

Ontological assumption is that interpretivism adopts a relativistic ontological position; our senses give us insight into our real world. Life is meaningless without consciousness (Scotland, 2012:11). Epistemology assumption is that according to interpretive epistemology, the real-world phenomena form the basis of the subjectivism (Scotland, 2012:11). Methodology assumptions are that an interpretive research framework is based on seven principles proposed by (Klein & Myers, 1999:70). It includes the “fundamental principle of the hermeneutic circle, principle of contextualisation, principle of interaction between the researcher(s) and the participants, principle of abstraction and generalisation, principle of dialogical reasoning, the principle of multiple interpretations and the principle of suspicion”. An interpretative research paradigm is typically used in qualitative research and aims to clarify the subjective details that may stem from social action (Abdulkareem & Ismaila, 2017).

### **2.2.3 Critical social theory**

According to Ngwenyama (1991:2), critical social theory focuses on improving the human condition as its primary objective.

The goals of critical social theory, cited by Ngwenyama (1991:2) at the opening of the Institute for Social Research were as follows:

“On the contrary, according to the critical theory of society (as opposed to the positivist view of social science), men are historical forms of life themselves. Assuming the conditions of reality from which science starts out, it does not rely solely on probabilistic laws for establishing and calculating its intentions. In each case, the outcome depends not only on nature, but also on what men choose to do with it.”

Ontological assumption is that a critical paradigm assumes historical realism as its ontological position (Scotland, 2012:13). Reality is the product of constant internal influences that are constantly constructed by individuals. Critical epistemology is based on societal ideology; it is

a subjective view that references real-world phenomena. Knowledge is permeated by social relations and is socially constructed (Scotland, 2012:13). Methodology assumptions are that theoretically, critical scholars presume social reality as historically constituted and that it is manufactured and reproduced by humans (Myers, 1997).

#### **2.2.4 Critical realism**

Archer *et al.* (2016) cite that the principles of critical realism include a set of philosophical positions on matters such as causality, structure, people, and modes of explanation. In addition, critical realism emerged in response to post-positivist crises in the social and natural sciences of the 1970s and 1980s. According to critical realism, the evidence around us can serve as an accurate glimpse of reality; however, it is subject to fallibility, social relationships, and subjective interpretations (Sturgiss & Clark, 2020:143). The goal of this alliance is to establish a proper postpositivist social science (Archer *et al.*, 2016).

Ontological assumption is that it observes the world as it is, regardless of how people perceive it. Cause-and-effect causal structures may not always be visible until they are activated in certain circumstances because the world is a multidimensional system (McEvoy & Richards, 2003). Epistemology assumption is based on observations and interpretations of participants' experiences according to critical realism, the world is described in a way that reflects it (Wynn Jr & Williams, 2012:793). Methodology assumptions, according to Wynn Jr and Williams (2012:795) state that critical realism is driven by the goal of developing explanations for how things act and behave.

#### **2.2.5 Paradigm appropriate for this study**

The purpose of this study was to develop adoption guidelines of CC in a HEI in South Africa. The four paradigms, positivism, interpretivism, critical social theory, and critical realism, were discussed and explained according to epistemological, ontological assumptions and methodological considerations. The paradigm relevant to this study was chosen based on the epistemological and ontological assumptions.

According to Klein and Myers (1999:67), in the field of information system, interpretive research has the potential to assist researchers in understanding the behaviour of individuals in social and organisational contexts; it can also help to develop new insights into information systems phenomena such as information system management and information system development. Through the meanings that individuals assign to phenomenon, it attempts to facilitate understanding of individuals (Klein & Myers, 1999:69).

This study did not fit the positivism paradigm because it was not objective, and there was no hypothesis testing. Positivism holds that the truth exists independent of external influences. In this study, critical social theory was not applicable as participants are empowered through the emancipation process. In critical research, reality is assumed to be incomplete, and its cultural studies focuses on action research. Although if applied both qualitative and quantitative, it mostly uses participants' observation, or triangulation methods. Critical realism involves quantitative approach for data collection which was incompatible with the purpose of this study as critical realism treats the world as theory laden, but not as theory determined.

Research paradigms are determined by their epistemological characteristics and ontological assumptions. The constructivist epistemology of qualitative research examines what it perceives to be a dynamic reality created by society through a holistic, descriptive, value-laden, and contextual perspective; in other words, from the people's perspective (Yilmaz, 2013:312). Conducting interpretive research within a contextual setting enhances the depth of understanding and knowledge of phenomena. This approach facilitates the interpretation of the meaning's participants attribute to their expressed views, as the research occurs within their social environment (Fossey *et al.*, 2002:727). A friendly environment enables participants to articulate their experiences more readily. Fostering such an environment strengthens the relationship between the researcher and the participant, emphasizing the socially constructed nature of reality (Fossey *et al.*, 2002:720). This is in line with an interpretive approach to the main purpose of this study to develop adoption guidelines of CC in South Africa HEIs. The next section examines the research methodology that we used for this study, considering the research paradigms that have been discussed.

### **2.3 RESEARCH METHODOLOGY**

Research methodology relates to the general research strategy used for conducting research, which will identify what methods to employ and how those methods will match the general research strategy (Alharahsheh & Pius, 2020:40). Research methodology does not prescribe a particular method for use, but rather emphasises the significance of the process pursued to achieve the objective of this study (Alharahsheh & Pius, 2020:40). Singh (2006:79) cites that a research methodology describes how a researcher moves from identifying a problem to arriving at a conclusion. By defining a methodology, you ensure that research work is conducted in a valid and scientific way (Singh, 2006:79). He adds that methodology refers to the techniques and tools used in solving the research problem. For a study to be successful, there must be correct procedures, principles, and techniques.

The perspectives and views of information technology (IT) governance and IT technical staff provided guidance in addressing the main objective of this study – to develop CC guidelines

in a South African HEI. A review of these perspectives and views led to the development of guidelines for CC adoption in HEIs in South Africa. As part of the research, the researcher evaluated the participants' narratives considering the literature's context.

### 2.3.1 Principle for Interpretative research

For conducting and evaluating interpretive studies, researchers can use a set of seven principles, as proposed by Klein and Myers (1999:70) illustrated on Table 2.2. As part of this research, it provides support.

**Table 2.2: Summary of the principles of hermeneutics and its application to this study**

Principle	Descriptions
1. The fundamental principle of the hermeneutic circle	The principles advocates that all human understanding is attained by iteration of the interdependent meaning of parts and considering the whole meaning that the parts form. This principle of human understanding is fundamental to all the other principles.
2. The principle of contextualisation	It requires critical reflection of the social and historical background of the research setting. This is to help the intended audience to see how the current situation under investigation emerged.
3. The principle of interaction between the researcher(s) and the participants	The principle requires critical reflection on how the research data were socially constructed through the interaction between the researcher(s) and participants.
4. The principle of abstraction and generalisation	It requires relating the idiographic details revealed by the data interpretation. This is done by applying principles of the hermeneutic circle and of contextualisation to theoretical, general concepts that describe the nature of human understanding and social action.
5. The principle of dialogical reasoning	The principle requires sensitivity to possible contradictions between the theoretical preconceptions guiding the research design and actual findings with subsequent cycles of revision.
6. The principle of multiple interpretations	It requires sensitivity to possible differences in interpretation among the participants and are typically expressed in multiple narratives or stories of the same sequence of events under study. This is similar to multiple witness accounts even if they all tell it as they saw it.
7. The principle of suspicion	This principle requires sensitivity to possible prejudices and systematic alterations in the narratives collected from the participants.

The following principles will be discussed.

#### 2.3.1.1 The fundamental principle of the hermeneutic circle

A key principle in the philosophy of language believes that all human understanding comes from iterating the interdependence of parts and evaluating the whole meaning that is formed from the parts. Every other principle is grounded in this principle of human understanding

(Klein and Myers (1999:71). The idea of a hermeneutic circle implies that we can understand a complex whole based on our preconceptions of its parts, as well as the relationships between them. The main aim of the researcher in this study was to develop guidelines of CC in HEIs in South Africa. The understanding was interpreted according to the participants' views.

Understanding the questions is developed based on each participant's response. After understanding is gained, each participant interprets that understanding from their own perspective (Gill *et al.*, 2008:291). Every interview followed the same principle, which applied to each individual answer and to the entire interview. New interviews were handled in the same manner, while also seeing them as a part of the entire process.

### **2.3.1.2 The principle of contextualisation**

Gumperz (1992:39) mention that by integrating broad ethnographic perspectives with specific conversation-analytic insights, he developed the concept of contextualisation to elucidate how individuals construct meaning in their interactions.

Using contextualisation, the intended audience can see how the current situation under investigation evolved by placing the subject matter in its social and historical context (Klein & Myers, 1999:73). By investigating and collecting additional data related to the background of the participants, the researcher obtains more historical understanding. Talking to participants in interviews, making sure they understand and can explain their answers, helps the researcher to understand things better.

### **2.3.1.3 The principle of interaction between the researchers and participants**

Researchers who adhere to this principle must place themselves and their subjects in a historical context. Social researchers do not just gather data like rocks at the shore. The data are all around. Interaction between the researcher and the participants, rather than fact, is the means by which the facts are produced (Klein & Myers, 1999:74). In the research process, the researcher must consider how social experiences are constructed through interactions with participants. Therefore both researchers and participants are considered important interpreters and analysts of data (Klein & Myers, 1999:74). This study involved interviews as the data collection method. Participants were given the opportunity to give full and open answers during an interview to get unbiased feedback. If the participants gave unclear responses, the researcher followed up on the same question.

#### **2.3.1.4 The principle of abstraction and generalisation**

The previous two principles focus on those aspects that are specific to the situation under study (Klein & Myers, 1999:75). Interpretive research values documenting unique situations but questions the idea of universally applicable laws governing human behaviour across cultures. However, that is not the complete picture. Interpretive field studies have been abstracted and generalised by philosophical debates (Klein & Myers, 1999:75). In this study, to aid understanding of the IT staff and academics perspectives about the CC, we had to apply logic to the gathered data. Qualitative data drive interpretive research, but quantitative data can support correctness and greater clarity of what the researcher is trying to convey, i.e. to abstract/generalise what they are seeing. Both IT staff and academics had an opportunity to offer their perspectives of CC in HEI, but it was also significant to collect all the information for purposes of identifying a common challenge.

#### **2.3.1.5 The principle of dialogical reasoning**

Using the data gathered from their research, researchers must confront the preconceptions (prejudices) which influenced their original research design (i.e. lenses through which they interpreted their research) (Klein & Myers, 1999:76). They add that as the researcher, it is essential to make the historical intellectual basis (i.e. the underlying philosophical assumptions) of this study as transparent as possible to the reader. The hermeneutical method assumes that prejudice is the basis of interpretive understanding, but researchers must differentiate true prejudices that enable understanding from false prejudices that bring misinterpretation (Klein & Myers, 1999:76). There are several voices of participants, and these voices can complement and contradict each other, as well as the literature. As part of the analysis and interpretation process, the researcher made sure that all views and expressions of the participants were considered.

#### **2.3.1.6 The principle of multiple interpretations**

Klein and Myers (1999:77) mention that by seeking out and documenting multiple perspectives with their reasons, the researcher can examine the influence that the social context has on actions under study, according to the principle of multiple interpretations. The evaluation of reasons may be influenced by issues related to power, economy, and values. In addition, researchers must examine the contradictions inherent in multiple viewpoints themselves, in order to revise their analyses accordingly (Klein & Myers, 1999:77). For this study, participant interpretations could vary, even when participants relate the same information which is related to the adoption of CC in HEIs, therefore multiple participants will differ as well. Multiple perspectives of the same event should be considered. Research

findings will reflect this complexity of voices. In this case, the context can be important. It is quite common for different participants to answer the same question differently due to their subjective perception and observations of the situations. Views about one event may be offered from multiple angles. To interpret multiple concepts derived from their empirical findings and the literature, the researcher must condense the findings and theory into a unified picture.

### **2.3.1.7 The principle of suspicion**

Klein and Myers (1999:77) cite that in this approach, the analysis of the data is clearly not sufficient to explain its significance. In this way, the researcher can understand and read the society behind the words of the actors. In this social world, there is power structure, vested interests, and limited resources to meet the goals of various actors who engage in the construction and implementation of this social world.

Critical thinking is used to collect and interpret data, interpret results, and write reports. This ensures a contextual assessment of the whole process. During data collection, the researcher is required to act with extreme understanding to avoid modifying the data collected from the subjects. Considering all contributions rather than focusing on one specific involvement alone, the hermeneutic circle principle helps in determining the understanding of each involvement in context with the broader discourse.

### **2.3.2 Theoretical grounding**

Research approaches are strategies and methodologies that cover everything from general hypotheses to specific techniques for gathering, analysing, and interpreting data (Gabriel, 2013). Hyde (2000:83) supports this by saying that inductive reasoning and deductive reasoning are two general approaches for reasoning that allow for new knowledge to be acquired.

Johnson-Laird (1999:110) urges that in reasoning, perceptions, ideas, and assertions are used to draw conclusions. Goel *et al.* (1997) mention evaluating arguments as a way of reasoning. Arguments give some reason for accepting another proposition based on one or more propositions. New knowledge can be acquired by both inductive reasoning and deductive reasoning, two general approaches to reasoning. A theory is built by inductive reasoning by first observing specific examples and then establishing generalisations about them. Deductive reasoning is the process of determining whether a widely accepted theory can be applied to a specific situation based on an established theory or generalisation (Heit & Rotello, 2010). A comprehensive approach to qualitative data analysis can be achieved by

applying both deductive and inductive approaches. To make sense of data and understand what's happening, one must immerse themselves in it by reading and digesting (Kumar & Ujire, 2024).

### **2.3.2.1 Inductive**

Hyde (2000) defines inductive approach as a method of building theory starting by observing specific instances and then attempting to generalise the phenomena under investigation. DeCarlo (2018) explains that an inductive technique requires a researcher to start by gathering information that is pertinent to their area of interest. After gathering a sizable amount (Streefkerk, 2023) of data, the researcher will pause data collecting to stand back and gain a bird's eye view of their data. At this point, the researcher examines the data for patterns while trying to create a hypothesis that may account for those trends. Streefkerk (2023) adds by saying when there is little to no existing literature on a topic, it is common to perform inductive research, because there is no theory to test. The inductive approach consists of three stages: Observation, seeking patterns and developing a theory or general (preliminary) conclusion (Streefkerk, 2023). Kumar and Ujire (2024:60) agree by saying in an inductive research approach, the researcher gathers relevant data on the topic. After collecting a lot of data, they take a step back to see the big picture. At this point, they try to come up with a theory that explains the patterns they have found in the data.

### **2.3.2.2 Deductive**

Deductive research involves reading existing ideas about the subject being studied, reviewing what others have done, and then testing hypotheses that result from those theories (DeCarlo, 2018; Streefkerk, 2023). Essentially, deductive reasoning uses established theories to test whether they apply to a specific situation based on the generalisations and hypotheses (Hyde, 2000:83). A deductive approach may be a form of scientific investigation. In deductive reasoning, it is impossible to accept the premises and reject the conclusions. As a starting point, the deductive approach to accounting theory starts with specifying the objective. Once the objective is defined, it is important to clarify the definitions and assumptions. Based on the definitions and assumptions developed by the researcher, a logical structure will be developed to achieve the goal.

In this study, a hybrid inductive and deductive approach was adopted, given existing theory about CC in a South African HEI and the data collected by the researcher from the participants. The researcher initially derived a theory from the literature review, employing a deductive approach. Subsequently, by utilised an inductive approach, gathering data, observing, and forming theories based on data patterns.

The study employed a deductive approach for analysing the literature review and an inductive approach for examining the data collected from the participants.

The next section explains research methods and the one that was most applicable for this study.

### **2.3.3 Research methods**

Williams (2007:65) mentions that research can be carried out in three ways: quantitatively, qualitatively, or mixed methods. He adds by saying that according to the research question, the researcher predicts what type of data is needed. Are numeric, textual, or both numeric and textual data required, for instance? After assessing each approach, the researcher chooses one. Research questions requiring numerical data are typically answered by quantitative research methodology, those requiring textual data by qualitative methodology, and mixed method research questions requiring both numerical and textual criteria are usually answered by mixed method research methodologies (Williams, 2007:65).

#### **2.3.3.1 Qualitative research**

Lune and Berg (2017:12) state that researchers with a qualitative focus examine a variety of social settings and the people or groups that inhabit them to find answers. They add that researchers who study qualitative data are most interested in human behaviour and the settings in which they exist. By observing symbols, rituals, social structures, social roles, and so on, residents of these settings make sense of their surroundings. Qualitative research is crucial to understanding everyday life. Starman (2013:30) mentions that qualitative research emphasises subjective experiences and meanings as they pertain to the individual. It is characterised by the interpretative paradigm. Research results are largely influenced by a researcher's subjective view of a particular situation. A qualitative inquiry seeks to understand what a social or human issue means to an individual or a group (Creswell, 2003, 2017). There are no rigid guidelines for the final report. In this context, ones who support inductive research emphasise an attention to individual meaning, as well as the importance of rendering complex situations (Creswell, 2017).

#### **2.3.3.2 Quantitative research**

According to Khaldi (2017:19), quantitative studies fall into two categories: experimental and non-experimental. Depending on this study, it may be a true experiment, a quasi-experiment, or a single case study. Due to its focus on a single subject, it is rarely used in educational research. It is important to remember that single-subject studies are often seen as true experiments as they have a long and respected history in empirical psychology research

(Khaldi (2017:19). The distinction between them is that in a true experiment, a researcher can manipulate the variables under controlled conditions, whereas in a quasi-experiment, the variables are not targeted. Further, in this study the participants were randomly divided into experimental and control groups.

In psychosocial research, quantitative research methods are appropriate when factual data are required to answer the research question; when general or probability information is sought on opinions, attitudes, views, beliefs or preferences; when variables can be isolated and defined; when variables can be linked to form hypotheses before data collection; and when the question or problem is known, clear and unambiguous (Hammarberg *et al.*, 2016:495).

### **2.3.3.3 Mixed method**

Sandelowski (2000:246) cites that in recent years, researchers have increasingly used mixed-method techniques in their studies to enhance their insights and expand their scope. (Borrego *et al.*, 2009:57) mention that both quantitative and qualitative data are collected concurrently or sequentially; in a mixed-methods study, quantitative data are given a high priority. Research questions that are complex can be explored in a pragmatic way using a mixed-method approach (McCusker & Gunaydin, 2015:541).

This study would therefore be better suited to consider qualitative approaches in addressing its research questions. Elliott *et al.* (1999:216) state that as people encounter situations, engage in them, and live through them, qualitative research seeks to understand and represent these experiences and actions. For this study the researcher interacted with participants (IT governance and IT technical staff) applying the qualitative approach to seek more experience, knowledge and understanding of CC in HEIs in South Africa.

### **2.3.4 Case study method**

Morland (1992) defines case study as an in-depth study of a single phenomenon, whose boundaries and content can be conceptually and empirically clarified. He mentions that there are two important elements to this definition. Firstly, the phenomenon has a clear content, and secondly, it also has boundaries, which enable it to be examined. Case studies are used in various investigations, primarily in sociological studies, but also increasingly in teaching (Tellis, 1997:4). On the other hand, a case study is used to highlight the details from multiple perspectives. Widdowson (2011:26) mentions that case studies offer a valuable method of investigating and researching a single case. By replicating successful outcomes across similar cases, the effectiveness of the approach under investigation can be proven.

VanWynsberghe and Khan (2007:82) mention that case study can be defined as a method, strategy, research design, or methodology. Case study as a methodology would imply that a case study is a technique, procedure, or method for gathering evidence. Among the well-known case study research techniques are interviews, participant observation, and document analysis. In this study a researcher used the interviews techniques as data were gathered from IT governance and IT technical staff from a South African HEI. To develop a field's knowledge base, case studies are particularly useful. Case studies can challenge current theories and be a source of innovation (Queirós *et al.*, 2017:377).

The purpose of qualitative research is to explore and understand the meaning individuals or groups assign to a particular social or human issue (Creswell, 2017:32). Researchers develop research questions and procedures, collect data in the setting of participants, analyse the data inductively building from particulars to general themes, and interpret the data. This study explores participants' knowledge and skills in CC within HEI, examining factors driving or hindering the use of CC applications. It aims to provide insights for improving technology integration in educational contexts.

The following section describes the interpretive research plan for this study, including how participants were selected as well as how data were collected and analysed.

#### **2.3.4.1 Case study as an appropriate method for this study**

Schell (1992:2) mentions that researchers can maintain the holistic characteristics of real-life events while investigating empirical events using the case study method, which is the most flexible of all research designs. It refers to an empirical inquiry that addresses a real-life or hypothetical issue.

- investigates a contemporary phenomenon within its real-life context,
- when the boundaries between phenomenon and context are not clear; and in which
- multiple sources of evidence are used (Schell, 1992:2).

Through the utilisation of a diverse array of data sources, qualitative case studies offer researchers a unique opportunity to thoroughly investigate and describe phenomena within their contextual frameworks (Baxter & Jack, 2008:544).

The relative usefulness and application of case studies, indeed any type of qualitative research, is subject to interpretation. As a result, this study adopted a qualitative case study approach, because this study focused on investigating or gathering more in-depth knowledge of CC adoptions in HEIs. A case study is a comprehensive examination of a specific subject, including a person, a group, a place, a phenomenon, an event, or an organisation. In

education, clinical, business, and social research, case studies are commonly use (Shona, 2019). When you want in-depth knowledge of a specific topic in the real world, a case study is appropriate for research. In this case study, you'll learn about the important features, implications, and meanings of the case (Shona, 2019).

### **2.3.5 Data collection method**

Luloff and Elmendorf (2001:140) mention that during data collection, communication processes need to be effective so that it can empower the participants to communicate, facilitate and listening reduce conflict. Collaboration during data collection should be promoted (Luloff & Elmendorf, 2001:140). Collaboration occurs when people explore their differences constructively and seek solutions that go beyond their own perceptions. The researcher in this study collaborated with participants with the aim to seek knowledge and understanding about CC adoption guidelines in HEIs in South Africa. Research in-depth interviews is a direct, personal, and an unstructured interview with each respondent. Here, the researcher asks a generic question and encourages the respondent to speak freely about the topic (Queirós *et al.*, 2017:378). They add that a deep interview provides a lot of rich information while also allowing the researcher to ask follow-up questions, get additional information, explain previous answers, and establish connections between topics. Alshenqeeti (2014:41) mentions that during an interview, people have a variety of powers that are interrelated. Interviewers may (intentionally or unintentionally) exert such power on their interviewees, but it is not a prerequisite for that to happen. This relationship would be better balanced by extending the interview.

Campbell (2015:202) mentions that during interviews in case study design, participants are given the opportunity to tell their own stories by asking how and why questions. An interview can then be conducted after explaining the purpose of this study and getting consent from the participant. According to De la Croix *et al.* (2018:452), an interview can be structured or semi-structured; an interview can be structured if the same questions are asked to each interviewee in the same order. Open interviews start with a question, but the outcome is largely determined by the interviewee's response. Semi-structured interviews fall somewhere between these two methods, using a few questions to address predetermined themes, but leaving more room for the interviewee's thoughts and for potential follow-up questions. They add that in health professions education research, semi-structured interviews are common.

In this study the interview protocol was semi-structured, with probes and follow-up questions. As part of the interview process, the researcher acted as an active listener to reduce bias. In this study, IT governance and IT technical staff from the HEI were interviewed. This enabled the researcher to develop CC adoption guidelines in HEIs. Based on the literature review,

semi-structured interviews were conducted with IT governance and IT technical staff. Researchers conducted semi-structured interviews using case study questions based on the literature to develop CC adoption guidelines at HEIs in South Africa.

#### **2.3.5.1 Participant selection**

Participants were selected based on their knowledge of or insight into CC at an HEI. According to Lopez and Whitehead (2013:124), in qualitative research, effective sample selection is of the utmost importance, since inappropriate procedures may seriously impact the findings and results. Non-probability sampling is used in qualitative research. In qualitative research, non-probability sampling occurs when researchers select a specific group or when the total population is unknown.

Quantitative research is focused on understanding observed phenomena in a specific context with specific individuals, rather than trying to generalise from samples to the population as a whole (Johnson *et al.*, 2020:141). Participants in this study were the IT governance and IT technical staff from an HEI in South Africa. Prior to appointments, participants were informed about the purpose of the research and why they were asked to participate. In selecting participants for interviews, the researcher looked for those with experience and knowledge in the implementation of CC in a South African HEI.

#### **2.3.5.2 Data analysis method**

Jacelon and O'Dell (2005:217) mention that after data collection has been completed, the researcher must begin with data analysis. Data collection and analysis are described by (Mariano, 1995:479) as proceeding hand-in-hand. As soon as the data have been grouped into manageable portions with coding, the interpretation process begins. The data collection and coding phases of the research process overlap, although this phase of the research process can last well after data collection (Jacelon & O'Dell, 2005:218).

Alase (2017:15) mentions that the process of data coding often arises during the process of analysing interview transcripts for a qualitative research study, which is a very frustrating undertaking for novice researchers. Often, data coding is time-consuming and unnecessarily difficult. One of the most important parts of qualitative research is data coding; however, data coding processes and procedures are often confusing and frustrating.

Thomas (2010:317) states that researchers who use interpretive methods seek to gather data by interacting directly with the phenomenon being studied. Qualitative case studies emphasise the deductive interpretation of data through direct observation of what has been

observed by the researcher, as well as what the subjects have experienced and reported. Analysing qualitative data aims to uncover patterns, themes, and meanings.

Thomas (2010:317) discusses understanding the importance of searching for patterns in the data that may explain or identify causal relationships. In this study the researcher focused on the entire volume of information, then broke it apart and reassembled it to make sense. Organising data into categories allows researchers to make comparisons and contrasts between patterns, to reflect deeply on certain patterns and complex threads, and to make sense of them. The data that were collected from IT governance and IT technical staff from an HEI in South Africa were analysed and interpreted.

## 2.4 RESEARCH DESIGN

This section describes the research design. Akhtar (2016:68) explains that the purpose of research design is to outline the proposed research project; the research design is the glue that connects all parts of the project. A research design is an approach of implementing a study that has clearly defined its structures. The purpose of this study was to develop CC adoption guidelines in HEIs in South Africa. As shown in Figure 2.1 below, the researcher analysed the pertinent literature followed by selecting an appropriate research methodology to answer the research questions. In turn, this directed the process of gathering and analysing data.

Baskarada (2014:1) cites that researchers often conduct case studies on individual units such as people, communities, and organisations. The researcher can gain a deeper understanding of a research problem or situation through case studies by gaining a holistic perspective of the issue (Baskarada, 2014:1). Therefore, the researcher used the qualitative approach in this study which supported by case study design to gain a better understanding from IT governance and IT technical staff about the knowledge they have related to the adoption of CC in an HEI.

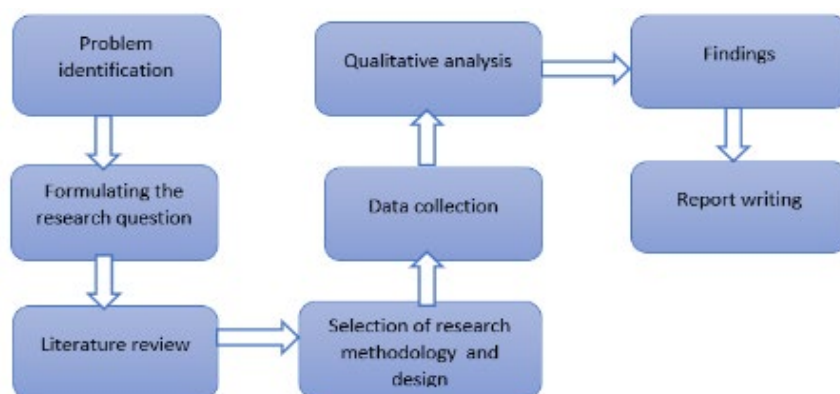


Figure 2. 1: Presentation of the research design process

Interviews were used by the researcher to collect information for a case study. The actions conducted during data gathering and analysis flow logically from the research questions to the research findings and concluded by report writing, as shown in Figure 2.1. Participants from an HEI in South Africa were interviewed individually. Within the interpretative paradigm, the case study approach was used by the researcher. The IT governance and IT technical staff selected from a South African HEI should have knowledge directly or indirectly of the topic or to questions that were asked. The data gathered from IT technical staff and IT governance were analysed by the researcher to find recurring or salient themes. In-depth interviews were used by the researcher to acquire a deeper knowledge from the participants.

There should be a clear understanding of why a study is being conducted by a researcher. It is important to understand what type of evidence is being required and variations that could be expected (Baskarada, 2014:6). The researcher should identify the steps to take if such variations occur (including what to do in such a case). In order to ensure the validity of most of the main research topics, researchers should obtain sufficient confirmatory evidence prior to the data collection process (Baskarada, 2014:7). In this study, the researcher has a deep understanding why this study was conducted, as the researcher gave a brief explanation to the participants before the data collection process started.

After the data collection needs were analysed, the first step was to prepare the data and make sense from the data that have been collected (Figure 2.1). The data were simplified and analysed to make it reliable. During the analysis process the researcher was able to identify the participants' knowledge of identifying understanding of CC adoption in an HEI. The researcher was then able to identify the patterns that would make the researcher aware about any conflict or supporting themes. Therefore, the data were transformed into codes, themes and groups so that it could be interpreted.

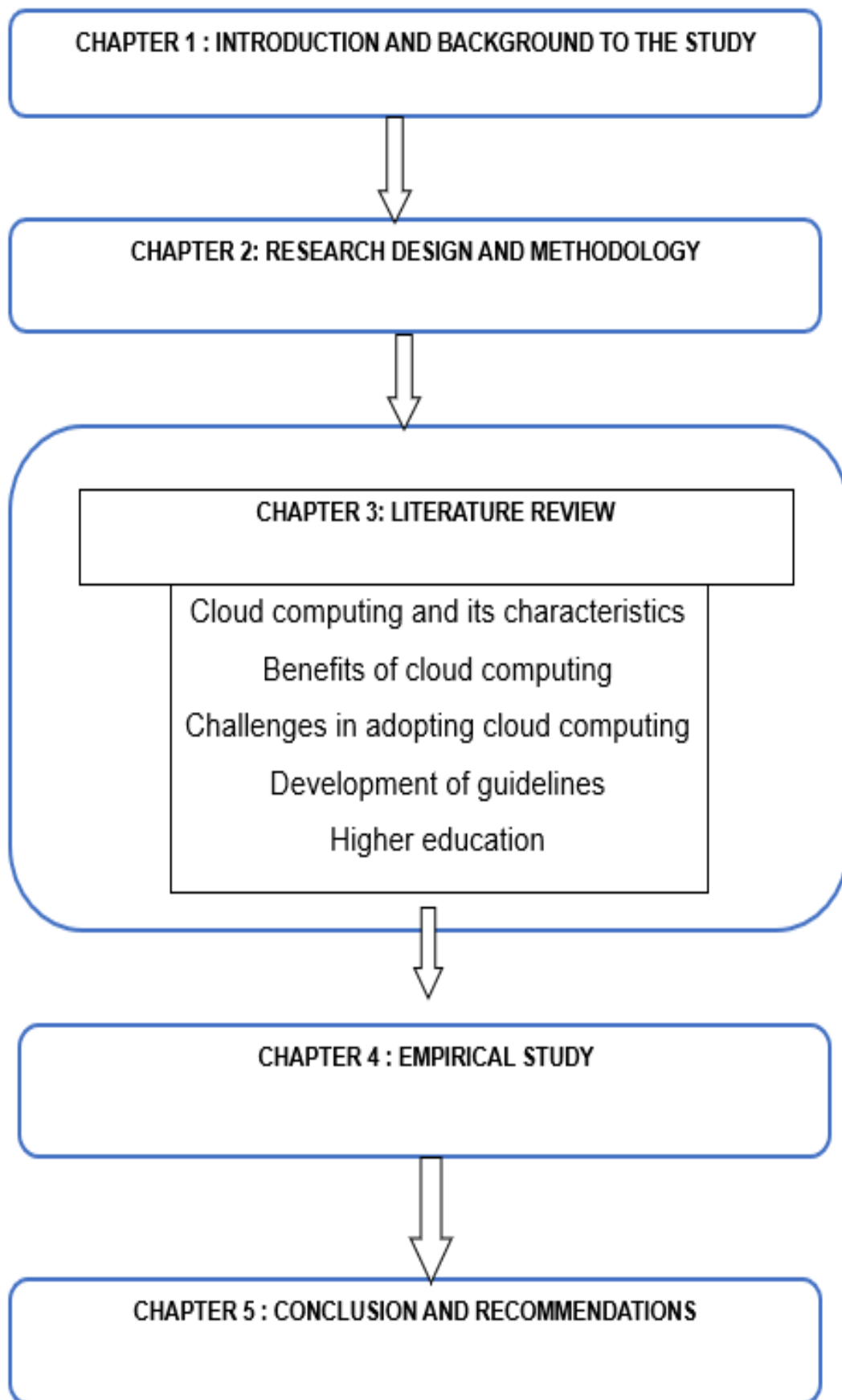
## **2.5 SUMMARY**

The purpose of this study was to develop CC adoption guidelines at HEIs in South Africa. The chapter outlined the theoretical objective, it discussed different types of paradigms, and identified the interpretative paradigm as an appropriate paradigm for this study. In addition to describing how interpretive research was used in this study, it described the research design, including the process for choosing participants, evaluation, and ethics of the research, including methods for gathering data and analysing it.

The researcher discussed CS in detail as an appropriate research method to this study. The seven principles of interpretative research mention by Klein and (Klein & Myers, 1999:70) have

been addressed in detail and how they were implemented in this study. This study strategy, approach, and methodology were outlined in this section.

The next chapter focuses on the literature review of this study, specifically on exploring key concepts. This involves an investigation of previous studies that have been conducted on the adoption of CC in HEI.



## CHAPTER 3: LITERATURE REVIEW

### 3.1 INTRODUCTION

The purpose of this study was to develop adoption guidelines of cloud computing (CC) in a South African higher education institution (HEI). To achieve this, the second goal (T02) of this chapter is to review literature, discuss the background of cloud computing, and explore its characteristics and deployment models. The chapter focuses on the benefits of CC and developing guidelines for its use in HEIs. It addresses theoretical objectives T02, T03, T04, and T05 to provide a theoretical background and review literature on CC adoption guidelines in HEIs. The chapter aims to extract guidelines from the literature review on facilitating CC adoption in HEIs, addressing the study's first empirical objective (E01).

Cloud computing, as a main paradigm of resource and service delivery, is considered as the next evolution of computing (Qasem *et al.*, 2019:63722). Sirohi and Agarwal (2015:115) emphasise that CC is a paradigm or way of enabling convenient access to shared computing resources on demand through the Internet. CC is flexible, collaborative, cost-effective and scalable; it is widely adopted in private and public organisations.

Higher education institution, among other organisations, have gained significant benefits from CC (Qasem *et al.*, 2019:63722). An easy-to-adopt technology, CC comes with a simple and latest architecture. According to several research studies, cloud technology has many benefits for the education sector, and this was addressed by theoretical objective (T03). Generally, CC is used in HEIs for student information systems and learning management systems (Attaran *et al.*, 2017:25; Mell & Grance, 2011; Pardeshi, 2014a). These days, information technology (IT) is widely used in various fields of life, and this is possible because it has the capacity to cooperate with a wide variety of knowledge fields (Wijaya & Avian, 2022:471). According to Shayan *et al.* (2014:416), CC has changed the world of IT services in a number of ways: development, deployment, scalability, updating, maintaining, and charging.

The chapter is divided into sections. Section 3.1 presents the introduction. Section 3.2 focuses on CC, a CC definition, its models, and characteristics. Section 3.3 focuses on the benefits of CC. Section 3.4 describes the challenges in adopting CC. Sections 3.5 and Section 3.6 focus on the development of guidelines and key principles. Section 3.7 focuses on higher education. Section 3.8 focuses on the guidelines extracted from literature. Section 3.9 is the summary of the chapter.

## 3.2 CLOUD COMPUTING AND ITS CHARACTERISTICS

This section defines CC, it discusses all CC models, CC model deployment and higher education in the context of CC.

### 3.2.1 Defining cloud computing

Cloud computing has been defined differently by different authors, with some disagreeing that it is merely another name for a service that has existed for some time. Mell and Grance (2011:2) define CC as:

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

Qian *et al.* (2009:627) define CC as “a kind of computing technique where information technology services are provided by massive low-cost computing units connected by Internet protocol networks”.

Winkler (2011:2) cites that CC is defined as a computing environment or IT model that comprises technical components (software, hardware, networking and services) and the processes involved in the deployment of these components, which collectively enable us to build and deliver cloud services via the Internet or a private network Attaran *et al.* (2017:22) urge that there are many ways in which CC is used in IT today. Often, the term cloud refers to platforms that enable distributed computing – clusters of servers, a network, software, interfaces, among others that are needed to execute specific tasks. In computing terms, this cluster is delivered to the user as a service which the user can access as and when needed.

Cloud computing can be defined and interpreted in countless ways from multiple sources. As a result, the term cloud computing developed from the use of cloud shapes to represent certain types of networks, including the Internet as well as internal networks (Gorelik, 2013:8). Depending on the source, (Gorelik, 2013:8) says that CC may be defined as a set of applications delivered as services that are combined with data centre hardware and software that enable the applications. He adds by saying that CC, according to others, is a business model rather than a technology. Armbrust *et al.* (2009:4) refers to CC as both the software and hardware in data centers that deliver applications over the Internet to provide services to users. As a result, this process has been referred to as Software as a Service (SaaS).

Xi (2014:14) mentions that using the CC, consumers can access on-demand computing resources across the Internet. In terms of IT equipment, there are few or no upfront costs for CC adopters. Cloud computing is most important because it allows for the expansion of computing resources and data for an environment with constantly varying requirements. CC offers an IT framework that is flexible enough to adapt to business needs, as evident from the definition of CC. Additional characteristics of CC have been outlined by (Nordin *et al.*, 2017:3).

As a result of the preceding definitions, CC can be summarised as follows: it refers to the provision of resources via the Internet as a virtual pool. The CC model refers to the use of networked computing for delivering services and software to users on-demand. According to NIST, the definition of CC is the most appropriate for this study since it has been used extensively in similar studies. The purpose of this study focused on the development of CC guidelines in South African HEIs. The next section explains the concept of CC.

### **3.2.2 Characteristics of cloud computing**

The National Institute of Standards and Technology (NIST) identifies the following five characteristics of CC (Hogan *et al.*, 2011:14; Mell & Grance, 2011:2; Rashid *et al.*, 2019:421).

In the CC at the HEI, the growth rate or the adoption of CC is staggering. In addition, there is an increasing number of benefits that CC can provide. CC has become more common among HEIs and has been the subject of several questions and concerns. Due to the large number of consumers, HEI can pool their resources online. Online information can be accessed by consumers (end-users) via their mobile devices (such as laptops, tablets). These characteristics are listed below.

#### **3.2.2.1 On demand service**

Mell and Grance (2011:2) mention that it is possible for a consumer to unilaterally order computing capabilities for themselves, such as server and network storage, without interacting with each service provider. This has been supported by Britto (2011:1064) and Novkovic (2017), saying that with computing capabilities and resources provisioned automatically, customers can handle their computing needs on their own without requiring any human intervention. Therefore, manufacturing organisations can incorporate additional computing resources as needed without having to go through a cloud service provider.

There are only two things that need to be true for on-demand self-service to work: availability of the service must be constant (or some reasonable approximation of constant), and the client organisation must be able to modify the service received, without contacting the hosting company (Olive, 2011:2). The customer can adjust their services without any assistance,

which means that users have access to self-service functionality for uploading, building, deploying, scheduling, managing, and reporting their business (Erkoç & Kert, 2011:3). Shaikh and Meshram (2021:65) mention that by using an automated process, a consumer can provide computing functions unilaterally, such as server time and network storage.

### **3.2.2.2 Broad network access**

Novkovic (2017) relates that CC resources are accessible over the network by a variety of platforms. As a result, cloud services are typically accessible over an Internet connection. CC and broad network access rely heavily on network bandwidth and latency, since they help to ensure a high quality of service on the network (Novkovic, 2017). This is particularly important for serving time-sensitive manufacturing applications. Especially for first-time sensitive applications in manufacturing this is crucial. Olive (2011:2) cites that an application with broad network access will be accessible from nearly any networked appliance. There are a variety of options; including, but not limited to a laptop, a desktop computer, a smartphone, and a tablet device able to access these computing resources via the Internet and use them at the end-user's site through the use of heterogeneous platforms. Device's built-in web browser is one of the most common methods of accessing the wide network, since it is one of the most ubiquitous' clients available (Dillon *et al.*, 2010:27; Olive, 2011:2; Shaikh & Meshram, 2021:65).

### **3.2.2.3 Resource pooling**

Cloud computing providers pool their computing resources in order to serve multiple consumers, either by using multi-tenancy, or a virtualisation model, in which physical and virtual resources are dynamically assigned and reassigned based on the needs of the consumer (Dillon *et al.*, 2010:27). Asset pooling is done by using multi-inhabitant models to provide support to clients at the same time (Yadav *et al.*, 2022:231). These assets include aspects such as data transmission from the organisation, virtual machines, handling power, and inventory limits, done in such a way that the virtual and actual assets are effectively designated and dealt with according to the customer's requirements. In addition, these resources are pooled together in multitenant cloud services, such as network bandwidth, virtual machines, memory, processing power, and storage, so that they can serve multiple customers simultaneously. Furthermore, both physical and virtual resources are dynamically allocated based on customer requirements (Britto, 2011:1064).

Arutyunov (2012:174) explains that through multi-consumer computing, service providers can allocate physical and virtual resources based on consumer demand and pool resources to serve multiple customers simultaneously. The provider controls the actual allocation of

resources provided to the consumer, whereas consumers only control the basic parameters of the service (for example the volume of data or the access speed) (Arutyunov, 2012:174). In some cases, consumers may be able to choose the data centre where the desired data is processed.

#### **3.2.2.4 Rapid elasticity**

According to Dillon *et al.* (2010:27), consumers are able to use computing resources to scale up whenever the need arises, and to downscale once they have done. They further mention that customers do not have to commit to anything upfront. In addition, resource provisioning appears infinite to them, so they can rapidly increase their consumption to meet peak demand at any time. It is possible to deploy and scale resources at any quantity and at any time based on demand (Britto, 2011:1064). The cloud offers consumers flexible access to computing resources that can be scaled up or down when needed (Kaur & Singh, 2013:473).

#### **3.2.2.5 Measured service**

Shaikh and Meshram (2021:65) cite that the systems that utilise cloud resources automatically control and optimise resource utilisation by using billing capabilities (pay-per-use) at a certain abstraction level (e.g. storage, processing, bandwidth, and users). The consumption of CC is only charged based on what the consumer has used (Kaur & Singh, 2013:473). Britto (2011:1064) adds to this argument by saying that the vendor monitors, controls, and reports metered customer usage of resources and services in order to maintain high levels of transparency between customer and vendor. Deployment models are also used to classify cloud service. Providers can charge by the hour for the use of resources and provide only what is needed to meet the demand with this capability.

The next section discusses the CC models.

### **3.2.3 Cloud computing models**

Cloud computing consists of three models that are Infrastructure as a service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). These services provide support and are part of the delivery system of CC, based on findings in prior studies (Gong *et al.*, 2010:276; Hogan *et al.*, 2011:15; Liu *et al.*, 2011a:1; Mahmood, 2011:122; Mohammed & Zeebaree, 2021:20; Parekh & Sridaran, 2013:38; Sanger & Johari, 2022:490). CC systems include both the client and the server, as well as three primary methods of service delivery (Mohammed & Zeebaree, 2021:20; Purushoththaman & Bhavani, 2022:562). Britto (2011:1065) urges that there are several differences between these three service models, including the nature of the service, the level of customers engagement and vendor control. In addition, between these

models; companies can and do utilise separate cloud service models based on specific client needs for various departments within the company. The three cloud delivery models are explained in detail below.

### **3.2.3.1 Software as a Service (SaaS)**

Software as a Service (SaaS) refers to the model of distributing applications by making them available on a network, generally the Internet, hosted by a vendor or service provider (Kuyoro *et al.*, 2011:251). They are becoming more prevalent, making SaaS an increasingly popular delivery model. In SaaS, cloud services are typically provided by cloud applications supported by cloud infrastructure (Noor, 2008:76). In addition, the application can be accessed by consumers via a web browser installed on various client devices. There is no underlying infrastructure that the consumer needs to manage or manipulate, such as a server or an operating system; they may, however, be given some limited control over application configurations (Noor, 2008:76).

A multitenant architecture allows a single application to be accessed by thousands of customers through the browser (Knorr & Gruman, 2008:1). Unlike traditional hosting, there is no upfront investment in hardware or software licensing on the customer's side, and on the provider's side, the costs are low when there is only one app to maintain. Almost everyone has already used this type of cloud service at some point (Neto, 2011:3). He says SaaS cloud models include both the software and all the infrastructure provided by the service provider. HEIs can access this service via a web interface. There is a wide variety of services available to consumers, from e-mail services like Gmail to financial products like Mint (Neto, 2011:3).

SaaS is a form of IT solution that is accessible online and is managed by the software provider rather than by your company (Holistic CIS, 2019).

The following are examples of SaaS (Purushoththaman & Bhavani, 2022:566).

- E-mail and office productivity: In this category are applications such as e-mail clients, word processors, spreadsheets, and presentations.
- Billing: Various billing monitoring and management applications are available.
- Customers Relationship Management is a typical call-centre app. It is based on how the users use the system and the products and services to which they subscribe.
- Financials: Accounting applications record and report financial activities such as processing of expenditures, generating invoices, payroll, and tax management.

Gorelik (2013:20) cites that SaaS providers control the software application. A few examples of SaaS applications are online mail, project management software, customer relationship management software, and social media platforms.

The SaaS model does not require the customer to buy software, but instead allows the customer to rent it for a monthly or per-use fee (Mather *et al.*, 2009:18). These services are sometimes provided free of charge for limited periods of time; hardware, software, and support are typically included in the purchased service. It can be accessed from any authorised device. Mary and Rose (2020:5469) state that SaaS has become increasingly popular in recent years. The purpose of this study was to develop adoption guidelines of CC in South African HEIs. The CC model (SaaS) is ideal for HEIs because they only pay for what they use, for instance Microsoft 365 applications, online mail, and financial products. The transition of higher education sectors towards SaaS platforms facilitates a reduction in the number of servers required. SaaS represents a significant advancement for higher education institutions.

### **3.2.3.2 Platform as a Service (PaaS)**

In PaaS, clients do not need to develop infrastructure for their applications because the model offers pre-built application platforms (Gorelik, 2013:20). Based on the application requirements, PaaS automatically scales and configures required infrastructure components. In PaaS, developers acquire applications and platforms including tools, libraries, and services based on the cloud infrastructure and provide them to developers (Noor *et al.*, 2018:76).

Rashid and Chaturvedi (2019:422) mention that these services are more advanced versions of CC. Cloud service providers offer, run, and maintain both operating systems (i.e. the operating system) and other computing resources through PaaS (Rashid & Chaturvedi, 2019:422). They further explain that application development, hosting, and support are also included in PaaS services. Additionally, collaboration, database integration, security, web service integration, and scaling can be provided. Users do not need to manage their own hardware or software resources, and there is no need to hire experts to do the work.

Therefore, that means HEIs do not develop their own infrastructure; it is provided by the cloud service providers. Ouda *et al.* (2022:199) mention that it depends on the network and web browser how PaaS is secured. An application security level consists of two primary software components: application security on the user side and platform security on the platform side. The providers, who safeguard user applications as well, are therefore responsible for the platform's security (Ouda *et al.*, 2022:199).

The following are examples of PaaS (Stephen & Raza, 2019):

- AWS Elastic Beanstalk,
- Windows Azure,
- Google App Engine,
- Apache Stratos, and
- The OpenShift.

### 3.2.3.3 Infrastructure as a service (IaaS)

In IaaS cloud service providers, the consumers will have access to resources such as processors, storage, networks, and other essential computing resources, and it enables the consumer to run arbitrary software, including operating systems and application software (Zissis & Lekkas, 2012:584). In addition, operating systems, storage, deployed applications, and networking components are under the control of the consumer. Infrastructure as a service makes use of dedicated CC resources that are shared only by contracted clients, typically at a pay-per-use rate. As a result, there is no need for huge upfront investments in computing hardware such as servers, routers, and processors (Kuyoro *et al.*, 2011:250; Ramgovind *et al.*, 2010:2).

Infrastructure as a service allows consumers to control the processing and storing of data (Arutyunov, 2012:174). By using this feature, consumers can deploy and run arbitrary software, such as operating systems, platforms, and applications. Consumers have limited control over a set of networking components and can manage operating systems, virtual storage, and deployed applications (Arutyunov, 2012:174). The main physical and virtual resources of a cloud are managed by the cloud provider, including the network, the servers, operating systems, and storage systems.

The purpose of this study was to develop adoption guidelines of CC in South African HEIs. The researcher has identified three different cloud computing models and has explained the differences between them. It has been explained how CC models can be implemented in the higher education sector. Dogra and Kaur (2013:332) mention that by deploying, storing and networking, consumers can run random software, including operating systems and applications. Cloud infrastructure may not require consumer management or control, but consumers may be able to manage operating systems, data storage, and deployed applications, along with certain networking components (Dogra & Kaur, 2013:332). Clients of IaaS clouds directly utilise the IT infrastructure that is provided.

The following are examples of IaaS (Stephen & Raza, 2019):

- Digital Ocean,

- Amazon Web Services (AWS), Microsoft Azure, and
- Google Compute Engine (GCE).

Based on Table 3.1 (Bokhari et al., 2016:894), a comparison of SaaS, PaaS and IaaS services based on theoretical papers that address many factors are illustrated.

**Table 3.1: Comparison of cloud computing models (Bokhari et al., 2016:894)**

Item	SAAS	PAAS	IAAS
<b>Level of control</b>	Usage and usage-related configuration	Limited administrative	Full administrative
<b>Consumer activities</b>	Cloud service is configured by the user.	Provide testing, development, management, and deployment of cloud-based solutions.	Installation, management, and monitoring of software required for configuring and setting up bare infrastructure.
<b>Characteristics</b>	<p>Using a one-to-many mechanism, users have access to applications at anytime from anywhere.</p> <p>Commercial software is accessed via web.</p> <p>Software upgrades and patches do not need to be managed by the user.</p> <p>Different software pieces can be integrated using Application Programming Interfaces.</p>	<p>A cloud-based platform is provided for users to develop applications.</p> <p>Application development services including testing, deploying, hosting, and maintaining.</p> <p>Different user interface scenarios can be modified, created, deployed, and tested using web-based tools for UI creation.</p>	<p>A virtualised hardware and storage platform is provided on top of which users can build their own infrastructure.</p> <p>Allows for dynamic/self-scaling.</p> <p>Multiple users can use the same hardware.</p> <p>Supported OS and Platform independent.</p>
<b>Provider activities</b>	The management, maintenance, and implementation of cloud services as well as monitoring the use of clouds by users	Platform configuration and provisioning required infrastructure, middleware, and other IT resources. Monitor cloud usage by consumers.	Cloud computing service providers are responsible for managing and provisioning storage, physical processing, hosting, and networking the required monitoring of cloud usage by consumers.
<b>Service available</b>	E-mail, office 365, Automation, website & Virtual desktop, Salesforce.com, Google documents, Clarizen.com, project management	Development integration, service and application test.  Google App Engine, Microsoft Azure.	Virtual machines, operating systems, network storage, Amazon.

### **3.2.4 Cloud deployment models**

The NIST cloud description identifies four deployment modes for cloud infrastructure: public cloud, community cloud, private cloud, and hybrid cloud (Liu *et al.*, 2011b:10). Essentially, differences are measured by the degree to which the computing resources are made exclusive to a cloud consumer. Mahmood (2011:122) urges that there are three ways to deploy and classify CC, including private, public, and hybrid cloud. There are different ways to construct and implement CC environments, and there are also different ways to access and use them (Von Faber:45).

In cloud deployment models, the infrastructure for the deployment is determined by where it resides and by whose authority it is controlled (Rountree & Castrillo, 2014). It is important to decide which deployment model you should use when deploying a cloud.

A cloud deployment model describes how resources will be shared through the cloud. There are three categories of deployment methods that are discussed below.

#### **3.2.4.1 Public cloud**

Public clouds are ones where cloud infrastructure and computing resources are made accessible to the general public via the Internet (Liu *et al.*, 2011b:10). They add that public clouds are owned and operated by companies that sell cloud services, and they serve a wide range of clients. Mary and Rose (2020:5468) say that the third parties manage, maintain, and administrate the pool of resources and the entire cloud infrastructure in this model. By acquiring an agreement with a trusted cloud service provider, HEIs can adopt the application and services.

Mahmood (2011:122) states that an external cloud is a service provided by a third party that is hosted and managed by a cloud service provider. He adds that public clouds are also known as external clouds. It is the cloud provider's responsibility to install, provision, manage and maintain the system (Mahmood, 2011:122). Rostami (2021:16) suggests that through the Internet, end-users would have access to third-party services and resources. The service provider would host and secure the customer's applications and data on its infrastructure. A multitenant environment would be one in which the end-users only pay for the resources they use. Data centres would be inaccessible to end-users (Rostami, 2021:16). In a virtual computing environment, resources are shared among multiple virtual nodes, accessed by Application Programming Interface (APIs) built on top of the physical hardware.

### **3.2.4.2 Private cloud**

In this model, the service and data would be managed by the organisation exclusively for that specific purpose, but they would enjoy all the benefits of a public cloud (Rostami, 2021:16). Hence, there would be no multitenancy involved. The customer usually gets more administrative overhead with private cloud computing although it gives them greater control over their infrastructure, and security concerns are reduced, as shown Table 3.2. The organisation builds and manages infrastructure. The cloud data centres are virtualised data centres behind a firewall, and they are a private space for systems inside the cloud data centre (Tariq, 2019:408).

In order to obtain application services from third parties, HEIs should develop their own CC environment where researchers, students, and faculty can benefit from private clouds because they are more secure (Mary & Rose, 2020:5468).

### **3.2.4.3 Hybrid cloud**

According to (Gorelik, 2013:19), hybrid clouds combine private and public clouds to provide computing resources. Saraswat and Tripathi (2020:282) cite that users with a license and the general public can access.

A hybrid deployment model can be managed internally or have a third-party that manages it outside your organisation (Diaby & Rad, 2017:55). Rostami (2021:16) cites that to run an application on clouds is determined by several factors, including the application criticality and data sensitivity, certifications and standards required, laws, and more.

### **3.2.4.4 Community cloud**

Kaur and Singh (2013:472) state that community clouds are created for groups with similar needs, such as mission, security, and policy requirements. Within these clouds, they share infrastructure, data, applications, and security measures. Comparatively expensive to public clouds, it offers high privacy, security, and policy compliance but is shared among fewer organisations. Many private and public clouds are integrated in this cloud, which is shared by a wide range of institutions with similar interests and requirements (Diaby & Rad, 2017:55; Mary & Rose, 2020:5469). Kumar and Goyal (2019:7) mention that in most cases, cloud service providers offer cloud services to groups of customers who share common objectives and goals, as well as safety, privacy, and compliance concerns. Private clouds, a community cloud can be implemented either as an on-premises community cloud or as an off-premises cloud outsourced to a hosting company. It may also exist on and off premises (Kumar & Goyal, 2019:7).

Table 3.2 shows a comparative analysis of cloud development models, namely private cloud, community cloud, hybrid, and public cloud, with a specific focus on their impact on the adoption of CC in HEIs in South Africa. The assessment centres on key considerations such as cost, security, and geographical location, aiming to distinguish their effects on the adoption dynamics within the educational landscape.

**Table 3.2: Comparison of cloud development models**

Deployment model	Cost	Location	Security
Public	Low: Public cloud computing resources are not owned or managed by organisations. Organisations must pay for the resources they use.	Outside premise	Low: Some organisations may access computing resources via the Internet, which poses a challenge due to the insecure nature of the Internet, which may be shared by multiple organisations.
Private	High: Because private clouds are dedicated, their deployment costs are higher.	Off or on premise	High: A particular organisation has its own resources. These resources cannot be shared.
Hybrid	Moderate: Having both on-premises and cloud environments require maintenance, which can be moderate to high.	Off or on premise	Moderate: An organisation can choose which services it wants to deploy in the public cloud (e.g. commodity services) and which services it wants to access on-premises.
Community	Low: There is a cost sharing arrangement with each party.	Off or on premise	High: A common objective, shared purpose, and shared responsibilities shared by different organisations.

### 3.3 BENEFITS OF CLOUD COMPUTING

This section explains the benefits of CC as a reason why HEIs need to implement CC.

Carroll *et al.* (2011:3) cite that the primary force behind the rise of CC is cost effectiveness. This improved IT resource management, business focus, effectiveness, dependability, availability, rapid development, deployment, change management, better performance, and increased mobility are some of key advantages. Moving to the cloud was credited as helping to improve automation, support and the use of green IT data centres. Cloud technologies provide so many benefits, including unlimited scalability, high performance, low upfront costs, excellent fault tolerance, and pay per use (Bokhari *et al.*, 2018:161).

This study conducted by Qasem *et al.* (2019) mentions that the adoptions of CC in higher education have many benefits at HEIs, which include:

### **Readily accessible online applications**

Students are certainly aware of cloud-based services like Google Apps and Dropbox, which are free, simple to use, and widely available and are also familiar with the idea of CC. There are numerous advantages to cloud-based systems in the education sector, including their accessibility, quick response time, and ease of implementation. However, performance issues may arise occasionally. It is possible to use some applications online, such as Google Apps for Education or Microsoft Office 365 in the classroom (Qasem *et al.*, 2019).

### **Flexible learning environments**

As cloud technologies are highly configurable, teachers can create an entirely new teaching and learning environment. Three cloud tools can be integrated to help teachers to explain their e-learning course using Google Apps, Facebook, and mind-mapping applications (Qasem *et al.*, 2019:63730). A personal learning environment could also be configured for long-term education (Ko & Young, 2011).

### **Mobile learning support**

Cloud technologies have substantially larger capacity than traditional network infrastructures because they can transcend other computer restrictions by providing tremendous processing capabilities and data storage capacity given the servers on which they are kept (Qasem *et al.*, 2019:63731). Because data sharing is a key component of this learning system, the cloud is essential to mobile learning (Thobejane, 2021:62). It assumes responsibility for data sharing security and load control during peak access times without impacting on network band access (Rao *et al.*, 2012:4).

### **Cost reductions in hardware and operations**

Adopting cloud technology can help HEIs to save money in a variety of ways. On-demand services, scalability, and pay-per-use technology are examples of cloud technologies (Qasem *et al.*, 2019:63731; Rao *et al.*, 2012:1). Due to cost savings and increased competitiveness, large businesses will also profit from CC.

### **Reduce the costs of software**

Higher education may reduce costs significantly by embracing free cloud-based technologies like Google mail and Google apps, where using the program is completely free (Qasem *et al.*, 2019:63731). The price of hiring a new IT service from a cloud service provider is significantly

less than the cost of purchasing hardware and software assets (Rodríguez Monroy *et al.*, 2012:26).

### **Collaborative working**

With CC in education, students can collaborate on assignments online from anywhere in the world, even if they are not physically present in the same classroom. It is also possible to collaborate online between teachers across departments and schools in order to share lesson plans or feedback efficiently. For marginalised students who lack access to traditional educational facilities, CC in education enhances connectivity in the classroom. Developing the skills and knowledge required to succeed in today's world can be achieved through cloud-based learning (Qasem *et al.*, 2019).

When considering new technologies for HEIs, especially those with limited budgets, they should weigh their options carefully. In comparison to traditional technologies, CC offers the following advantages (Pardeshi, 2014b:591):

- **Mobility:** Mobile devices are widely used by students nowadays to access data. By using their smartphones, laptops, or tablets, students can refer to textbooks and even do their homework online.
- **New Services:** Online learning and video conferencing are becoming increasingly common at colleges and universities today.
- **Storage:** Universities and colleges can expand storage capacity quickly with scalable cloud storage. There is a large volume of data that HE institutions have to deal with, including student data and faculty data.
- **Efficiency:** Increasing efficiency is a priority for institutions of higher learning.

Therefore, literature shows that HEIs embrace CC, not just for the sake of it, but to reap the benefits that come with utilising cloud technology.

### **3.4 CHALLENGES IN ADOPTING CLOUD COMPUTING**

Despite the advantages, cloud service providers offer challenges that contribute greatly to the CC environment (AlZain *et al.*, 2012:5492) . However, the literature review highlights that despite the clear benefits of CC in education, it also reveals a multitude of challenges faced by organisations in its implementation.

Chou (2015:137) states that information system outsourcing is closely related to the rise of CC. Despite the benefits derived from outsourcing information systems, such as reducing operational costs, accessing new and updated technology, sharing resourcing and challenge, among others, there are challenges associated with this process (Chou, 2015:138). Challenges associated with outsourcing information systems directly and indirectly affect customer service quality.

When adopting CC in higher education, it is crucial to evaluate its effectiveness by considering both the benefits and limitations associated with this technology (Massadeh & Mesleh, 2013:42). The challenges faced by HEI are mentioned below as follows:

- Cloud computing does not run all applications at HEIs.
- Control: cloud environments vary greatly in terms of how much control the user has.
- Security: Data privacy is a major concern: users lack control over their data, and they do not know where it is located.
- Interoperability: The lack of universal standards or interfaces increases the chance of getting stuck with a single vendor lock-in.
- Reliability: several existing cloud infrastructures are built on commodity hardware that is prone to unexpected failures.

Since the beginning, the era of CC has been marked by numerous challenges. The adoption of CC in the higher education sector comes with many challenges and issues that need to be considered (Ananthi & Arul, 2019:3273; González-Martínez *et al.*, 2015:140; Kim, 2009:67; Mircea & Andreescu, 2011).

They mention the following categorised challenges and limitations which are associated with the adoption of CC in HEIs:

- **Vendor lock-in:** One of the key obstacles is an inadequate understanding of methods, standards, and tools that will enable cloud services and cloud providers to exchange information compactly and interoperate. Therefore, the client is completely dependent on the services of the cloud provider (Pallathadka *et al.*, 2022:2246). It is called a vendor lock-in problem when educational institutions use one cloud service provider exclusively (Ananthi & Arul, 2019:3273). There are four major lock-in challenges when you work with a single cloud provider: data transfer, infrastructure, application and human resources (Chan, 2017). There are no universal standards and interfaces, posing the challenge of vendor lock-in (Massadeh & Mesleh, 2013:42). Because the data of educational institutes are very vulnerable and large, it becomes financially and technically challenging to move all resources from one cloud service provider to

another. To prevent vendor lock-in, educational establishments must have interoperability with the cloud (Al-Rasheedi & Khan, 2021:198).

- **Governance loss:** Loss of governance occurs when services are outsourced to unauthorised parties (Ananthi & Arul, 2019:3273; Pallathadka *et al.*, 2022:2246) When a client uses CC, they relinquish their control to the provider, which puts their data and applications at challenge. The provider may not be responsible for security under the service level agreement. Since every business is inherently focused on preventing unauthorised access, usage, fraud, or deletion of client data or applications, they use the phrase regulations (Pallathadka *et al.*, 2022:2246).
- **Challenge in compliance:** Hybrid clouds, which combine CC services from several providers with those delivered on-premises, are challenging to manage in terms of compliance (Ananthi & Arul, 2019:3273). Shayan *et al.* (2014:418) mention that before migrating to CC, one should consider the challenges that are associated with it: confidentiality, integrity, and availability of data can be assured with knowledge of challenges and well-planned management of them. Shayan *et al.* (2014:418) state that if something is done incorrectly without considering both the provider's and users' challenges, economic failure will result, and market share will be lost. Data integrity is helpful for validating data and ensuring reliability and consistency (Sirohi & Agarwal, 2015:116). They add that there are many security challenges and attacks due to the Issues caused by the lack of integrity. As data centres are distributed all over the world, organisations may not know where their stored information is or who has access to it (Al-Rasheedi & Khan, 2021:198). To maintain control over their data, cloud service providers are setting up data centres in the countries where the organisations are located. This is due to the possibility of data processing in distant countries being insecure and susceptible to hacking (Al-Rasheedi & Khan, 2021:198).
- **Cloud service termination:** As a result of insufficient financial support in the competitive IT world, it leads some providers to close down their service offerings (Ananthi & Arul, 2019:3273).
- **Supply chain failure:** Data loss can result from any corruption in the chain (Ananthi & Arul, 2019:3273).
- **Separation failure:** Computing resources are shared in distributed architecture environments. Multitenancy poses a challenge (Ananthi & Arul, 2019:3273).

- **Intercepting data in transit:** There are many physical machines involved in data transmission. Cybercriminals steal secured data during a man in the middle attack (Ananthi & Arul, 2019:3273).
- **Insufficient deleting of data:** When a client requests a cloud resource be removed, there is no way to respond because users cannot see or control cloud resources. There is no way for the consumer to find out whether the account was deleted, or how soon it was done (Pallathadka *et al.*, 2022:2247). When a request is made to delete a cloud resource, there is a potential that the data might not be removed successfully. To reduce this challenge, strong encryption is required (Ananthi & Arul, 2019:3273).
- **Challenge of changing of jurisdiction:** Often, servers in cross-border areas are hacked by local authorities, compromising confidential information (Ananthi & Arul, 2019:3273).
- **Security, Data and privacy:** Pallathadka *et al.* (2022:2247) state that education sectors find it difficult to verify how data are processed by cloud providers. Adoption of the CC in HEIs is hampered by data security by a wide margin (Gorelik, 2013:24). It is important for companies and organisations to know that their data are safe since it is their most valued asset.

Data loss, phishing, botnets (remote computer networks), positioning of resources, multitenancy, authentication, and logging of system activity are all significant security issue (Pallathadka *et al.*, 2022:2247). As a result of attacks such as guest-hopping attacks, which are done by attacking stored data, security issues arise (Pallathadka *et al.*, 2022:2247). Users lose control about where their data are stored, which is a major concern (Massadeh & Mesleh, 2013:42).

The Integrity of personal information has become one of the major concerns (Kim, 2009:67). Security and privacy cannot be guaranteed against all possible threats, including software bugs, hackers becoming more sophisticated, inadequate procedures, human error, and human malfeasance. Sirohi and Agarwal (2015:116) mention that since data are growing day by day, several security challenges are arising, and data privacy is one of the security challenges associated with CC. Gital and Zambuk (2011:367) say that security of an enterprise information is a primary concern for CC adopters. Sirohi and Agarwal (2015:116) mention that managing data trust is a major concern which results in a lack of transparency, and the other is a breach of security and privacy.

According to Qasem *et al.* (2019:63732), for many industries, including education, the most pressing concern is security associated with the implementation of CC. The software producers of cloud services must ensure that all their applications are confidential, secure, and available. Among the most important factors is verifying users, since password management itself may compromise security (Qasem *et al.*, 2019:63732). Some permissions need to be given to the appropriate staff members based on their specific role in the organisation.

- **Malicious insider:** Pallathadka *et al.* (2022:2247) cite that this is the most challenging issue in CC because of the incalculable implications. The growth of CC has increased the challenge of insider attacks among certain occupations. System administrators, security service providers, and cloud service providers are among these occupations (Pallathadka *et al.*, 2022:2247). It is not uncommon for organisations to be victimised by malicious insider threat, particularly in cloud environments, where systems are shared with untrusted parties, accessible from the public Internet, and organisations have limited control over their systems (Al Nafea & Almaiah, 2021:784).
- **Availability and Support:** CC has one serious issue regarding availability. In cases like these, the CC vendor either goes out of business or is no longer able to deliver the service in the manner that was initially promised to the end users (Kim, 2009:67). For CC to be embraced, top management must be persuaded to adopt it. In educational institutions, decision-makers will recognise the value of CC through exposure to its culture and benefits (Mokhtar *et al.*, 2014:190). As a consequence, vendors must be vetted, and even then, they should have a back-up plan. End-users and enterprise users both require support to resolve problems (Kim, 2009:68). In both cases, end-users are using CC and enterprise users are using on-premises computing. Kim (2009) adds that cloud users today are left to fend for themselves if they are using SaaS free of charge. Support is provided by enterprises. Users expect better support from CC vendors than what they are used to from on-premises computing (Kim, 2009:68).

Ananthi and Arul (2019:3273) highlight the challenges associated with the adoption of CC:

- **Loss of backup:** Physical security events are insufficient, which makes it possible to lose backup.
- **Unauthorised access to premises:** Data centres can be accessed by unauthorised individuals.

- **Theft of computer equipment:** Physical data centres can only be accessed by authenticated persons.

Most providers state that they shall not be liable for the effects of security breaches or unauthorised changes, disclosures, or interruptions due to malicious activity (Dogra & Kaur, 2013:333). The security challenges associated with the data processed in a public cloud may differ from those associated with applications running in a private cloud. The challenges related to the cloud are the responsibility of consumers. Dogra and Kaur (2013:333) mention that although there is a promise that providers will protect consumer data to the best of their ability, all surveyed providers disclaim security responsibility for data losses, breaches, or service interruptions. They offer consumers only service credits in the event that their availability expectations are not met (Dogra & Kaur, 2013:333).

Adoption of the CC in HEIs is hampered by data security by a wide margin (Gorelik, 2013:24). It is important for companies and organisations to know that their data are safe since it is their most valued asset. Having full control over data allows companies to feel confident when they store it internally (Gorelik, 2013:24). Mosher (2011:35) posts that the challenge associated with external CC services is similar to the challenges associated with any outsourcing arrangement and arises from allowing corporate data to be processed or reside on devices external to the corporate environment. However, some of these challenges may be increased due to CS's inherent characteristics.

From the literature review, the adoption of CC in HEIs can be categorised into different category as technical, organisational, environmental, financial and governance (Ananthi and Arul (2019:3273); (Dogra & Kaur, 2013:333; Kim, 2009:68; Massadeh & Mesleh, 2013:42; Pallathadka *et al.*, 2022:2247; Shayan *et al.*, 2014:418).

Based on a range of scholarly literature reviews, the researcher developed the following factors: technical, environmental, governance, financial, and organisational. Table 3.3 to identify the categories of CC and the associated factors influencing its adoption in HEIs.

**Table 3.3: Cloud computing adoption factors in HEIs**

Category	Factors	References
Technical	Vendor lock-in	Ananthi and Arul (2019:3273).Al-Rasheedi and Khan (2021:198), Massadeh and Mesleh (2013:42)
	Security, Data and privacy	Massadeh and Mesleh (2013:42), Pallathadka <i>et al.</i> (2022:2247), Gital and Zambuk (2011:367), Sirohi and Agarwal (2015:116)
	Malicious insider	Al Nafea and Almaiah (2021:784); Pallathadka <i>et al.</i> (2022:224)

Category	Factors	References
	Theft of computer equipment	Ananthi and Arul (2019:3268); Pallathadka <i>et al.</i> (2022:2247)
	Loss of backup	Ananthi and Arul (2019:3273); Gorelik (2013:24)
	Unauthorised access to Premises	Ananthi and Arul (2019:3273)
Organisational	Cloud benefits Security risk Flexible learning Mobile learning support Collaborative working Vendor -lock in: Storage Efficiency	Sirohi and Agarwal (2015:116); Qasem <i>et al.</i> (2019), Ko and Young (2011), Pardeshi (2014:591), Pallathadka <i>et al.</i> (2022:2246), Massadeh and Mesleh (2013:42), Al-Rasheedi and Khan (2021:198)
	Cost reductions in hardware and operations Reduce the costs of software Cloud service providers Procurement of hardware Pay-as-you-go model	Qasem <i>et al.</i> (2019:63731), Rao <i>et al.</i> (2012:1), Rodríguez Monroy <i>et al.</i> (2012:26), Ananthi and Arul (2019:3273), Pardeshi (2014:591)
	Compliance Location of data Data protection	Ananthi and Arul (2019:3273), Shayan <i>et al.</i> (2014:418), Al-Rasheedi and Khan (2021:198)
Financial	Senior management support Organisational change Service providers Challenge of jurisdiction Outsourcing	Kim (2009:67); Ananthi and Arul (2019:3273), Chou (2015:137), Dogra and Kaur (2013:333)
Environmental	Compliance Location of data Data protection	Ananthi and Arul (2019:3273), Shayan <i>et al.</i> (2014:418), Al-Rasheedi and Khan (2021:198)
Governance	Senior management support Organisational change Service providers Challenge of jurisdiction Outsourcing	Kim (2009:67), Ananthi and Arul (2019:3273), Chou (2015:137), Dogra and Kaur (2013:333)

The successful adoption of CC in HEIs relies on a comprehensive understanding of the social system, encompassing not only technological aspects, but also factors such as organisational personnel, environmental considerations, and community dynamics within the HEI. Achieving successful adoption and implementation of CC in HEIs requires a holistic approach that addresses all these interconnected elements. The endorsement of CC adoption by senior management within HEIs is paramount due to the financial implications involved. Ensuring compliance with service providers is crucial, alongside the imperative upskilling of technical staff to grasp the holistic approach, as the successful adoption of CC relies on the intricate interplay of these factors (Thobejane, 2021:87).

The next section deals with the development of guidelines that ease the adoption of CC in HEIs.

### **3.5 DEVELOPMENT OF GUIDELINES**

It is important to select guidelines that address a clear problem or concern that would be addressed with guidelines. Interested groups should convene a multidisciplinary panel. In addition to identifying what conditions and problems the guidelines will cover, it should specify the desired outcomes (NHMRC, 2000:2). An optimal approach for developing guidelines involves a transparent, explicit process based on research and evidence, with a rating to reflect quality. Clifton and Petrosino (2016) mention that even without a solid research base, the strength of supporting evidence should be clear. According to Tito and Newby (1998:88) a guideline does not directly influence a process by encouraging or hindering it. Instead, it aids in making informed decisions based on the available information. The main purpose of a guideline is to clarify and offer necessary recommendations. Hence, guidelines are defined as tools that aid decision making and have been extensively evaluated before being implemented (Loane & Wootton, 2002:64). In the development and implementation of guidelines, to maintain certain standards, they should be flexible, even for general use.

Grol (1993:146) states that one of the most important elements of achieving high-quality care is the development of standards and guidelines. To avoid problems in general practice, guidelines have to be developed that match general practice needs. These guidelines are developed using a model that integrates current experience in a specific field.

For guidelines to be effective and appropriate, the following conditions must be met (Grol, 1993:147):

- To enhance credibility and reproducibility of results, it is necessary to analyse the scientific literature, reach consensus, and formulate guidelines.
- Scientific foundations and feasibility in everyday practice are all important factors in the development of guidelines.
- There should be a clear and explicit definition of the aims of the guidelines.
- When developing guidelines, procedures for implementation and evaluation should be incorporated from the beginning. Guidelines are not self-executing.

The method that guidelines are applied should be clear as to the assumptions upon which each proposal is founded and the degree to which it meets the needs of the intended user (Grimshaw *et al.*, 2004:2). The guidelines' main goal is to make it simpler for institutions to

carry out their duties. However, in accordance with the accountability principle, they continue to be in charge of ensuring that these commitments are met (Achim, 2018).

### 3.6 KEY PRINCIPLE OF GUIDELINES

There are nine basic key principles that the researcher adopted for the development of the guidelines (NHMRC, 2000:1).

During the guideline development, the main focuses were standards, consistency, and acceptability. Table 3.4 provides a detailed overview of the nine key principles guidelines that were considered during the development process of guidelines. The researcher showed how each principle was followed and put into action based on the data gathered from participants.

**Table 3.4: Nine key principles of guidelines**

<b>Principle</b>	<b>Description</b>
P01 : The focus should be on outcomes when developing guidelines (NHMRC, 2000:1).	Develop guidelines focusing on outcomes, ensuring alignment with objectives throughout the process. Use study results to guide development. The guideline was developed with an objective and goals in mind before it was developed. Outcomes and results regarding the adoption of CC in HEIs were to improve the adoptions of CC in HEIs in South Africa.
P02 : It is important to base guidelines on the best evidence available (NHMRC, 2000:1).	Base guidelines on best available evidence, including interview data and empirical findings. Consider participant experiences for comprehensive recommendations. This study relied heavily on interviews conducted for the purpose of collecting data. Guidelines and recommendations aimed at enhancing CC within HEIs were based on participants' experiences and theoretical data.
P03 : It is important that guidelines are based on the best scientific evidence and that their recommendations are described as strong (NHMRC, 2000:2)	Incorporate all available scientific evidence, acknowledging varying viewpoints even if they contradict. Ensure recommendations are robust and well-supported.  This simply implies that while designing guidelines for the adoption of CC in South African HEIs, data analysis (i.e. coding and theme generation) must include all user perspectives.

<b>Principle</b>	<b>Description</b>
P04 : Resource constraints should be considered when developing guidelines (NHMRC, 2000:2)	<p>Consider resource limitations identified through empirical data. Regularly evaluate and mitigate constraints during guideline development.</p> <p>The empirical data acquired in the interviews was used to identify the resource limitations affecting the development of CC adoption guidelines in South African HEIs.</p>
P05 : Consumers must be involved in the guideline development process (NHMRC, 2000:2).	<p>IT governance and technical staff were involved in the development of guidelines that is to ensure alignment with institutional requirements and stakeholder demands. The perspectives of IT governance and IT technical staff were represented and addressed throughout the development of these standards.</p>
P06 : Flexibility and adaptability should be key characteristics of guidelines (NHMRC, 2000:2).	<p>Provide flexible guidelines for CC adoption in South African HEIs, adapting to diverse demographics and resources. Adapt implementation as per institution-specific needs.</p> <p>The suggested standards for CC adoption should allow for flexible implementation at South African HEIs.</p>
P07 : A target audience is considered when developing guidelines for dissemination and implementation (NHMRC, 2000:2)	<p>Develop clear guidelines tailored for effective dissemination and implementation in South African HEIs. Ensure language and clarity meet audience understanding.</p>
P08 : Guidelines should be evaluated for their implementation and impact (NHMRC, 2000:2).	<p>Continuously evaluate guideline implementation and impact. Incorporate stakeholder feedback for ongoing improvement.</p> <p>As soon as all HEI stakeholders approve and accept the guidelines, this principle will undergo verification and testing.</p> <p>This study was conducted by continuously assessing the recommendations and viewpoints of the participants.</p>
P09 : A regular review of guidelines is necessary (NHMRC, 2000:2)	<p>Regularly update guidelines based on current research and technology. Ensure ongoing relevance and effectiveness.</p> <p>As soon as all HEI stakeholders approve and accept the guidelines, this principle will undergo verification and testing.</p> <p>This study was conducted by continuously assessing the recommendations and viewpoints of the participants.</p>

The objective of this study was to develop CC adoption guidelines in South African HEIs. The guidelines development process has been determined, as have the essential concepts that will govern the development process.

The next section discusses higher education and how it is applied in the context of this study.

### 3.7 HIGHER EDUCATION

In today's world, the HEI landscape is constantly evolving and undergoing change, mainly due to the adoption of new and developing technologies. Using technology effectively in higher education is increasingly recognised as essential in providing high-quality education to meet the needs of 21st century students and to prepare them for the challenges they will face (Masud *et al.*, 2012:552). Higher education has recently started to use cloud services, such as PaaS and cloud IaaS, Since the mid-1990s, SaaS models have been widely used in various industries, including higher education (Britto, 2011:1065). It is important for the society and a nation to develop HEIs. University research and higher education have been implementing high-end IT infrastructure in the last few years (Singh & Baheti, 2017:708). A new tool for education is CC; new resources, digital contents, virtual labs, and administrative tools are included for educational institutions, such as cloud-based text books, multimedia learning materials, and cloud-based text books (Singh & Baheti, 2017:708).

Katz *et al.* (2010:2) cite that it is possible to contribute to enterprise productivity and efficiency by having a mature cloud of on-demand infrastructure, application, and support services. They identify the ten important characteristics of CC in HEIs with respect to demand SaaS, PaaS, and IaaS:

- Improving the efficiency of higher education by driving lowering IT capital and operational costs.
- Ensuring transparent alignment of IT demand, costs, and funding.
- Increasing IT resources and services.
- Facilitating the further standardisation of IT.
- Reducing IT supply bottlenecks to accelerate time to market.
- Defending enterprise IT services against ad hoc consumerisation.
- Increasing the availability of scarce IT talent.
- Creating a path toward a five-nine and 24x7x365 environment.
- Provide access to renewable energy-powered cycles and storage.
- Improving interoperability within and across institutions.

Britto (2011:1066) mentions that CC as a utility model or pay-as-you-go model provides schools and universities with a cost-saving measure during times of economic crisis and in the face of increasing IT costs, decreasing IT budgets and escalating demand for IT services.

CC is widely used in academic institutions, as pedagogical potential is created by sharing this technology (Shana & Abulibdeh, 2017:174).

According to Erkoç and Kert (2011:3), CC is being used by many research institutes to solve problems that are continuously expanding in terms of computing and storage capacity. CC has been driven by three key characteristics (Foster *et al.*, 2008:1) which are as follows:

- Rapidly falling hardware prices and an increase in computing power and storage capacity, along with multi-core architectures and supercomputers comprising hundreds of thousands of cores.
- Rapidly expanding data sizes for scientific instrumentation and simulation, and Internet publishing and archiving.
- The wide adoption of services computing and web tools.

Universities are turning to CC to reduce their IT complexity and costs by replacing software traditionally installed on campus computers (and the computers themselves) with applications delivered via the Internet (Sasikala & Prema, 2011:321). Behrend *et al.* (2011:231) cite that a technological innovation such as CC could both cut IT costs for colleges and alleviate time constraints for students, giving them access to more learning tools.

Cloud computing has many benefits for educational institutions; the following are a few of those benefits (Erkoç & Kert, 2011:3; Siegle, 2010:41; Singh & Baheti, 2017:710):

- Universities can be able to share their technology infrastructures with businesses and industries to facilitate research advancements.
- Universities can use CC to combat ever-increasing resource requirements and energy costs. In addition to enabling institutions to teach in new and different ways, CC also helps them to manage projects and large workloads.
- Students will have a better understanding of new technologies once they enter the global workforce.
- By utilising CC, students and teachers can use applications that do not have to be installed on their computers, as well as access saved files from any Internet-connected device.
- There is no need for expensive textbooks; digital books are used, which can be accessed anywhere and at any time.

- All learning materials are current and updated. It is not necessary for students to use outdated learning materials. Online learning materials are accessible wherever and whenever students need them.
- It does not require expensive hardware (such as servers, supercomputers,). CC allows the institution to pay as they go. Users have access to hardware via the cloud wherever they are.
- Software (web servers, MS office, operating systems, development tools, and others) do not need to be expensive. Users can access cloud-based applications from anywhere.
- On the cloud, students and teachers have access to more opportunities and resources.

The provision of quality education poses a number of challenges to HEIs today (Ali, 2019:90).

A few of these challenges include:

- The distribution of current learning and teaching resources is not based on needs but rather on the rationales of individual education institutions, that contribute to unbalanced development among HEIs.
- Infrastructure needs for HEI education and training are not adequately financed, and placement opportunities for prospective students are not readily accessible.
- Particular educational institutions lack the expertise needed to support, operate, and maintain existing infrastructure.
- Due to the limited number of qualified educators in specific areas, there is imbalanced expertise distribution across institutions.

Shrivastava and Chandan (2022:8) explain that a CC system is a network-based computing system that has emerged recently. Files, e-mails, and other forms of information are stored and can be shared with several people at one time in the cloud. Using CC, high-resolution multimedia content can be stored digitally and accessed remotely. In addition, network backups enable CC to offer data security. The cloud service provider maintains ultimate control. By using CC, learning environments can be more convenient and secure and real-time collaboration can be enabled in a more efficient manner. The cloud is cost-effective because it does not require physical hardware. The adoption of cloud technology poses a security challenge due to the sharing of sensitive information with the service provider. Higher education will see CC increase by 26% by 2027 (Shrivastava & Chandan, 2022:8).

Qasem, Abdullah, *et al.* (2020:63722) mention that in the computing world, CC has been called the next generation. CC has replaced traditional methods for providing resources and services. Due to its scalability, cost-effectiveness, flexibility, and collaboration, CC is widely adopted in private and public organisations. Users and organisations, including HEIs, rely on these features.

Rezaeian and Wynn (2022:979) mention that as technology has advanced, education has become more flexible and is no longer confined to chalkboard classrooms or textbooks. Using smart devices, learners are now in contact with one another or with their teachers. They are also able to access a variety of learning resources. CC has been widely accepted by academic institutions since 2018 for its scalability and affordability, making it an ideal solution to address the requirements of the higher education system. Using CC services has allowed educators and students to have more benefits and maximise the learning outcome of an institution (Rezaeian & Wynn, 2022:979). CC has resulted in major benefits for the education industry today when everyone is battling the COVID-19 pandemic to the best of their ability. The technology has revolutionised the teaching-learning process, from maintaining student records to how data are stored, to how online educational platforms are upgraded (Grover & Nandal, 2024).

### **Cloud computing technology for higher education institution**

Education has also been affected by the growing adoption of CC. CC has also found its way into the operations of educational institutions (Chibaro, 2015:27). We are increasingly relying on cloud-based applications in our daily lives. We all use cloud applications in one way or another, including e-mail, YouTube, Dropbox and others.

According to (Adam, 2020), higher education organisations benefit from CC in many ways: including storing data, organising online classes, migrating university network infrastructures, and taking advantage of cloud services. CC offers educational and financial benefits in higher education: students can create personal portfolios, complete assignments, and access self-service options on the web (Attaran *et al.*, 2017:162). A pandemic caused the cloud to become the main service for storing information in academic institutions. When online study was the only option, CC services contributed to the quality of education. By using virtual laboratories and simulation environments, students can develop skills that do not require them to be physically present at schools. Students can do better academically and be more productive if they use CC in higher education (Elgelany & Alghabban, 2017:122).

According to (Elgelany & Alghabban, 2017:122), in higher education, CC technology is an attractive option due to the benefits it can provide to academics and students. In addition to the accessibility and ease of use offered by CC, the users have the option of accessing the

site from their mobile devices or any combination of these methods at their convenience. In educational environments, sharing, processing, editing, and storing large volumes of data is another distinct advantage.

Educators and students can benefit greatly from CC. These devices, such as smartphones, tablets, and laptops, allow users to interact with one another and access this information (Weber, 2013:19). He adds that computer systems with centralised control are capable of processing large volumes of data, particularly graphics; managing complex functions; and storing huge amounts of keyword searchable information.

### **3.8 GUIDELINES EXTRACTED FROM LITERATURE**

Large enterprises already integrate CC into their existing IT systems and applications because of the cost savings, operational efficiency, scalability, and business agility it offers (Ahmed & Allawi, 2020:124). The newcomers, trying to enter the arena, must understand the current requirements and provision to ensure that what is being done is aligned with the business' long-term vision. In CC, different services are combined. Education has a lot to gain from CC. Education is essential to a nation's development because it promotes creativity and empowerment (Ananthi & Arul, 2019:3268).

According to Masud *et al.* (2012:552), academics typically use CC for the following purposes:

- Creating a personal workspace.
- It is a convenient tool for making teaching and learning interactive; has a high degree of social interactivity.
- Personal learning environments are used by many people as an alternative to institutionally control virtual learning environments, learning management systems with customised tools to meet their needs and preferences; educators are always learning.
- This opens the possibility of ubiquitous computing.
- Everything is backed up on a thumb drive and transferred between devices without any need to transfer it.
- If you buy a new computer, you do not have to copy all the information or data from the old one to the new. In addition, you will be able to create a repository of information that will remain with you if you want to save it.
- Provides a high degree of processing power comparable to a supercomputer.

Tout *et al.* (2009:2) cite that in large university server rooms, huge amounts of air conditioning are typically installed in order to keep the required temperature. The adoption of CC permits significant savings in this area. Further, it would be possible to reduce the need for physical security requirements for such rooms, such as fortified safes and advanced door locks (Tout *et al.*, 2009:2).

The benefits of CC in HEIs have been discovered by many researchers. There are essential key principles for the guidelines development that will guide the researcher when adopting CC guidelines. According to the literature, these principles should be considered during the guidelines' development process. In order to develop adoption guidelines for CC in South African HEIs, the primary focus of this research was governed by the guidelines that will assist HEIs in adopting CC.

Based on the literature review in Table 3.5, the initial set of guidelines has been formulated to facilitate the adoption of CC in South African HEIs. Hence the researcher formulated the following guidelines based on the literature review (LG).

**Table 3.5 Emerged guidelines from literature review**

<b>Guideline</b>	<b>References</b>
LG01: Managing technical risks in Cloud Computing.	Massadeh and Mesleh (2013:42) Pallathadka <i>et al.</i> (2022:224) Ananthi and Arul (2019:3273)
LG02: Secure IT governance for remote learning integration.	Qasem <i>et al.</i> (2019), Rodríguez Monroy <i>et al.</i> (2012:26), Pardeshi (2014b:591) Ananthi and Arul (2019:3273), Shayan <i>et al.</i> (2014:418)
LG03: Cost optimization through efficient management.	Kim (2009:67) Ananthi and Arul (2019:3273), Chou (2015:137), Dogra and Kaur (2013:333)
LG04: Cloud data management and compliance challenges.	Ananthi and Arul (2019:3273), Shayan <i>et al.</i> (2014:418), (Al-Rasheedi & Khan, 2021:198)
LG05: HEIs need governance for policy oversight and decision-making.	Kim (2009:67), Ananthi and Arul (2019:3273), Chou (2015:137), Dogra and Kaur (2013:333)
LG06: HEI must secure data, modernize applications and train staff.	Massadeh and Mesleh (2013:42)

In Chapter 4 the researcher tested these guidelines through interviews with IT technical staff and IT governance who have used the technology in decision-making at HEIs.

Next, the guidelines were elaborated on in detail.

## **LG01: Managing technical risks in cloud computing**

Managing technical risks in CC refers to the process of identifying, assessing, and mitigating potential technical challenges and vulnerabilities that may arise when using CC services. This factors involve the technical infrastructure setup within HEIs .If these technical factors are not considered it could lead to malicious insiders, loss of backup due to inadequate physical security measures, unauthorised access to data centres and theft of computer equipment (Ananthi & Arul, 2019:3273; Pallathadka *et al.*, 2022:2247). Data loss, multitenancy, authentication, and logging of system activity are all significant security issues that need careful consideration in CC environments. These factors could pose serious threats to the confidentiality, integrity, and availability of data and services. Multitenancy refers to where multiple users share the same physical infrastructure and resources (Massadeh & Mesleh, 2013:42; Pallathadka *et al.*, 2022:2247).

Understanding the infrastructure and architecture is crucial in assessing technical factors, as certain technologies may not be compatible with new CC technology. Authentication and physical access to data centres, both within HEIs and among service providers, should be mandatory considered for all parties involved. HEIs occasionally face unauthorised access incidents, necessitating tight authentication measures and access control protocols at all times.

## **LG02: Secure IT governance for remote learning integration.**

HEIs face organisational challenges that affect the adoption of CC. Vendor lock-in remains an ongoing concern for HEIs. Vendor lock-in is a challenge due to the lack of universal standards and interfaces. Moving all resources from one cloud service provider to another is financially and technically scary, especially given the vulnerability and size of educational institutes' data (Massadeh & Mesleh, 2013:42; Pallathadka *et al.*, 2022:2246).

The literature review reveals that CC adoption in HEIs still faces significant challenges, particularly regarding security risks (Sirohi & Agarwal, 2015:116). Support from IT governance is crucial to ensure buy-in and key decision-making regarding CC adoption in HEIs, given their responsibility to make critical decisions on IT infrastructure (Mokhtar *et al.*, 2014:190) . As CC adoption impacts on the entire institution, involvement off all IT technical staff and stakeholders is essential for successful implementation in HEIs.

Cloud computing offers numerous benefits for educational institutions. CC helps HEIs to manage resources, remote teaching, and IT projects. Students able to access applications and files from anywhere (Erkoç & Kert, 2011:3; Siegle, 2010:41; Singh & Baheti, 2017:710).

The literature review recommends that adopting CC in HEIs requires organisational change, focusing on cultural shifts. It is essential to upskill and raise awareness among IT staff, backed by IT governance. Educating all users about the benefits of CC is crucial. Also, addressing security and data privacy concerns within the organisation is vital before migrating to CC.

### **LG03: Cost optimization through efficient management**

It has been proven from the literature review that using a pay-as-you go model (Britto, 2011:1066) can be cost effective, as HEIs will benefit from utilising a consumption-based model, enabling them to only pay for the resources they use. Budgeting for new hardware infrastructure at HEIs can be significant costs. The annual rise in hardware prices (procurement) poses a financial challenge for HEIs. The adoption of CC can introduce potential financial stability and it requires careful consideration of its implications within HEIs (Erkoç & Kert, 2011:3).

One of the primary motivations for HEIs to adopt CC is cost savings, making it crucial to thoroughly understand the factors involved. While the initial capital costs in CC adoption may be lower, operating costs tend to increase compared to traditional IT approaches. Additionally, ensuring compliance between the HEI and the service provider is essential, given the significant role service providers play in the adoption of CC, particularly concerning financial applications.

### **LG04: Cloud data management and compliance challenges**

In CC, the level of control varies widely among environments, posing challenges for users to manage their data effectively. Data privacy is a significant concern, as users often lack control over their data and are uncertain about its location (Massadeh & Mesleh, 2013:42). Managing compliance becomes complex with hybrid clouds, integrating cloud services from multiple providers with on-premises solutions (Ananthi & Arul, 2019:3273). Data protection and privacy concerns persist as key environmental factors within HEIs. Maintaining the integrity of personal data has become a major stumbling block. Despite ongoing efforts, complete assurance of security and privacy remains elusive due to various threats like software vulnerabilities, sophisticated hacking methods, procedural lapses, human mistakes, and malicious activities (Kim, 2009:67).

Therefore, addressing the issue of data location requires HEIs to engage with service providers equipped with SLAs and policies outlining data location protocols. The adoption of CC in HEIs is influenced by both internal and external environments, encompassing factors such as data location, policies, and legal/compliance requirements. Moreover, the absence of

technology standards within service providers can affect system compatibility and interoperability. Hence, it is essential to consider both internal factors within HEIs and external factors outside the institution.

#### **LG05: HEI needs governance for policy oversight and decision-making**

Governance factors play a crucial role in HEIs by overseeing the development of policies, ensuring compliance, managing risks, and maintaining data governance. However, challenges with data governance in HEIs hinder the adoption of CC. The loss of governance occurs when services are outsourced to unauthorised parties, resulting in clients relinquishing control to the provider. This situation poses potential risks to the security and integrity of their data and applications. Due to governance deficiencies, many service providers lack sufficient financial backing in the IT landscape, leading to the closure of their services (Ananthi & Arul, 2019:3273). The issue of data ownership impacts significantly on the accountability of service providers, who often neglect their responsibility to safeguard customer data (Pallathadka *et al.*, 2022:2247).

Therefore, there is a need for a governance structure within HEIs capable of monitoring and developing policies and compliance frameworks to oversee the adoption of CC. Key factors such as the service level agreement (SLA) and licensing issues must be carefully considered by this IT governance body when selecting service providers. Consequently, a robust governance structure is essential to enforce policies and regulatory standards, facilitating the transition from traditional practices to the adoption of CC in HEIs.

#### **LG06: HEI must secure data, modernize applications, train staff**

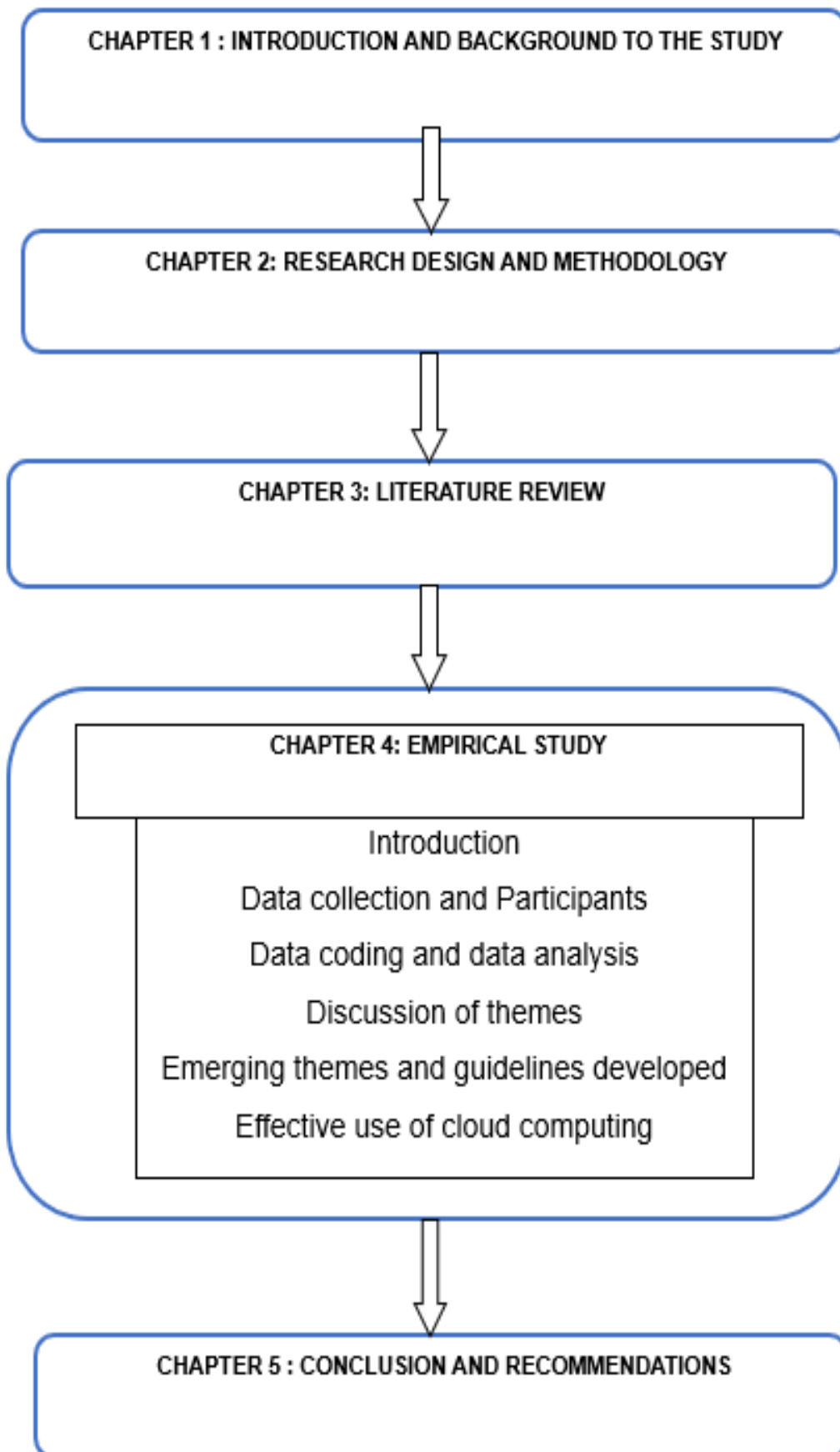
Higher education institutions encounter challenges in adopting CC, primarily stemming from concerns regarding data security and compliance. Ensuring that data are securely stored and comply with relevant regulations is crucial. Additionally, HEIs face obstacles as not all applications are compatible with CC (Massadeh & Mesleh, 2013:42).

Based on the literature review, it is imperative for HEIs to implement comprehensive data security measures and access controls to safeguard sensitive information stored in the cloud. Furthermore, prioritising application modernisation is crucial, given the prevalence of applications running in cloud environments. This underscores the need to evaluate existing applications and prioritise those compatible with the cloud environment. Additionally, best practices dictate that training and upskilling of staff on CC should be prioritised for effective implementation.

### **3.9 SUMMARY**

The chapter presented the CC guidelines, its characteristics, and models. The chapter details the key principle of guidelines for crafting effective development guidelines. The adoption of CC in higher education is still very young. Resources, issues, challenges, and eventually best performance and standards are expected to undergo numerous changes in the future. However, there are some sought-after advantages that could help institutions of higher education benefit from the new system. The literature review primarily focused on explaining the study's key concepts and principles in developing guidelines. The study aimed to develop guidelines for CC in HEIs, both generally and specifically for this research. Guided by key principles, the researcher extracted guidelines from the literature review. These guidelines emphasize various factors identified in the literature, highlighting technical, organizational, financial, environmental, and governance aspects, and how technology can be effectively utilized in HEIs.

The empirical findings of this study were presented in the next chapter. As the next chapter discusses, these findings and results were used to develop guidelines for the adoptions CC in South African HEIs.



## **CHAPTER 4: EMPIRICAL STUDY**

### **4.1 INTRODUCTION**

The purpose of this study was to develop adoption guidelines of cloud computing (CC) in a South African higher education institution (HEI). The objectives of this chapter were to achieve the second empirical objective (E02) to extract adoption guidelines on how HEI can facilitate CC adoption from data gathered and analysed – to make sense of it. Data were gathered from the participants, analysed on order to make sense of it. The third empirical objective (E03) focused to incorporate guidelines based on the perceptions and experiences of the participants into guidelines extracted from literature on how HEI can facilitate CC adoption. It incorporates literature on how HEIs can facilitate CC adoption. The first empirical objective (E01) to extract guidelines from the literature review on how HEI can facilitate CC adoption.

This chapter describes the method used to collect and analyse data in this study. The findings of the research are also discussed. Results of this study are related to the research questions. This chapter reviews the empirical research conducted by carefully examining the information received from participants during interviews. It describes this study's participants, how data were gathered, and how the analysis of the data was done. The purpose of this chapter is to describe the methods used in collecting and analysing data for this study. The findings of the research are also discussed. Based on the research questions, the findings relate to this study's purpose. Information technology (IT) management, IT technical staff and HEIs can use data to identify, describe and explore how to adopt CC in higher education.

Section 4.2 explains the data collection of this study. Section 4.3 discusses the participants and Section 4.4 focuses on the data coding. Section 4.5 explains data analysis that includes the steps that were used to analyse data. Section 4.6 discusses the themes as findings from the data. Section 4.7 focuses on the emerging themes and guidelines developed. Section 4.8 focuses on the response to this study research. Lastly, Section 4.9 summarises all the processes and results of the chapter.

### **4.2 DATA COLLECTION**

Semi-structured interviews were used in this study to extract participants' viewpoints by inquiring about their opinions and experiences with CC in higher education. According to circumstances, interviews were conducted in-person or virtually facilitated by a tool such as Microsoft Teams. During interviews, participants were asked for their consent and assured of anonymity. Participants were given the opportunity to consent to having their interviews

recorded. Every interview was summarised with behaviour notes and compiled immediately after completion.

A comprehensive literature review of CC adoption guidelines in South African HEIs was presented in Chapter 3. Using the literature findings as a starting point, the empirical research can be formulated. Semi-structured interviews were used to collect qualitative data from participants. A literature review pertaining to CC and HEIs was used to formulate semi-structured interview questions as included in Appendix A Interview Questions.

The method of data collection adhered to the notion of interaction between researcher and participant, according to Klein and Myers (1999:72). In the interview process, by asking suitable questions, the researcher gained an understanding of this study setting and the experiences of the participants. Each participant was scheduled for an interview, and a consent form outlining the research was e-mailed to them prior to the interview. Interviews were recorded with participants' permission. The researcher transcribed and added comments regarding behaviour to each interview.

### **4.3 PARTICIPANTS**

As stated in Chapter 1, the objective of this study was to develop CC adoption guidelines in a South African HEI. The researcher used interviews to collect data. Participants held a variety of positions, ranging from senior management to technical staff. Data collection was eligible to all selected interviewees due to their positions within the department, as indicated by the information provided.

Qualitative research often centres around a select few participants chosen for their extensive knowledge and experience within the IT departments of HEIs. These individuals were carefully selected due to their familiarity with CC concepts and their specific expertise relevant to this study. This includes participants who have demonstrated long-term tenure within HEIs, showcasing their adaptability to evolving technologies and deep understanding of CC principles. For the interview process, participants were randomly selected. The participants interviewed were all North-West University (NWU) employees. Choosing a combination of IT governance and IT technical staff was based on the idea of determining whether the two backgrounds would have significant differences in CC technology and in higher educational experience.

Participants were contacted by distributing an e-mail through a formal university channel. Participation in this study was voluntary, and all interested IT governance and IT technical staff were clearly informed of its purpose before the interview process began.

Participants signed consent forms before participating in this study. Recruiting prospective study participants according to this study objectives allowed the researcher to recruit approximately 25 participants. The IT industry is still dominated by males; therefore, the researcher did not choose gender; participation was voluntarily.

For this study 25 participants were invited to participate but only nine individuals ultimately participated in the interviews. This lower turnout was influenced by various factors, including scheduling conflicts, lack of availability and challenges in reaching potential participants.

The data analysed in this study came from only eight participants. One participant was excluded because the interview responses was provided in writing. The researcher aimed to follow up on certain answers, but the participant was unavailable for further interaction, therefore, the data from this participant were not included in this study as the researcher fail to gain further clarity insight for some questions. Despite these obstacles and the smaller sample size, the data collected from the nine participants yielded comprehensive insights, allowing for a thorough analysis of the research objectives.

The list of participants is shown in Table 4.1. This category of participants normally produces high-level reports that are used to make critical organisational decisions. The participants are identified as P1 to P8, with P1 to P5 comprising the Technical IT staff and P6 to P8 representing the IT governance team.

**Table 4.1: Participants**

<b>Participant</b>	<b>Role</b>	<b>Race</b>	<b>Years of experience</b>	<b>Gender</b>
1	Team lead: Service desk	White	12 years	Male
2	Team lead: Teaching & Learning	White	20 years	Male
3	Senior Business Analyst	African	9 years	Male
4	Senior Consultant	White	16 years	Male
5	Operations Technical Supporter	African	18 years	Male
6	Senior Manager: Operations	White	25 years	Male
7	Chief Director IT	White	40 years	Male
8	Digital Strategist	African	30 years	Male

Interviewees selected for data collection hold relevant positions within the HEI, thereby contributing to the process of data collection. The researcher created an interview guide and used it to ensure that no questions were left out of the interview. All the participants have worked in their current positions for more than three years. Having worked in their current

positions for longer would provide them with a greater level of knowledge and insights about the organisation. So, participants were able to communicate effectively and share understandings.

The purpose of this assessment was to determine the respondent's backgrounds. Table 4.1 illustrates the demographic details of the participants. In this category, more general aspects such as respondents' position in the organisation, gender, race, and years of operation at the HEI were assessed. Table 4.2 below illustrate the guiding question of this study.

**Table 4.2: Guiding questions**

<b>Basic questions/Demographic details</b>		
What is your position?		
How many years and experience do you have in the field of IT?		
What is your gender? (Options: Female/ Male /prefer not to say)		
<b>Part 2: Interview question</b>	<b>Motivation</b>	<b>Reference</b>
1. How would you define CC in your own words?	To determine and affirm whether the participants understand CC.	Mell and Grance (2011:2); Winkler (2011:2)
2. In terms of IT Services, how is the university embracing cloud-computing?	To determine or get an understanding from participants how IT services at the university can be utilised through the use of CC.	Rodríguez Monroy <i>et al.</i> (2012:26)
3. Does the NWU have any plan to adopt CC?	To get information from participants if NWU has measures in place to adopt CC.	Attaran <i>et al.</i> (2017:25); (Mell & Grance, 2011; Pardeshi, 2014b:591)
4. Regarding the current level of ICT development, would it affect CC adoption?	To determine whether the development of ICT would have an impact on CC.	Ahmed and Allawi (2020:124)
5. Do you have confidence in migrating NWU services to the cloud? Do you trust cloud services?	To determine the confidence and trust that NWU has in cloud services	Mahmood (2011:122)
6. What factors would you consider while selecting a cloud service provider?	To determine if participants have specific requirement to choose the service provider	Bokhari <i>et al.</i> (2016:894)
7. Do you believe that CC is cost-effective?	To determine whether participants believe that CC can reduce cost	Carroll <i>et al.</i> (2011:3)
8. To what extent can the use of CC impact teaching and learning experience?	To check whether the adoption of CC can impact teaching and learning	Adam (2020) Elgelany and Alghabban (2017:122)
9. Does IT have services that are running on the CC currently? If yes, what is the experience.	To check whether participants are using any cloud services in IT	Qasem <i>et al.</i> (2019)

<b>Part 2: Interview question</b>	<b>Motivation</b>	<b>Reference</b>
10. Do you believe that by utilising CC, can improve availability of services in IT?	To determine whether the adoption of CC can improve the availability of IT services	Katz <i>et al.</i> (2010:2)
11. Do you think training is required for related positions when CC can be introduced?	To determine if participants will need training or skills of CC adoption	Ali (2019:90)
12. In your opinion, what are the major CC stumbling blocks in your institution?	To determine if the participants are aware of any challenges that can affect the adoption of CC.	Shrivastava and Chandan (2022:8)
13. How do you view the benefits that CC can offer to your university?	To determine if the participants are aware of CC benefits	Qasem <i>et al.</i> (2019)

Interview guiding questions play a crucial role in qualitative data collection. The questions are designed to elicit detailed responses that will assist researchers in gaining a deeper understanding of participants' experiences and perspectives. By guiding conversations with these questions, valuable insights can be uncovered that contribute to a thorough understanding of the research topic. Data collection based on meaningful and contextually relevant guiding questions is essential for achieving the goals of research.

#### **4.4 DATA CODING**

In qualitative research, coding is one of the fundamental concepts that researchers use to break down their data and create new knowledge (Elliott, 2018:2850). An important part of data analysis is coding or categorising (Basit, 2003). It is possible to code portions of text by selecting the line numbering in the document, or by emphasising the quotation that is to be coded. Using the coding method, the researcher had to construct order out of the different patterns and commonalities of participant experiences and views. Qualitative data can be analysed in many ways to produce meaningful findings. As a general method of coding data, the data are analysed, codes are generated based on relevant information, sorted into clusters, and labelled to create themes (Adu, 2019:13).

Qualitative data coding uses inductive and deductive coding. Refer to Chapter 2 for a detailed explanation. As there is an existing history of CC adoption in HEIs, a deductive coding analysis was applied in this study. The categories/themes for CC were pre-defined from the literature review.

#### **4.5 DATA ANALYSIS**

To perform data analysis, it is crucial to understand and interpret the collected data. Researchers record communication between themselves and their subjects during content

analysis in qualitative research (Datt & Chetty, 2016). According to Zhang and Wildemuth (2009:3), the following steps should be followed when analysing data: prepare the data, define the unit of analysis, develop codes and categories, test the codes and categories, code all the text, assess your coding consistency, draw conclusions from the coded data and report on the findings and method.

A detailed discussion of the findings is provided in this section based on the data collected from IT governance and IT technical staff. The researcher adhered to Klein and Myers (1999:72) principles of interpretivism.

Researchers found that factors influencing HEI adoption of CC varied according to how participants defined them, based on their experiences and knowledge. Diverse responses came from IT governance and IT technical staff members, indicating that the participants' perceptions are diverse due to their backgrounds and positions within the higher education sector.

The respondent P6 (IT governance) said:

*“Cloud computing for me is an IT infrastructure platform or a service that I’m running primarily, not on premises. So, when I refer to primarily not on the premises, I refer to the public cloud.”*

The response for P3 (IT technical staff) said:

*“Cloud computing is like storing or accessing data or applications over the Internet or via the Internet. And it can be accessed from anyway, so, therefore, I guess that of what making CC. Um, a reality is Internet. So, in my own words, I would say is accessing information over the Internet.”*

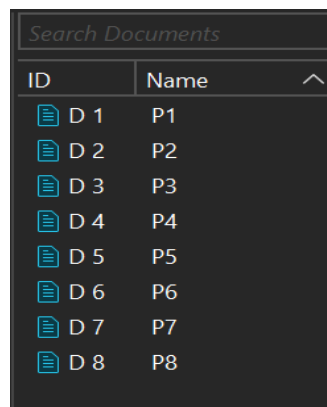
As a result, the answers given by the participants to the question about how to define or comprehend CC show the knowledge gap between technical staff and IT governance.

Text documents were created from the transcribed interviews. Data from the transcribed interviews were analysed using a qualitative data analysis tool called ATLAS.ti. Codes and themes were identified based on the objectives of the research and concepts identified from the literature. Qualitative data were analysed using content analysis.

Zhang and Wildemuth (2009:3) suggest the following phases for analysing data.

### 4.5.1 Step 1: Preparation of data

Organizing and preparing the data, i.e., transcription of the interviews conducted by the researcher, is the first step in qualitative analysis. Following the organisation of the data, the researcher will analyse the whole pool of information to develop a general concept. To begin the analysis, the data must be transformed. Thus, the researcher will be able to organize data systematically according to a finite number of categories while also making sense of the data. According to the order of interview, each participant was given an identification number. Figure 4.1 illustrates a list of participants with numbers ranging from 1 to 8; as an example, P1 is participant number 1.



ID	Name
D 1	P1
D 2	P2
D 3	P3
D 4	P4
D 5	P5
D 6	P6
D 7	P7
D 8	P8

Figure 4.1: ATLAS.ti participant identification

### 4.5.2 Step 2: Define the unit of analysis

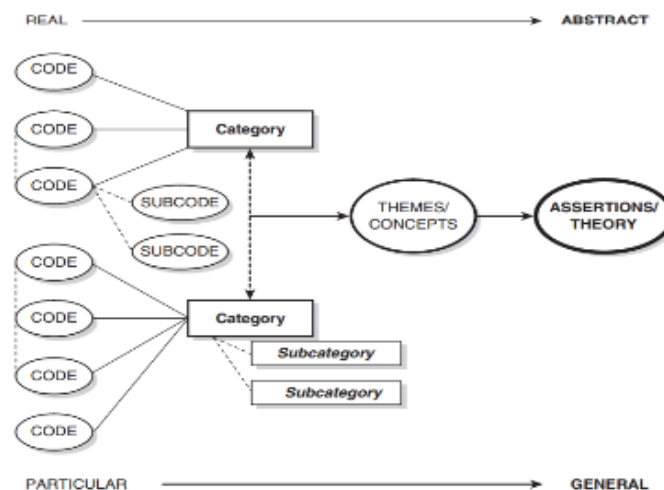
The researcher will read and familiarise him/herself with data that will help to generate the list of ideas about the data and what is so interesting about the data. In the second phase, initial codes are created based on categories addressed in interview questions to flag interesting aspects of primary data. During this study, participants were asked a series of questions. Analysis units were words, phrases, or sentences that were used to classify the content into themes. It is important to choose a theme that presents an idea for the unit of analysis. In other words, the theme's data must be added to that unit. Content analysis involves dividing text into basic units for classification. It means categorizing content from word or phrase to sentence level into units or themes.

### 4.5.3 Step 3: Developing categories and coding scheme

In this step coding and categorization take place, and codes are grouped based on their relationship. From categories emerge themes, which, in the end, result in the developed theory. A theme represents some level of response or meaning within the data set, and

captures something important about it in relation to the research question (Braun & Clarke, 2006:84). An analysis of codes aimed at identifying themes in the data, i.e., patterns that are significant or interesting, and using them to address the research or talk about a topic. By analysing the code categories, themes were identified, which then helped to conclude this study in terms of meaningful information (Maguire & Delahunt, 2017:3353).

Through the analysis of data, examination of previous studies, and consideration of theoretical frameworks, researchers can construct categories and coding schemes. A coding scheme and subcategories for the analysis will be developed next. A number of sources are used to develop this, including primary data, theories on similar topics, and empirical studies. Figure 4.2 illustrates the process of developing categories and coding. The participants' responses were coded and compiled to form categories, leading to the development of themes, as illustrated in Figure 4.2.



**Figure 4.2: Provides a description of developing categories and coding scheme (Saldaña, 2021:12)**

#### 4.5.4 Step 4: Test codes and categories

Ensure that codes and categories are applied consistently to analysed text by testing them. Coding the sample of existing data by the research team is essential to ensuring consistency. It is necessary to recode if the consistency among researchers is low. An analysis unit, such as a piece of text, is coded in this step. As a unit of analysis, responses to questions were used. To analyse undirected content, one must take an undirected approach in coding.

A rephrasing of question 8 was decided during the interviews. There was a problem understanding the question among the participants. As a result, the question has been

rephrased as follows: "In your opinion does the use of CC impact teaching and learning experience?"

The researcher first tests the codes by selecting question 13 from different participants which the aim to get an understanding as they respond to the same question to make sure that the codes are applied consistently to be analysed. Participants selected were P1, P2, and P7. The complete set of interview questions as included in Appendix A "INTERVIEW QUESTIONS" is also available in Table 4.2 in Chapter 4 . Participants' responses to question 13 are reported in the first column of Table 4.3 the second column contains their assigned codes.

**Table 4.3: An overview of unit testing**

Answers to question 13 extracted "How do you view the benefits that CC can offer to your university?"	Codes assigned
P1: <i>"The increase productivity and capacity, it's basically a snowball effect."</i>	Ability to adopt CC: <b>Efficiency</b>
P2: <i>"I think. If he does have any benefits. The main benefit I would think, is if we reach the certain capacity and there are no maybe additional funds or to help with it is to make use of CC in a capacity where we can accommodate more students or staff to our environmen.t"</i>	Ability to adopt CC: <b>Scalability</b>
P 7: <i>"I think we've touched on some of the benefits, that the benefits are immense. If we really have got a proper cloud migration stroke, cloud adoption strategy, the one is obviously the fact that we don't have to lay out massive capital."</i>	Cost management: <b>Cost savings</b>

Codes were applied consistently to these three participants' responses and re-evaluated to confirm they reflected the text's intent/meaning and correlated well with the question's objective. Using a question as a unit of analysis will limit the coding and analysis process when the unit is a response. Therefore, the entire interview response of a participant must be considered a unit of analysis to analyse them more logically. Additionally, a participant's response to a question should be considered within the context of the overall interview and within the context of their interview in relation to the other participants. To make analysis easier, we added a prefix to some codes to indicate specific interventions or points in time within the course, where necessary, to indicate a specific intervention or point within the course to add context.

#### **4.5.5 Step 5: Code all the text**

It is necessary to apply coding to the data after ensuring coding consistency in the previous step. Each participant's response was coded in this step. A consistent code was assigned to each response based on an analysis of the responses. The list of all the codes from the participants were included in Appendix C, "LIST OF CODES FROM EMPIRICAL DATA". In the next step, the researcher will analyse the consistency of the coding after all the text has been coded.

#### **4.5.6 Step 6: Assess consistency of codes, categories and themes**

To achieve the research goal, interview questions are designed to elicit responses that will enable the code creation process. The analysis of data was presented clearly in order for meaningful conclusions to be drawn. Thirteen questions were posed to the participants in this study to see how South African HEI embrace CC. All the questions that were asked to the participants were related to the adoption of CC in HEI. It is important to recheck your coding consistency after coding the entire data set. There is no guarantee that the coding of the whole corpus of text will be consistent and reliable, even if a sample is coded consistently and reliably. To determine the consistency of newly created codes, new codes are manually noted. Coding is carried out by re-evaluating previous interview responses. In early stages of coding, processes were used in response. The codes were grouped together and the researcher able to create themes/category from the transcribe data from the participants.

Based on the data analysis described above, data collected from participants is used to generate the themes. The researcher developed the following themes from the data collected and the themes were aligned with the literature Chapter 3, Table 3.3: technological, environmental, governance, financial, and organisational factors, and challenges of CC in higher education.

Detailed discussions on the themes follow below.

### **4.6 DISCUSSION OF THEMES**

Ryan and Bernard (2000) mentioned that it is essential to discover themes when analysing qualitative data. Researchers identify abstractions, often fuzzy, as themes before, during, and after data collection. What are the sources of these themes? Literature reviews, of course, generate themes. Themes emerge from richer literature review. Vaismoradi and Snelgrove (2019) mentioned that a theme is what data conveys to the audience according to its cultural context and subjective meaning. This study phenomenon can be transformed into a theme by combining codes with common references, high transferability, and ideas that can be united

across it. In other words, a theme is an underlying meaning behind similar data pieces that connects them and can be used by the researcher to answer their question.

#### 4.6.1 Theme: Technological factors

Kim (2009:67) mentions that CC adoption is met with several concerns by users. Support, interoperability, security, compliance, and availability are among them. The enterprise is generally the only one concerned with compliance. Even though on-premises computers and software still exist, all of the concerns the users have are the same. Below is Table 4.4 displaying the codes extracted from participants that pertain to technological factors.

**Table 4.4: Codes related to technological factors**

Codes	P1	P2	P3	P4	P5	P6	P7	P8	Total
Technology: Availability	1	0	1	1	0	1	1	0	5
Data security: Data access	0	0	1	0	0	0	0	0	1
Data security: Data availability	0	0	1	0	0	0	0	0	1
Data security: Data privacy	1	0	0	0	0	0	0	0	1
Data security: Data loss	1	0	0	0	0	0	0	0	1
Data security: Data management	0	0	1	0	0	0	0	0	1
Technology: Benefits	0	1	0	0	0	1	0	1	3
Technology: Security	0	1	3	1	3	0	0	1	9
Challenges: Lack of awareness	0	0	0	0	0	1	1	1	3
Technology: Technical skills	0	0	1	0	0	0	0	0	1
Technology: Technological challenges	1	0	0	0	0	0	0	0	1
Technology: Technological innovation	0	0	0	0	0	1	0	0	1
Technology: Technological transition	0	0	0	0	0	0	0	1	1
Technology: Technology integration	0	0	2	0	0	0	0	0	2
Technology: Technology usage	0	0	0	0	0	1	0	0	1
IT infrastructure: Internet access	0	0	1	0	0	0	0	0	1
Ability to adopt CC: Complexity	3	0	0	0	0	0	1	0	4
CC: Policy and regulations	1	0	0	0	0	0	0	0	1
CC: Training requirements	1	0	0	0	0	0	0	0	1
Technology: Trust	1	0	3	0	2	2	0	0	8
<b>Total</b>	<b>10</b>	<b>2</b>	<b>14</b>	<b>2</b>	<b>5</b>	<b>7</b>	<b>3</b>	<b>4</b>	<b>47</b>

The following codes have emerged from the transcripts of the participants that focus on the technological adoption of CC in HEIs: Technology availability, complexity, data security and privacy, data loss, scalability; IT infrastructure, and a lack of awareness. The technological factors codes are discussed below.

#### Technology availability

When the researcher asked the participants about question 10, “Do you believe that utilising CC can improve the availability of IT services?”, they responded as follows:

Participants had slightly different views if CC could improve technology availability at HEIs.

According to P3, *“Yes, um, look when you are in the cloud the service provider does not have a one data centre. So, depending on where you are. So, it then improves your redundancy level. So, you have availability from wherever you are”*, therefore the adoption of CC can increase the availability of IT services; regardless of your location, you can access data.

P3 further said that it also increases the speed to access the IT services. P3 mentioned that: *“If I’m in in Joburg or in the island, my data could be there. It’s quicker for me, it increases speed, it’s quick for me to access my data”*.

The participant went on to say that if service providers have many data centres, you may access your data from anywhere in the world at any time. The speed and redundancy of data access will depend on the geographical locations of the data centres, which will be distributed throughout the world. In certain cases, data access could be quick and redundant; on other occasions, it could be slower.

Another participant concurred that the availability of technology will not be impacted by the positioning of data centres at various locations because you will not even be aware of which data centres you are linked to.

*P7 said, “when the subscription takes place in a data centre that’s in the US, if there is a shift to a data centre that’s in Europe, you cannot even feel it because they have got the higher availability arrangement built into their designs. So, on that, the service will improve.”*

Participants compared the availability of technological services on premises compared with the cloud services from a variety of perspectives, with a focus on the impact on support.

*P7 said, “However, there is something that one needs to be careful of, because now when something goes wrong at the university, you can pick up a phone and speak to a consultant, or you can walk to consultant office and say: when are you going to fix this thing, please? Class is standing still. I can’t teach now with all the services in the cloud.”*

Therefore, according to the participant, on-site service will be more reliable for a contact class session than virtual session. Participants explained that there is difference between the on-premises and the cloud in terms of the availability of technologies or services, although most of participants agreed that the cloud could improve the availability of technology.

Another participant had different views and was uncertain if CC could increase the availability of services.

P6 said: *“Yes and no. Yes, because these people have teams that teams is available. So, the cloud providers livelihood depends on the availability of their services, absolutely. So, they make sure that everything is up and running all the time.”*

The participant elaborated that the accessibility of cloud services is contingent upon the availability of a network. In the unfortunate event of a network outage, users would be unable to perform any tasks. The participant illustrated this with a scenario.

P6 said: *“But, umm, they all things like latency and they all things like you dependent on the network and these things do go down we've seen it last week. When the Internet line was down on the East or the West Coast, two of the Internet lines were down on the West Coast and that affected our teams and teams' meetings that the sound was absolutely bad just because of that. So and so it's a yes and a no. But I think it's more a yes than a no.”*

## **Complexity**

Participants mentioned that there is complexity to adopt CC at HEIs as it depends on the Internet connection. It is even difficult to access basic application from Microsoft application like Teams.

P2 said, *“obviously if you don't have access to the infrastructure as well, it's probably, I mean, if you don't have Internet service or connection, there's no way you can use Skype computing server.”*

Another participant mentioned that the lack of or outdated policies and guidelines also contribute to the complexity adoption.

P1 mention that *“So it comes down to the policies and regulations that we need to have in place before actually migrating a specific service or software or even hardware requirements over to a CC platform.”*

## **Data loss**

Namasudra *et al.* (2017:10) mention that it is possible for data loss to occur if the cloud service provider stops its services due to financial difficulties or other reasons. Since the servers no longer hold the data, users cannot access it in the future.

Participants give their views about data loss which relates to CC. The mail server needs to have adequate storage space for redundancy, to avoid a challenge of losing data, if there is lightning or theft as it poses a significant problem.

*P1 said, "You know, if you're running that e-mail server that I have mentioned, and you've got no rights storage on it or if lightning hits or they steal the unit and you've got a problem because your data is lost."*

Participants mentioned that there is a challenge of data loss when using Microsoft applications, as failure to save may result in the loss of data.

*P4 mentioned that "For example, I found the auto-saving of Office very helpful, although it's not always working. Not all of us wants to use Next cloud. Personally, I prefer Google Drive or MediaFire. The moment you say it's not auto-saving, then whatever you're working on the document, if you want to save it, it doesn't auto-save the possibility to lose that data."*

Participants added that cybersecurity remain concerns on adopting CC as it poses challenge for HEIs to lose data,

*P6 cited that "The main factor will be your cybersecurity and the prevention of incidents and the protection of your data. That will be the ... how can I say that's where you will make a distinction between the rest? Because if you are a company that is notorious for losing data or even you know some of your data are being attacked and copied the way and that will be a big thing."*

## **Data security**

Data security is one of the top listed concerns on the adoption of CC worldwide. Data security is of primary concern to customers and cloud users who store private information such as banking information, health information, etc. (Kirubakaran *et al.*, 2023:1881).

Participants expressed their views about data security as one of their top worries when adopting CC. They also worry about whether a third party will be able to access their data.

Participants worried that every check box must be considered to mitigate every challenge related to the security of the data.

*P1 said, "How's the data protected both physically and in transit? Do we know where all iterations of our data are? So, at the end of the day, one would have to hope that the predetermined list of tick boxes is covered, and that due diligence was actually*

*done prior to the use of any particular system and linking a relevant security challenge or score to the use of whatever function and system is needed.”*

Participants had questions about whether their information could be safeguarded sufficiently to prevent leaks and exposure:

*P2 mentioned that “so they won't put something on a third-party storage if we can't be guaranteed the information won't be leaked or compromised in anyway, so that's the biggest timely box and it's basically the terms of conditions of CC service providers and but it blocks almost everyone in the industry.”*

The participant also mentioned that it would be hard to share all data with service providers without a guarantee that other stakeholders would not access it. *“I doubt and if company will give you 100% guarantee on anything. It's impossible. Something can happen at any stage. So, in this case, certain things are only available on campus, so that's the main stumbling block.”*

Participants said that the service provider should be able to guarantee that the data were secure and could only be accessed by their owner.

P3 supported P2 and said:

*“Yeah, I think security as well security practises by the vendor or by the service provider, they need to have a repetition of you being able to secure your data. I mean I can make any template typical example with Google for instance. You know Google says the information might belong to you, but they've got the rights to use it. If and when for, you know such things you know, and it would then become sceptical.”*

The participant expressed a similar viewpoint to P1, P2, and P3, emphasising that ensuring service provider compliance with data regulations is of the utmost importance.

*P4 said, “Security is first: As if the services provider should provider's security measures, data encryption practices, access controls and certifications. Ensure that you have robust security protocols in place to protect your data and meet your specific security requirements. Then we've got compliance: Determine if the cloud service provider complies with relevant industry regulations.”*

Participants used the following real-world illustration to illustrate how not all applications could be transferred to the cloud because some included sensitive data:

P8 mentioned that *“When we move Outlook to cloud but they are applications like all systems that they are little bit sensitive on like and salaries and remunerations office or salary.”*

## **Scalability**

The CC model allows users to increase and decrease cloud services as they need them (Namasudra *et al.*, 2017:8). It is possible for institutions with limited financial resources to save money by utilising cloud-based technology, which allows them to spend the money they saved on more important tasks, such as licensing and infrastructure management. Further, by providing reliable information resources and applications, scalability, and high-quality functionality, CC allows universities to compete more effectively (Helaimia, 2023:137).

Participants elaborated that by scaling the institution could be able to save or utilise resources that were needed at that time.

P1 mentioned that; *“You're going to pay extra for, but when looking at one of these service providers, one would typically like to go for an agile and scalable approach, something that's a little bit more flexible and it keeps you from growing or shrinking, depending on how your own needs progress over time.”*

Participants mentioned that by scaling it helps to save/manage cost of the institution.

P3 said, *“you pay for the service. Uh, and you're able to scale, you know, either scale up. You can manage your cost by scaling and scaling up, scaling down depending on, you know depending on the use and the need at this at that point at that point. So, I think it'll really save costs it'll save costs in the long run.”*

Other participants had a different perspective on scalability because many people assume that everything is always available and affordable when they hear the term "CC".

P6 expressed the option by saying, *“In the end, I think there is a misconception that cloud is cheap. It's not cheap. It, it will most probably cost you more than it cost you. Now if you look at total cost of ownership, but it gives you a lot of other stuff that you don't have now and that's agility. And I mean you can scale easily.”*

Hence, participants held varying perspectives on scalability, influenced by their respective roles, IT governance perceived things differently from IT technical staff.

## IT infrastructure

Participants provided examples of how the institution is currently utilising cloud services through their external service platforms.

Participants elaborated on how clients have embraced the adoption of software as a service. P1 briefly confirmed that by saying:

*“There's very little database being hosted externally. There's one or two, but mostly that's hosted internally virtual servers. We have a HPC running on campus, so there's HPC cluster in one of the machine rooms. And then there's the software as a service. That is a growing field with external vendors. Those include stuff like Microsoft Office 365.”*

Microsoft Office 365 is one of the applications that the participants are utilising at the HEI.

Other participants were concerned about the cost of maintaining institutions during load shedding, which would necessitate the purchase of large quantities of fuel rather than the usage of cloud services. The participant noted that maintaining the on-premises infrastructure requires a lot of resources (human resources) but upgrading the infrastructure could be more expensive than using a cloud platform.

*P3 said that: “You know, upgrading the hardware. You must think about the personnel to look after the data centre itself. So, you must pay somebody's salary until the age of 65 years or it might cost you more to have your own data centre than to move to the cloud you know when you move to the cloud you don't have to worry about hardware upgrades.”*

Another participant clarified that although the institution has begun implementing software as a service as an initial step to adopt cloud, it is not yet ready to use cloud infrastructure.

*P6 said: “Absolutely, and I think, uh, when you think about priorities, I think we will definitely start with software as a service that we've already started with then platform as a service and then infrastructure as a service, I think we will not start with infrastructure as a service. We will start with software as a service, but yes, the smart cloud strategy needs to be part of our strategy to move to the cloud.”*

## **Lack of awareness**

Participants indicated that users frequently use Microsoft Office without realising that it is a component of cloud services. P6 said: *"I don't use a lot of cloud services; I use my Microsoft 365 every day and I mean for me that is absolutely fair enough."*

Despite not knowing or understanding CC, participants highlighted how clients of the institution are more at ease utilising the programs or platforms with which they are familiar.

P8 indicated that *"I think the first one is really our awareness. You know, people spoke about the cloud, but they are not aware about the cloud services. So that's the first thing that we need is to have a cloud services awareness. The second thing is fear of the unknown. You know, people are comfortable knowing that my seller is sitting in that room and always open the door and see it happening nicely there."*

## **Conclusions based on technological factors**

Based on the technological theme, it showed that adoption of CC could improve the availability of IT services despite your location: It further has the benefits of global data distribution, which means users can be able to access IT services (data) through cloud services channel from different or multiple data centres across the world. It also has the advantage of high speedy accessibility if data centres are closer to their locations. The availability of IT services has an advantage of business continuity, as data centres distribute business continuity. However, their reliability and contingency planning still need to be taken considered as participants were concerned about the reliability of on-premises compared to virtual services, especially on critical situations such as class sessions. Therefore, recommendations to develop contingency planning that would be able to address such issues with the cloud services should aim to provide uninterrupted services, and such mechanisms need to be in place.

On this basis it has been suggested that HEIs need to evaluate data protection and recovery, to ensure that data are protected and can be a transit within the cloud infrastructure. It is important to ensure that there is access to the cloud service provider that will be able to provide a disaster recovery plan. It has also been suggested that intellectual property is very important and remains a concern and needs to be taken into consideration before the adoption of CC in HEIs. Regarding the understanding of the cloud services model, it has been suggested that is important to educate the stakeholders about all the cloud services models (SaaS, PaaS and IaaS). It has been recommended that the adoption of CC in HEIs need to be starting with SaaS and then could progress to the other models. It has been suggested that the adoption of CC in HEIs could bring cost saving to the universities, which means they can increase agility,

scalability and accessibility of information. Policies and procedures all need to be taken into consideration before migrating any services to the CC platform.

#### 4.6.2 Theme: Environmental factors

Low *et al.* (2011) cite that an organisation's environmental context is determined by its industry, competitors, and government policies and visions. Organisations often adopt new technologies to remain competitive due to technology changes. A company may consider adopting new technologies because of competition with rival companies. As an example, an organisation can better understand its environment when it adopts CC.

The codes presented in Table 4.5 were extracted from the participants' transcripts and focus on environmental factors that impact on the adoption of CC in HEIs: data privacy and protection, regulatory compliance, a lack of support, and data location.

**Table 4.5: Codes related to environmental factors**

<b>Codes</b>	<b>P1</b>	<b>P2</b>	<b>P3</b>	<b>P4</b>	<b>P5</b>	<b>P6</b>	<b>P7</b>	<b>P8</b>	<b>Total</b>
Data security: Access controls	0	0	0	1	0	0	0	0	1
Data security: Backup procedures	1	0	0	0	0	0	0	0	1
Data security: Big data and analytics	0	0	0	1	0	0	0	0	1
Data security: Concerns about privacy	0	0	0	0	0	0	0	1	1
Data security: Cybersecurity	1	0	0	1	0	0	0	0	2
Data security: Data access	0	0	1	0	0	0	0	0	1
Data security: Data availability	0	0	1	0	0	0	0	0	1
Data security: Data backup	1	0	0	0	0	0	0	0	1
Data security: Data breach	0	0	0	0	1	0	0	0	1
Data security: Data compliance	1	0	0	0	0	0	0	0	1
Data security: Data governance	0	0	0	1	0	0	0	0	1
Data security: Data loss	1	0	0	0	0	0	0	0	1
Data security: Data management	0	0	1	0	0	0	0	0	1
Data security: Data location	0	0	1	1	0	0	0	0	2
Data security: Data privacy	1	0	0	0	0	0	0	0	1
Data security: Data processing	0	0	0	0	1	0	0	0	1
Data security: Data protection	0	0	0	1	0	0	0	0	1
Data security: Data security	1	1	1	2	0	0	0	0	5
Data security: Data transfer	0	0	1	0	0	0	0	0	1
Data security: Due diligence	1	0	0	0	0	0	0	0	1
Challenges: Lack of awareness	0	0	0	0	0	1	1	0	2
Challenges: Lack of clarity	0	0	0	0	1	0	1	0	2
Challenges: Lack of engagement	1	0	0	0	0	0	0	0	1
Challenges: Lack of information	0	0	0	0	0	0	0	1	1
Challenges: Lack of knowledge	1	0	0	0	0	0	0	0	1
Challenges: Lack of organization	1	0	0	0	0	0	0	0	1
Challenges: Lack of support	0	0	1	0	0	0	1	0	2

Codes	P1	P2	P3	P4	P5	P6	P7	P8	Total
Challenges: Lack of training	3	1	1	2	1	0	3	0	11
<b>Total</b>	<b>14</b>	<b>2</b>	<b>8</b>	<b>10</b>	<b>4</b>	<b>1</b>	<b>6</b>	<b>2</b>	<b>47</b>

### **Lack of support**

Participants explained that a lack of training and knowledge of IT professionals result in a lack of support. P7 said: *"You know where we don't have people that have operated in the cloud environment who can hold us and say don't worry, it's not that difficult."*

When participants were questioned about their trust in the service provider and their expectations regarding support, some participants expressed doubt about receiving full support from the service providers. This was their response, P3 said, *"Technical skills. are they able to ensure that we as the university can deploy whatever we need to deploy? Will they be able to support us, and you know provide us with the necessary measures?"*

Participants had different views on confidence of adopting CC at the institution.

As security concerns remain, participants explained that there is a lack of support that the personnel should have, so that, should anything go wrong, they would be able to provide that support, thus the service provider should give full support.

P3 said, *"So, when you choose a service provider, I think we must consider security practices, the ability to provide support, technical capability, their reputation or the trustworthy. Uh, you need to know that specific provider."*

Participants also raised worries about the security of their data stored in the cloud. They expressed uncertainty regarding potential tampering with the data and questioned who would be available to provide support when needed.

P8 said, *"Like I've said, when you put the information there on the cloud, you don't know if someone can look at your data. So, we don't know how they have full support on the data or we've got a certain part or we've got a full support of data and they only manage infrastructure, We don't know."*

### **Data privacy and protection**

Chen and Zhao (2012:650) mention that among the primary issues related to CC that need to be addressed are data security and privacy protection issues.

The participants detailed a scenario involving the institution's need to transition from an old system to a new cloud-based mail Outlook application. During this migration process,

participants concerns were raised about the handling of sensitive information. The participants highlighted the details involved in ensuring the secure transfer of data while transitioning to the new system, emphasising the need to address these concerns effectively.

*P1 said “The transition of Outlook to the cloud is underway, but certain sensitive applications, particularly those related to salaries and remunerations, are causing concern. The salary office is currently scrutinizing these applications, holding meetings, and discussing the implications of moving such critical functions to the cloud. The uncertainty surrounding the environment is acknowledged, and there is a recognition that moving the payroll to the cloud might pose challenges, with definitive decisions yet to be made.”*

Another participant raised further concerns, pointing out that there is a challenge of data being used as part of a marketing strategy. This worry stems from the perceived inability to control their data once it is stored in the cloud.

*P3 said: “Say I am going Google Way is they can take your data for marketing or whatever. We never know where, who, they can sell it to or stuff like that. So, when you choose a service provider, security concerns security practices are one. I think we could also, we must consider, you know security practices, the ability to provide support technical capability, their reputation or the trustworthy,”*

It is essential to maintain continuous security for institutional data, covering various aspects such as student records, research data, and intellectual property. P4 mentioned that *“First things. Data security and privacy at the university. We handle sensitive data, including student records, research data, and intellectual property. The data security and privacy concerns can be a significant stumbling block.”*

Data protection remains the most important factor on storing data to the cloud, as P5 said.

*“The main factor will be your cybersecurity and the prevention of incidents and the protection of your data. That will be the ... How can I say that's where you will make a distinction between the rest? Because if you are a company that is notorious for losing data or even you know some of your data are being attacked and copied the way and that will be a big thing.”*

## **Regulatory compliance**

Companies can increase productivity, increase internal controls, and fix inefficiencies by following compliance procedures.

P4 said that, *“Yeah, identifying suitable CC solutions, creating a migration strategy and implementing the necessary changes. It may include selecting a cloud service provider, configuring and deploying cloud resources, migrating data and applications, training employees on utilising cloud services effectively. CC adoption requires careful planning and consideration of factors such as security, compliance and data governance, governance and integration with existing systems.”*

Regulatory compliance in CC is of paramount importance for HEIs. Compliance helps to safeguard intellectual property and ensures the privacy and security of information, addressing concerns related to data breaches or unauthorised access.

P1 said. *“Uptime breaches, security level backups, whatever the case may be. So, there's no short yes or no answer if the necessary due diligence was done by a credible either our own team of investigators or an external some of the compliance regulations require external vendors to do that kind of negotiation and checking up on vendors. If that was done and you have regulatory compliance, then I'd say yes we do, but I personally I think there's too little of our staff members that are actually trained prior to being appointed. They are trained in the field, which is a dangerous thing.”*

Compliance with SLA with the service providers is very much important. P1 said that *“I think it's very right word then with the right vendor there's a increased availability. Again, it'll depend on your SLA and which vendor you take, increased flexibility and scalability, which is I think one of the major advantages.”*

### **Data location**

Odun-Ayo *et al.* (2017:30) mention that customers "see" virtual servers when they store data, so it appears that data are stored in a specific location with a certain name, but in reality, no such location exists. Several data centres across several geographic locations could be used to store the users' data. Because the cloud manages storage locations dynamically around the data centres, some data may be stored in a different location from time to time. Users still manage storage space as if they were using a desktop computer, even though the location of the data is virtual.

When participants were asked about the factors to consider before adopting CC, they stressed the crucial need to have a clear understanding of the data storage location.

P4 said, *“Uh, you know of that specific provider. So yes, I think those are some of the factors that we can be able to that we must consider, and I think they are their*

*data centres where they are located. We must also maybe you know try to think of that. Uh, you know, it's no use, uh, we move to the cloud and most of their data centres are not within Africa or within reach. You know, when there's a political climate that just goes and then we are affected, you know, you know those why and all of those but ...Yeah. So, so I think we must consider some of those aspects."*

Some participants emphasised that it does not matter where the data centre is located as long as they can access data any time.

*P4 said, "you got multiple data centres at multiple locations. So, depending on where you are, So, it can improve your redundancy level and I will have access to the data. therefore, it means I'll be able to work."*

However, as per another participant's viewpoint, data accessibility remains unaffected by the location of data centres. For instance, if there is any disruption occurring at the data centres in the US, the data centre in Africa will not experience any impact due to the highly robust infrastructure design in the US.

*P7 said, "When the scripton takes place in a data centre that's in the US, the shift to a data centre that's in the Europe, you cannot even feel it because they have got the higher availability arrangement built into their designs."*

## **Recommendations on environmental themes**

It has been recommended that HEIs need to upskill their staff to enhance their knowledge and skills that would assist to operate in the CC environment.

They need to prioritise security and service provider selection as it remains connected when choosing the service provider before HEIs adopt CC. The handling of sensitive data, such as intellectual property, students' records, and research data needs to be of high importance.

It was also recommended that awareness about CC in HEIs is important that will be able to overcome the misconception and reduce fear of other staff members about the unknown. The benefits of CC during awareness need to be communicated with staff members inside the HEIs. The physical location of data centres needs to be considered when choosing the service providers, thus, to ensure redundancy, availability, and accessibility of data. HEIs need to perform diligence and compliance checks to emphasise the importance of selection of the service providers.

Therefore, the recommendation centre on emphasis on the technical expertise and also prioritising data security while addressing the concerns of data privacy and intellectual property before selecting.

#### 4.6.3 Theme: Governance factors

Alkhater *et al.* (2014:1042) cite that when planning before adopting a new technology, organisations normally consider the degree of difficulty involved.

This study that was conducted by (Qasem, Asadi, *et al.*, 2020b:21) cites that it is important for HEIs to adopt CC with the support of their top management and information communication technology (ICT) departments. Furthermore, the adoption of CC in HEIs is associated with improving tech readiness and security because of the processes already in place. It is therefore important that decision-makers focus on developing these organisational resources to maximise the benefits of cloud services. Table 4.6 shows how many times each of these codes which were governance factors occurred.

**Table 4.6: Codes related to governance factors**

<b>Codes</b>	<b>P1</b>	<b>P2</b>	<b>P3</b>	<b>P4</b>	<b>P5</b>	<b>P6</b>	<b>P7</b>	<b>P8</b>	<b>Total</b>
Cloud computing: Multi-cloud strategy	0	0	1	1	0	0	0	0	2
Technology: Ownership	1	0	0	1	0	1	0	0	3
Technology: Security	0	1	3	1	3	0	0	1	9
Data security: Potential data loss	0	0	0	1	0	0	0	0	1
Data security: Privacy concerns	0	0	1	1	0	0	0	2	4
Data security: Challenge management	1	0	0	0	1	0	1	0	3
Data security: Security assurances	1	0	0	0	0	0	0	0	1
Data security: Legal concerns	0	1	0	0	0	0	0	0	1
Data security: Security breach	1	0	0	0	0	0	0	0	1
Technology: Intellectual property	0	1	0	0	0	0	0	0	1
IT infrastructure: Advantages of outsourcing	0	0	0	0	0	0	1	0	1
IT infrastructure: Service agreement	1	0	0	0	0	0	0	0	1
Ability to adopt CC: Strategic planning	0	0	0	0	1	1	0	0	2
IT infrastructure: Service level agreements	1	0	0	0	0	0	0	0	1
IT infrastructure: Service provider dependence	0	0	0	0	0	0	1	0	1
<b>Total</b>	<b>6</b>	<b>3</b>	<b>5</b>	<b>5</b>	<b>5</b>	<b>2</b>	<b>3</b>	<b>3</b>	<b>32</b>

The codes that emerged from governance themes are data ownership, legal concerns, intellectual property, service level agreement, strategic planning and cloud strategy.

## **Service level agreement (SLA)**

In research studies, Service Level Agreements are defined as formats for describing the agreed-upon service, defining the level of service, and addressing violations (Aljournah *et al.*, 2015).

Isa *et al.* (2019:417) mention that CC SLAs minimise the challenge of CC services between the client and the provider. Customers need SLAs to gain confidence, to feel secure, and to feel safe in the cloud environment. It will be difficult for organisations to adopt the technology if there is no clear SLA. As stakeholders in the public cloud environment, customer and cloud service providers play a role in this factor.

Participants mentioned their views about the SLA between the organisation and the service providers, P1: *“Again, it’ll depend on your SLA and which vendor you take, increased flexibility and scalability, which is I think one of the major advantages.”*

As another reason for the moderate rate of adoption, cloud service providers' lack of consistency with SLAs can affect performance negatively if they fail to meet SLA requirements and resolve downtimes promptly (Qasem *et al.*, 2019:10).

## **Intellectual property**

Paquette *et al.* (2010:277) cite that technology has reached the point when CC poses unique licensing issues that require a new approach to intellectual property. In addition to addressing security issues, CC also raises questions regarding access and usage. Users want to be able to safeguard their intellectual property rights while still having the flexibility to utilise the cloud on their terms.

In several studies (Spinola, 2009) clients have expressed the greatest concern with the protection of their intellectual property and data in the cloud.

P2 mentioned that *“Yeah. Again, not the main one I know of is the university won't use it if we have our own intellectual property. And, um, obviously the legal aspects, so they won't put something on a third-party storage. If we can't be guaranteed the information won't be leaked or compromised in anyway, so that's the biggest timely box and it's basically the terms of conditions of CC service providers and but it blocks almost everyone in the industry, I doubt any. And company will give you 100% guarantee on anything. It's impossible. Something can happen at any stage. So, in this case, certain things are only available on campus, so that's the main stumbling block in.”*

## Data ownership

It is imperative for businesses to retain control and ownership of their supply chain data, even when it is stored in the cloud. In order to control, access, and own the data, they must have clear contracts with their cloud providers (Yenugula *et al.*, 2023:195).

Participant mentioned that the service provider should make sure that the data ownership is protected. Participants mentioned that the data need to be protected as stipulated in the POPIA act as the institution currently has inhouse storage which is POPIA compliant. Most providers state that they shall not be liable for the effects of security breaches or unauthorised changes, disclosures, or interruptions due to malicious activity (Dogra & Kaur, 2013:333).

*P1 said, "Next cloud (fully supported and POPIA compliant) as in-house hosted cloud storage, then OneDrive is also an option that is semi-supported as it is part of our Microsoft licensing and also confirmed to be POPIA compliant but hosted external to the institution infrastructure and supported by 3rd party company."*

P1 expressed additional concern, expressing uncertainty about the safety of data residing on the cloud. *"the fact that Google drive it is not POPIA compliant and we have no say in where the data resides, we also are subject to their data handling and retention policies."*

P4 add by saying that: *"I can make any template typical example with Google for instance. You know Google says the information might belong to you, but they've got the rights to use it."*

## Strategic planning

Cloud computing requires a well-defined strategy that supports migration to the cloud, constituting a significant portion of the IT strategy of the institution. Service-oriented architecture is key to the success of the strategy implementation at the institution level, which provides the needed infrastructure for cloud use (Mircea & Andreescu, 2011:6).

Participants explained that the university needs to plan and embrace change as technology is changing every day, and governance of the institution needs to adapt with the change.

*P5 explained, "Well, the thing is if you want to move forward as a as an institution or a university or even a company, you need to introduce a proper and well thought-out strategic, the plans that you, that will take you to the next level."*

Another participant explained that the institution has strategy on the process to move other applications to the cloud.

P6 said, *“Uhm, all new implementations like for instance the new Student information system, the new HR system, the new LMS and so on will be in the cloud and when I said cloud there, I mean the, the public cloud. So, this the smart cloud strategy also refers to the fact that we can move, we can easily move services from one cloud solution to another cloud solution.”*

Participant 6 further said:

*“So for instance, from Azure to IWMS, because I think that’s one of the main problems that you have with the cloud, you get bogged down into one cloud solution like Azure for instance, uh. So, the smart cloud strategy is to be able to move between clouds. And to have a good, to have a good solution for hybrid cloud.”*

### **Cloud strategy**

Participants explained that they do have confidence to migrate the institution’s applications to the cloud provided that there is a clear cloud strategy.

The participant stressed the necessity for HEIs to reevaluate their strategies, emphasising that the adoption of CC demands a departure from outdated approaches.

P7 said, *“The adoption of cloud requires the organisation straight to change the strategy completely. You cannot adopt the cloud and continue in the way that you are doing things before.”*

P3 said, *“And migrate to the cloud, but I must just, I just identify that it’s key that we must have a cloud strategy because that is one that I think is going to assist you know and I believe part of the digital transformation or part of the digital transformation strategy must in, in, in in one way.”*

It’s important to select a good service provider if you have a strategy in place that will be able to guide you to make all the necessary changes.

P4 further said, *“Yeah, identifying suitable CC solutions, creating a migration strategy, and implementing the necessary changes. It may include selecting a cloud service provider, configuring, and deploying cloud resources, migrating data and applications, training employees on utilising cloud services effectively.”*

Therefore, according to the participants, CC adoption requires careful planning and consideration of factors such as security, compliance and data governance, governance, and integration with existing systems.

## **Recommendations for governance factors**

It has been suggested that HEIs need to consider the SLA and vendor selection that will be able to determine the choice of the cloud service providers. Therefore, service providers need to make sure that there will be no data leaks or compromises, and HEIs need to carefully review its intellectual property that will be aligned with HEI policies and requirements.

It is suggested that HEIs need to develop a very good comprehensive cloud strategy that will align the goals of institutions and will be able to guide the adoption of CC. The training of staff members needs to be considered for the effective utilisation of the cloud services within HEIs.

The prioritization of the next on-premises cloud solution is recommended based on its comprehensive support and alignment with the Protection of Personal Information Act (POPIA) compliance standards, particularly in its SaaS hosting model.

The use of one drive can also be considered by HEIs as testing before fully migrating to the CC, as this will give the HEIs time to prioritise solutions that would adhere to the data protection that is regulated by POPIA. Therefore, the location of where data resides needs to be considered when drafting the policies that will bind the HEIs and the cloud service providers.

The development of a cloud smart strategy needs to be well defined and HEIs need to emphasise its importance that will assist in the HEIs' digital transition to the adoption of CC.

The other main point was to take into consideration the understanding of the SLA with the cloud service provider, meaning that the HEI needs to clear the SLA with the services providers that will help to have a prompt resolution in case of technical difficulties. It is recommended that the SLA, service providers, legal aspects, and compliance need to be considered if HEIs need to transit their services to the cloud. The implementation or developing of the cloud strategy remains the key points that will foster the smooth migration of HEIs' process to the cloud.

### **4.6.4 Theme: Financial factors**

Just like in other industries, CC offers learning institutions significant financial benefits when it comes to infrastructure maintenance, including licenses, energy consumption, technical labour, and hardware purchases. By adopting CC, users will have a much better experience (Almajalid, 2017:6). Table 4.7 displays the codes extracted from the participants' transcripts, specifically pertaining to the theme of financial factors.

**Table 4.7: Codes related for financial factors**

<b>Codes</b>	<b>P1</b>	<b>P2</b>	<b>P3</b>	<b>P4</b>	<b>P5</b>	<b>P6</b>	<b>P7</b>	<b>P8</b>	<b>Total</b>
Cost management: Affordability	0	0	0	0	1	0	0	0	1
Cost management: Allocation of resources	1	0	0	0	0	0	0	0	1
Cost management: Cost effectiveness	3	0	1	0	0	1	0	0	5
Cost management: Cost efficiency	0	0	0	0	0	0	1	0	1
Cost management: Cost savings	0	0	0	1	0	0	0	2	3
Cost management: Cost-effectiveness	0	1	0	0	0	0	0	1	2
Cost management: Resource constraints	1	0	0	0	0	0	0	0	1
IT infrastructure: Advantages of outsourcing	0	0	0	0	0	0	1	0	1
Challenges: Limitations	1	0	0	0	0	0	0	0	1
Challenges: Negative impact	0	1	0	0	0	0	0	0	1
Challenges: Redundancy	0	0	1	1	0	0	1	0	3
Challenges: Stumbling blocks	0	0	0	1	0	0	0	0	1
Challenges: Uncertainty	6	3	3	2	7	7	9	6	43
<b>Total</b>	<b>12</b>	<b>5</b>	<b>5</b>	<b>5</b>	<b>8</b>	<b>8</b>	<b>12</b>	<b>9</b>	<b>64</b>

The codes that emerged from financial theme: cost reduction, cost effectiveness, outsourcing, and budget and finance.

### **Cost reduction**

CC adoption in the organisation is also influenced by the cost reduction factor. It has been found that cost reduction contributes to economic benefits. Furthermore, this factor contributes to the sustainability of operating costs within organisations by accelerating the adoption of CC (Isa *et al.*, 2019:415).

Participants agreed that the adoption of CC at HEIs could reduce cost.

*P5 said: “Yes, I would consider that, Let's take a pay-as-you-go model. Yes, CC typically operates as a pay-as-you-go model. Where organisations only pay for the resources and services they actually use. It eliminates the need for large upfront investments in hardware, infrastructure, and software licenses. It also reduces infrastructure costs.”*

*P1 agreed and added by saying that “Generally speaking, it does provide a function at a reduced cost. You know, that's basically the sales pitch for in the short term, but testing and perhaps I want smaller enterprises or the winning people when it comes to these kinds of things because they don't want to run their own data centre”*

## Cost effectiveness

Youssef (2012:840) mentions that rather than investing in complex and costly computing infrastructure and services, customers can choose to lease computing resources and procure IT services tailored to their requirements. Organisations and individuals will benefit from lower IT costs.

Participants were uncertain about if CC is cost-effective or not.

*P2 said: "I'm not entirely sure of financial cost benefit of using CC. I think as a long-term solution. It is because your initial capital investment. Uh, for your own infrastructure is not necessary, So I think it is cost effective in the long run from our understanding."*

However, another participant mentioned that the adoption of CC at the HEIs could be more expensive. P5 said: *"But it's more a cost factor still because it's very expensive for us to run that, that CC application or whatever. So yeah, we do have."*

Participants agreed that the adoption of CC could be cost-effective to HEIs as there would be no infrastructure needed.

*P6 said, "I think it is in, in some cases very cost-effective. Yeah, I think, there's no easy answer for that. And in other others, maybe, maybe not. But you always have to think about the broader advantages of the cloud and that, that's flexibility and you don't have to have any infrastructure on Prem and then things like that. So, but first specifically you have to look at the total cost of ownership."*

## Outsourcing

Businesses will often run a mission-critical applications and store business-sensitive data in private clouds, while outsourcing their support services to public clouds. With the push using cloud services, IT staff are also playing a major role in the transformation of enterprises and businesses (Motahari-Nezhad *et al.*, 2009).

*P2 said, "Well, as I understand it and it's mainly using resources that is not part of your own infrastructure. So, you're sort of borrowing or using uh from a third party to assist in, in what you're trying to achieve on your own setup."*

Participants mentioned that the HEI is still currently using the applications, such as Outlook, and its cloud-based application that has been sourced from external vendors.

P5 said, *“Even you know the application that we use now is a is a cloud type of application, you know Outlook but that is we using external vendors and then we do have our own strategy that we are starting to build up our own cloud solution that is hosted internally.”*

P7 said, *“It’s hosted by a third party. One of these three black players, and it actually allows you to access, as I say, both the technologies as well as the services that are located in that third party service.”*

## **Budget and finance**

Isa *et al.* (2019:417) cite that financial support for technology innovation becomes part of top management's support. The university decided to operate IT services in many ways due to financial considerations.

Participants mentioned that the team structure should undergo a transformation to align with the distinct skills required for on-premises and cloud environments. Additionally, the approach to design must adapt to the differences between these environments. Budget considerations also need adjustment, shifting from traditional asset purchases with depreciation to a model where services are consumed on an ongoing basis.

P 7 said, *“The structure of your team needs to change because the skills that are required are on premise versus the skills of a cloud environment. That's used in the cloud needs to change the way you design. Your budgets need to change because you are now consuming the service instead of buying an asset that's going to be depreciated over time.”*

## **Recommendations for financial factors**

Therefore, it is recommended that HEIs should consider the use of pay-as-you-go models, as they have benefits of paying all for the resource that the HEIs need to utilise to eliminate unnecessary expenditure on the infrastructure. HEIs need to access the short and long term of cost-efficiency of adoption of cloud computing that in terms of capital investment and of the base model subscription. It has been recommended that HEIs need to evaluate its total cost of ownership that is associated with the adoption of CC.

The HEIs need to understand the use of resources outside their own infrastructure before adopting CC. It is also recommended that HEIs need to explore partnerships with reputable cloud providers that could host the internal cloud solution on premises with the aim to ensure access of services. Therefore, the recommendation emphasises that HEIs need to explore the

pay-as-you-go model, with carefully assessing the cost reduction, and developing internal cloud solutions and evaluate the total cost of the ownership.

#### 4.6.5 Theme: Organisational factors

Organisational adoption of IT innovations is heavily influenced by top management's role and influence. To implement the cloud acceptance, top management needs to support the change. A decision from top management is needed to support this change in the organisation (Alkhatir *et al.*, 2014:1042). Business enterprises or educational institutions are founded on the organisational dimension (Mokhtar *et al.*, 2014:189). Isa *et al.* (2019:416) support that every department relies on the leadership of the top management. Table 4.8 displays the codes extracted from the participants' transcripts, specifically pertaining to the theme of organisational factors.

**Table 4.8: Codes related for organisational factors**

<b>Codes</b>	<b>P1</b>	<b>P2</b>	<b>P3</b>	<b>P4</b>	<b>P5</b>	<b>P6</b>	<b>P7</b>	<b>P8</b>	<b>Total</b>
Ability to adopt CC: Work flexibility	0	0	1	0	0	0	0	0	1
Technology: Availability	1	0	1	1	0	1	1	0	5
Technology: Benefits	0	1	0	0	0	1	0	1	3
Technology: Technical skills	0	0	1	0	0	0	0	0	1
IT infrastructure: Pay-as-you-go	0	0	0	1	0	0	0	0	1
IT infrastructure: Remote work	0	0	0	1	0	0	0	0	1
IT infrastructure: Online learning	0	0	0	0	0	1	0	0	1
IT infrastructure: E-learning	0	0	0	0	0	0	1	0	1
Cost management: Cost effectiveness	3	0	1	0	0	1	0	0	5
Cost management: Cost efficiency	0	0	0	0	0	0	1	0	1
Cost management: Cost savings	0	0	0	1	0	0	0	2	3
Cost management: Cost-effectiveness	0	1	0	0	0	0	0	1	2
Cost: Resource constraints	1	0	0	0	0	0	0	0	1
Cloud computing: Cloud storage	1	0	0	0	0	0	0	0	1
Cloud computing: Data centres	0	0	2	0	0	0	0	0	2
Cloud computing: Next cloud	0	0	0	1	0	0	0	0	1
Cost management: Affordability	0	0	0	0	1	0	0	0	1
Cost management: Allocation of resources	1	0	0	0	0	0	0	0	1
CC Platforms: Microsoft 365	0	0	0	1	0	0	0	0	1
Cloud computing Platforms: Microsoft Azure	0	0	0	1	0	0	0	0	1
<b>Total</b>	<b>7</b>	<b>2</b>	<b>6</b>	<b>7</b>	<b>1</b>	<b>4</b>	<b>3</b>	<b>4</b>	<b>34</b>

The codes that emerged from the organisational theme were cloud benefits, re-skilling, and a lack of training.

## Cloud benefits

Carroll *et al.* (2011) mention that IT-related costs are reduced in CC by lowering implementation and maintenance costs, purchasing, and supporting fewer items of hardware, transferring resources to a service provider, and eliminating power, cooling, floor space, and storage costs. There is a reduction in operational costs as well as paying only for what is needed (measured service).

Participants mentioned various advantages or benefits of CC adoptions at HEIs.

P1 explained that *“The increased productivity and capacity, it's basically a snowball effect. The more time we get, the more we'll be able to increase and become more, more efficient in what we do.”*

Adopting CC can prevent data loss, and P1 elaborated,

*“Data loss prevention and redundancies. You know, if you're running that e-mail server that I mentioned, and you've got no rate storage on it or lightning hits or they steal the unit and you've got a problem because your data is lost. But with most of the cloud storage providers and with even platform as a service, they've got snaps of a VM that can be placed back onto a different cluster should one of the clusters be damaged.”*

P2 mentioned that: *“I think. It does have any benefits. The main benefit I would think, is if we reach the certain capacity and there are no maybe additional funds or to help with it is to make use of CC in a capacity where we can accommodate more students or staff to our environment. That's, I think that's probably the best benefit university we can reach. Maybe more uh students or personnel.”*

P6 agreed by saying, *“Yes, I think the main thing is agility and scaling. The other thing, of course, is that, yeah, you will find that that many and then most solutions these days are not available on Prem anymore because they're not supported on Prem. Umm, so in in many cases you don't even have a choice, you only have a choice in the cloud. But I think scaling and quality is the main thing.”*

P4 added by saying that by adopting CC, the institution could save a lot of money on the infrastructure:

*“Cloud computing can save the university a lot of money to start with. It will provide elasticity. It will rely less on physical infrastructure without purchasing physical*

*equipment. Just that it enables easy access to educational resources and accessing tools from any location. Meaning a student can study from anywhere, any place.”*

P7 mentioned that CC has immense benefits, *“One of the benefits is the fact that you switch on the service almost immediately and like for instance, in the old ways where you'd have to sit, go through a requirement, and design a system you know find the needs of both.”*

### **Re-skilling and lack of training**

Participants emphasized the significance of training as a crucial consideration during the migration of higher education applications to the cloud. P8 said,

*“I think, I think training is needed because I as an IG IT professional, I don't even myself, I'm not familiar with cloud like I'm scared to put my data there, confidential and personal data day because I know IT person, we'll see it or you are seeing this data.”*

Participants further said that support is necessity. P7 said,

*“training is not just required, it's compulsory that we are trained because yes, you can be a hardware engineer and be able to create visualisation and be able to deploy a Unix or Linux or Windows Server. You can be able to, you know, write a system in visual basic or whatever.”*

Therefore, participants also referred to a lack of training awareness and fear of the unknown as one of the key complexities to adopt CC.

P7 said, *“Uh, you know, so there's quite a lot of the services that we are not using and if we were to be trained on the features that are variable in all these things that we are using, I think people would be a lot clearer in adopting cloud services. Well, it's not discussion somewhere. I think the first one is really our awareness. You know, people. Spoke about the cloud, but they are not aware about the cloud services. So that's the first thing that we need to have each really to a cloud services awareness. The second thing is fear of the unknown.”*

In addition, about training P1 said, *“Absolutely, the biggest deficit we have in our institution is training, forget the cloud-computing factor even, it's the biggest challenge we have period, this includes staff and students, both within IT and outside of it.”*

## Recommendations for organisational factors

It was recommended that if HEIs could the adopt CC, it could increase productivity and capacity. The adoption of CC in HEIs could mitigate challenges that are associated with physical server failures. CC could reduce redundancies and loss of data in HEIs. CC computing could be able to accommodate more students' records through its capacity expansion storage than traditional physical storage. It was also recommended by participants that the adoptions of CC offer agility and scalability. HEIs could benefit from CC with high cost saving as there will be no need to have physical infrastructure that HEIs need to spend more money. It has been recommended that CC could enable easy access to educational resources to students, as students could be able to study from any location.

It has been recommended that HEIs need to acquire additional skills before adopting CC, meaning that training and hiring new staff members with expertise skills of cloud technology need to be considered. The adoption of budget strategy is key within HEIs that needs to align with the consumption of the cloud services model. The HEIs' strategy needs to change so that it could be aligned with the change when adopting CC. HEIs need to have a continuous learning adoption culture that needs to promote learning to staff members who will be involving in the adoption of CC. Therefore, HEIs need to encourage proactive approach to developing skills. The collaborative approach with other IT industries needs to be considered as a way of cross-functional cooperation with other teams to ensure a successful adoption of cloud technologies.

### 4.6.6 Theme: Challenges of CC in higher education institutions

Participants expressed their views about the challenges that HEIs faced that hinder the adoption of CC. The codes that emerged from the participants about the challenges that higher education is faced with are confidence; uncertainty; a lack of training; redundancy; and dependence. Table 4.9 displays the codes extracted from the participants' transcripts, specifically pertaining to the challenges of CC in HEIs.

**Table 4.9: Codes related challenges of CC in higher education institutions**

Codes	P1	P2	P3	P4	P5	P6	P7	P8	Total
Ability to adopt CC: Adjustment	0	0	0	0	0	0	1	0	1
Ability to adopt CC: Agility	0	0	0	0	0	1	0	0	1
Ability to adopt CC: Change management	0	0	1	0	0	0	1	0	2
Ability to adopt CC: Compliance	1	0	0	2	0	0	0	0	3
Ability to adopt CC: Efficiency	4	1	0	0	1	3	4	2	15
Ability to adopt CC: Governance	0	0	0	0	1	0	0	0	1

Codes	P1	P2	P3	P4	P5	P6	P7	P8	Total
Ability to adopt CC: Policy and regulations	1	0	0	0	0	0	0	0	1
Ability to adopt CC: Reliability	1	0	0	0	0	0	0	0	1
Ability to adopt CC: Responsibility	0	1	0	0	0	1	0	1	3
Ability to adopt CC: Scalability	2	1	2	1	0	2	0	0	8
Ability to adopt CC: Strategic planning	0	0	0	0	1	0	0	0	1
Ability to adopt CC: Sustainability	0	0	0	0	1	0	0	0	1
Ability to adopt CC: Teaching and learning	0	0	1	0	0	0	0	0	1
Ability to adopt CC: Training requirements	1	0	0	0	0	0	0	0	1
Ability to adopt CC: Transparency	1	0	0	0	0	0	0	0	1
Ability to adopt CC: Work experience	0	0	0	0	0	0	1	0	1
Ability to adopt CC: Work flexibility	0	0	1	0	0	0	0	0	1
<b>Total</b>	<b>11</b>	<b>3</b>	<b>5</b>	<b>3</b>	<b>4</b>	<b>7</b>	<b>7</b>	<b>3</b>	<b>43</b>

## Confidence

Participants mentioned that they do not have full confidence to adopt CC due to trust issues with the cloud providers.

*P2 said, "The CC can help, but in certain circumstances and if you have the right people managing it, yes. So I would say I do have confidence in, in certain aspects of migrating University services, but when it comes to our own intellectual property, there's obviously legal aspects that, that the university will never put, something that's the impropriety information or developments onto a third party storage it's I mean you can't guarantee your work won't be hacked or stolen or anything like that."*

Participant 3 expressed his option by saying he does have confidence in running the institution services on the cloud. P 3 said,

*"Look, I will say yes. I have confidence in the end of which actually lives successfully migrating to the cloud. I mean, COVID-19 was one example where I can say changes inevitable. Change happened and then we must adopt. And security. Yes, I know. Security always is a concern. But I do have the confidence because I mean, look at how the Microsoft 365 platform has been embracing."*

Participant (P6) mentioned that he does trust the cloud, but it is not good as people think, they need to be very careful with the service providers, by saying

*"Yes, I do trust, but you have to be careful to think that the cloud is the silver bullet for everything. I don't think that is true. It's definitely not because of a lot of things like POPIA and all this kind of legislation and things like that, you have to be very careful."*

Another participant mentioned that is management's decision, but he does not have confidence in the cloud provider. P4 said, *"this decision should be done by management. But threats to data in the cloud are increasing daily. I feel no safer in the cloud than out of the cloud."*

## **Uncertainty**

Participants expressed their views when they were asked about the current state of IT, if that would affect the adoption of CC. P2 said, *"Uh, that's yet to be seen because it's nothing. It's nothing set in stone yet, so there's nothing officially said or anything. We'll have to wait and see."* Therefore, it shows that there is uncertainty where the adoption of CC can impact on other services. There is uncertainty about the data security, support or if they could trust the service provider.

P3 said, *"Do they have the necessary? Technical skills. Are they able to ensure that we as the as the university are able to deploy what whenever we need to deploy, Will they be able to support us, and you know provide us with the necessary you know measures that we can deploy successfully."*

Other participants were uncertain about the selection of service providers about their information security, and P5 mentioned that:

*"The main factor will be your cybersecurity and the prevention of incidents and the protection of your data. That will be the ... How can I say that's where you will make a distinction between the rest? Because if you are a company that is notorious for losing data or even you know some of your data are being attacked and copied the way and that will be a big thing."*

Uncertainty about cost effectiveness, P6 said that:

*"Umm, no, I don't think that it is cost effective the one reason is that the Rand dollar obviously at 18 or 19 Rand a dollar and I can't see and justify that that will be how can I say. A you know a thing that we will be able to sustain, you know, and the sustainability of affordability is a big thing for IT."*

P6 also attested to this by saying that *"I think it is in, in some cases very cost effective. Yeah, I think there's no, there's no easy answer for that. And in other others, maybe, maybe not."*

## **Re-skilling and a lack of training**

Participants had different views when the researcher ask them if training was required if CC could be introduced to the institutions. P3 said:

*“I think there must be a level of demonstration or like a how to guide of cause. Some people have no idea what it is, so maybe a small introduction of what it is actually. Uh, obviously descriptive with. Maybe imagery it makes easier to understand. So, I would say official training maybe not so much because it's not something you know. It's not necessary to be too technical for average user to do so. Again, it depends on what platform, what they're going to be using. So, the training part is maybe a bit vague, so I would say more an introduction of what it is and if there's maybe a specific program or service, they need to use in CC. Yes. Then training for th.at specific software or service is required.”*

Other participants highlighted the importance of comprehensive training, emphasising that it should be inclusive, covering both technical IT staff and end-users to ensure a holistic understanding of CC. P5 mentioned that:

*“definitely training will be needed and also to be familiar with the way the software or the application of cloud works like say the links how the links works and how they, the stories works. We also need training as in, as in IT people was no place university and as users.”*

P1 also agreed that training is need and said, *“It's the biggest challenge we have. Period and it includes both our staff and students, so not only on the platform of CC, but in IT at general, it's something that we really can work a lot.”*

P 7 said, *“I mean, there's a big push at the moment to not just produce people with paper, but people with skills that can be utilised by industry, people like AWS and people like Azure on the cloud side.”*

## **Recommendations on challenges for the adoption of CC**

The confidence of CC on migrating certain services to CC remains a concern. It was recommended that management needs to encourage and highlight he importance of adopting CC by choosing the right people with the necessary skills to manage the CC adoption effectively. The researcher suggested that the strategic approach of change needed to change so that it can be able to embrace new technologies like CC. The trust between the service providers and HEIs needs to be acknowledge with the importance of taking into consideration

the legal aspects such as POPIA. It is important that HEIs' governance needs to consider the technical skills that include cybersecurity and data protection, and will then be able to make proper decision to adopt CC. The cost-effectiveness needs to be considered as the fact of exchange rates could contribute to the adoption of CC in HEIs. The researcher recommends that staff training is required to both IT staff and end -users to keep them updated with new technologies like CC. It is recommended that introductory sessions are required with a descriptive imagery to make CC more accessible to both IT staff and IT governance within HEIs. It was further recommended that a continuous learning culture with new technology within HEIs should be mandatory to IT staff. Higher education needs to acknowledge that there is a challenge with IT literacy among both staff and students within, therefore awareness and training is required.

#### **4.7 EMERGING THEMES AS GUIDELINES**

The emerging themes have been incorporated into the set of guidelines for this study. This study's main aim was to create guidelines for the adoption of CC in South African HEIs. These guidelines were formulated by exploring the perspectives and experiences of participants within the institution. Based on the empirical work, the set of guidelines has been formulated to facilitate the adoption of CC in South African HEIs. Hence the researcher formulated the following empirical guidelines (EG):

- EG01: Evaluate data protection and recovery during cloud infrastructure migration
- EG02: HEIs prioritize cloud skills and continuous learning
- EG03: Adapt strategic approaches to embrace new technologies
- EG04: Develop a clear cloud strategy with digital transition and data policies
- EG05: Evaluate data centre locations for reliability and accessibility when choosing service providers.
- EG06: Assess cost-effectiveness before adopting cloud computing

Table 4.10 below illustrates the themes that have emerged from the empirical data collected from participants.

**Table 4.10: Emerged themes and guidelines from empirical study**

Theme name	Factors	Guidelines	Origination
Technological factors	Technology availability, Complexity, Data security and privacy, Data loss, Scalability, IT infrastructure, Lack of awareness.	Evaluate data protection and recovery during cloud infrastructure migration (EG01)	Participants fear the need to address every checkbox to mitigate data security challenges. P1, P2, P4 and P8 said <i>"How's the data protected both physically and in transit? Do we know where all iterations of our data are? So, ... one would have to hope that the predetermined list of tick boxes is covered"</i>
Organisational factor	Cloud benefits, Budget and finance, Re-skilling and lack of training.	HEIs prioritize cloud skills and continuous learning (EG02)	Participants agreed that training is a basic requirement. P1, P3 and P7 said <i>"definitely training will be needed and also to be familiar with the way the software works ..."</i>
Challenges of CC in higher education institution	Confidence, Uncertainty, Lack of training; Redundancy; Dependence	Adapt strategic approaches to embrace new technologies (EG03)	Participants not having full confidence in CC. P2, P3, and P6 said, <i>"Yes, I do trust, but you have to be careful to think that the cloud is the silver bullet for everything ..."</i>
Environmental factors	Data privacy and protection, Regulatory compliance, Lack of support, Data location.	Develop a clear cloud strategy with digital transition and data policies (EG04)	Participants emphasised that cybersecurity, and data location are concerns in adopting CC, posing data loss challenges for HEI. P4 said, <i>"we move to the cloud and most of their data centres are not within Africa or within reach ..."</i> P5 said <i>"The main factor will be your cybersecurity and the prevention of incidents and the protection of your data ..."</i>
Governance factor	Data ownership, Legal concerns, Intellectual property, Service level agreement, Strategic planning Cloud strategy		Participants stressed data ownership on the cloud and protection, referencing compliance with POPIA. P1 said <i>"fact that it is not POPIA compliant, and we have no say in where the data resides."</i> P2 said <i>"main one I know of is the university won't use it if we have our own intellectual property ..."</i> Participants urged institutions to adapt strategies for CC adoption. P3 and P7 said, <i>"migrate to the cloud must have a cloud strategy ..."</i>
Governance factor	Data ownership, Legal concerns, Intellectual property, Service level agreement, Strategic planning Cloud strategy	Evaluate data centre locations for reliability and accessibility when choosing service providers (EG05)	Participants discussed their views on the SLA between the organisation and service providers. P1 said, <i>"it'll depend on your SLA and which vendor you take, increased flexibility and scalability, which is I think one of the major advantages."</i> Participant trusts CC but emphasised caution with service providers. P6 said, <i>"Yes, I do trust, but you have to be careful to think that the cloud is the silver bullet ..., It's definitely not because of a lot of things like POPIA you have to be very careful ..."</i>

Theme name	Factors	Guidelines	Origination
Financial factors	Cost reduction, Cost effectiveness, Outsourcing.	Assess cost-effectiveness before adopting cloud computing (EG06)	Participants concurred that CC adoption at HEIs reduces costs. P5 said, "Yes, CC typically operates as a pay-as-you-go model ..." Use of vendor-sourced cloud apps can reduce cost. P7 said, "It's hosted by a third party ... and it actually allows you to access ..."

Table 4.11 below illustrates the themes that have emerged from literature review in Chapter 3. The table is structured to outline different essential themes that influence the adoption of CC in HEI, providing a comprehensive breakdown of factors and guidelines associated with each theme: Themes encompass critical categories of cloud adoption, including technical considerations, Organisational dynamics, financial aspects, environmental concerns, governance structures, and challenges faced by higher education sectors. Factors listed under each theme identify specific challenges or issues encountered in adopting cloud technology. Factors within each theme detail specific challenges and considerations that illustrate the complexities of adopting cloud computing. They highlight unique aspects of each theme and outline practical challenges that require attention and resolution. The guidelines support researcher in analysing technical challenges in adopting CC, ensuring robust solutions. They aid in understanding how organisational practices impact cloud integration success. They assist in evaluating cost-effective strategies for optimizing financial resources in CC. They focus on ensuring environmental sustainability and regulatory compliance in cloud deployments. They help establish effective governance frameworks to manage risks and ensure accountability. Additionally, they offer tailored approaches to address specific hurdles in HEI.

**Table 4.11: Emerged guidelines from Chapter 3 - literature review**

Themes	Factors	Guidelines
Technical	Vendor lock-in: Security, Data and privacy: Malicious insider Theft of computer equipment Loss of backup Unauthorised access to premises Compatibility dependencies	Managing technical risks in Cloud Computing (LG01)
Organisational	Security risk Vendor lock-in: Trust Skill training Cloud benefits Flexible learning Mobile learning support Collaborative working Storage Efficiency	Secure IT governance for remote learning integration. (LG02)

<b>Themes</b>	<b>Factors</b>	<b>Guidelines</b>
Financial	Cost reductions in hardware and operations Reduce the costs of software Cloud service providers Procurement of hardware Pay-as-you-go model	Cost optimization through efficient management (LG03)
Environmental	Compliance Location of data Data protection	Cloud data management and compliance challenges (LG04)
Governance	Senior management support Organisational change Service providers Challenge of jurisdiction Outsourcing	HEIs need governance for policy oversight and decision-making (LG05).
Challenges in higher education	Skill training Security concerns Data privacy and compliance Integration with existing IT systems Cost and budget constraints	HEI must secure data, modernize applications and train staff (LG06).

The final guidelines (FG) of this study emerged from a synthesis of both the literature review and empirical guidelines illustrated in Table 4.12 below.

**Table 4.12: Guidelines comparison literature review and empirical results on the emerged final guidelines**

<b>Guidelines of literature</b>	<b>Guidelines Empirical</b>	<b>Final list of Guidelines</b>
LG01: Managing technical risks in Cloud Computing	EG01: Evaluate data protection and recovery during cloud infrastructure migration	FG01: Ensures secure, scalable, and robust IT infrastructure for cloud adoption in HEIs
LG02: Secure IT governance for remote learning integration	EG02: HEIs should prioritize cloud skills and continuous learning	FG02: Emphasizes the need for HEI staff to develop technical skills for cloud initiatives.
LG06: HEI must secure data, modernize applications and train staff	EG03: Adapt strategic approaches to embrace new technologies	FG03: Mitigates data privacy, uncertainty, and training challenges for smooth cloud integration in HEIs.
LG05: HEIs need governance for policy oversight and decision-making	EG04: Develop a clear cloud strategy with digital transition and data policies	FG04: Establishes frameworks for cloud strategy and governance, aligning with institutional goals and regulations
LG04: Cloud data management and compliance challenges.		
-	EG05: Evaluate data centre locations for reliability and accessibility when choosing service providers	FG05: Encourages HEIs to collaborate with reliable cloud providers for expert management and SLA adherence.
LG03: Cost optimization through efficient management.	EG06: Assess cost-effectiveness before adopting cloud computing	FG06: Optimizes budget management for cloud adoption in HEIs, focusing on cost reduction, effectiveness, and outsourcing.

Next, this study provides a detailed discussion of the emerged guidelines.

#### **4.7.1 FG01: Ensures secure, scalable, and robust IT infrastructure for cloud adoption in HEIs**

Guideline LG01 was derived from the literature review and linked to guideline EG01 from the empirical research, and guideline FG01 represents the amended finalised guideline adopted. Data analysis revealed that HEIs are still relying on outdated infrastructure, incompatible with the integration of CC. Participants supported the adoption of CC, citing potential cost benefits, as institutions could pay for services based on their usage. Despite concerns about data security on the existing technology infrastructure, some participants cautioned that CC may not be as cost-effective as generally believed. Consequently, there was consensus that the transition to CC should occur in phases. This implies initiating the adoption CC services using the current infrastructure available at HEIs.

The research proposed that IT governance must scrutinise the current infrastructure and align application processes to prioritise services as a focal point. To accommodate changing HEI needs, IT governance needs to choose cloud solutions that are scalable. The researcher recommends that service providers are advised to play a crucial role in facilitating the transition from the current stage of technology to CC, therefore service providers need to be included in the whole process of migrating. Privacy and security standards must be adhered to by cloud service providers. Ensure regular security audits and encryption of all data.

#### **4.7.2 FG02: Emphasizes the need for HEI staff to develop technical skills for cloud initiatives**

Guideline LG02 originated from the literature review and was linked to guideline EG02 from the empirical research, and guideline FG02 represents the amended finalised guideline adopted based on empirical findings: HEIs' IT technical support staff must prioritise upskilling knowledge of CC to alleviate concerns and hesitancy surrounding its adoption. Data analysis revealed a notable lack of proficiency among IT technical staff, and a lack of expertise of CC application integration, as this hinders the HEI sector's readiness for this transition to CC.

To address this gap, the researcher recommended that IT technical staff undergo workshops and training specifically tailored to enhance their CC skills. Furthermore, it has been recommended that the active support of IT governance is crucial in fostering the successful adoption of CC. Their backing will play a pivotal role in advancing and optimising the integration of CC within HEIs, contributing to overall improvement and acceptance of this technology.

#### **4.7.3 FG03: Mitigates data privacy, uncertainty, and training challenges for smooth cloud integration in HEIs**

Guideline LG06 was initially adopted from the literature review, and guideline EG03 from empirical research, while guideline FG03 represents the finalized guideline adopted. Participants emphasised the existence of numerous challenges of CC adoption in HEIs. The paramount obstacle identified was the issue of data security and privacy, which remains a significant deterrent to embracing CC. Concerns arise regarding the assurance that data stored in the cloud will be secure and inaccessible to unauthorised individuals. Additionally, the lack of trust in service providers poses a substantial challenge.

To address these issues, the researcher recommends heightened awareness campaigns about CC within HEIs. Furthermore, benchmarking with institutions in developed countries is suggested to expedite the adoption of CC. Collaboration with experienced CC service providers could also play a vital role in overcoming challenges and facilitating a smoother transition to CC in HEIs.

#### **4.7.4 FG04: Establishes frameworks for cloud strategy and governance, aligning with institutional goals and regulations**

Guidelines LG05 and LG04 were initially identified from the literature review and integrated to form guideline EG04, which emerged from empirical work, leading to final guideline FG04. The insights gathered from participants' data emphasised the significance of robust IT governance support, deeming it a critical factor. Participants emphasised that obtaining support from management, particularly decision-makers, is imperative for the successful adoption of CC. The participants emphasised the necessity of a well-defined strategy for IT Governance in the adoption of CC. They further stated that this strategy should be communicated to all key stakeholders involved in the project for adopting CC.

This study recommends that IT governance actively informs decision-making processes related to CC. They should set a clear vision and strategy for how to adopt cloud services, including the organisation's goals, preferred cloud models (public, private, or hybrid), as well as the criteria for selecting the right ones. Nearly every major IT decision necessitates the backing of IT governance, making their support pivotal in the absence of which, the guidance and support from HEIs could impact significantly on the trajectory of CC adoption. IT governance shoulders the responsibility of scrutinising HEI policies and strategies, playing a crucial role in facilitating the adoption of CC within the institution.

#### **4.7.5 FG05: Encourages HEIs to collaborate with reliable cloud providers for expert management and SLA adherence**

Guideline EG05 that emerged from empirical work and was not part of the initial literature review, and guideline FG05 represents the final adopted guideline. Participants have indicated that a significant obstacle to the adoption of CC is the absence of trust between clients and service providers. Concerns about insufficient support from service providers strongly influence the decision to embrace CC. The SLA between clients and service providers have also emerged as a key consideration according to participants.

Research suggests that HEIs should collaborate with experienced service providers well-versed in computing. Establishing a memorandum of understanding between HEIs and service providers, guided by legal considerations, is recommended.

#### **4.7.6 FG06: Optimizes budget management for cloud adoption in HEIs, focusing on cost reduction, effectiveness, and outsourcing**

Guideline (LG03) originated from the literature review and is linked to guideline EG06 from empirical work and is represented as final guideline FG06. The financial aspects of the HEI must be considered, as highlighted by other participants in this study, as it could impact significantly on the progress of the migration.

Plan the institution's budget and finance strategy to align with the organisation's financial goals. Considering migration expenses, subscription fees, and long-term savings are important for both short-term and long-term budgeting.

### **4.8 RESPONSE TO THE FINDINGS**

Cloud computing plays a significant role in the teaching and learning in the HEI sector around the world as it has been proven by different scholars in Chapter 3. From the literature review it was clear that CC has significant benefits, it has been suggested by scholars and participants elaborated that it enhances teaching and learning, students can be able to study any way without having contact classes. The research revealed the perceptions of IT governance and technical staff regarding the adoption of CC in HEIs. Participants have expressed concerns about a shortage of technical skills, data security, a lack of support and uncertainty in embracing CC. IT professionals still need to have technical skills (Adedokun, 2021:123), and participants further indicated that training, workshops and awareness are necessary prior to the adoption of CC at HEIs in South Africa. The Table 4.13 provides a concise overview of the primary benefits, challenges, and recommendations linked to each guideline concerning the adoption of cloud computing in higher education institutions.

**Table 4.13: Summarising benefits, challenges, and recommendations for each guideline**

<b>Guideline</b>	<b>Benefits</b>	<b>Challenges</b>	<b>Recommendations</b>
Technology Infrastructure	Potential cost savings; phased adoption approach	Outdated infrastructure; data security concerns	Rigorous IT governance scrutiny; phased adoption; align with HEI needs
Proficiency in Technical Skills	Enhanced CC integration readiness through staff training	Lack of CC expertise among IT staff	Tailored training for IT staff; active IT governance support
Addressing Challenges	Increased awareness; benchmarking with developed institutions; collaboration with service providers	Data security and privacy concerns; lack of trust in service providers	Awareness campaigns; benchmarking; collaboration with experienced service providers
Cloud Strategy and IT Governance Support	Clear strategy communication; stakeholder involvement	Management and decision-maker support	Robust IT governance; clear communication of strategy; stakeholder involvement
Partnerships with Service Providers	Enhanced trust and SLA understanding	Trust issues with service providers	Collaborate with experienced service providers; establish clear SLAs
Financial Factors	Budget alignment with institution goals; long-term savings planning	Migration costs; subscription fees	Align budget with institution goals; plan for migration expenses and long-term savings

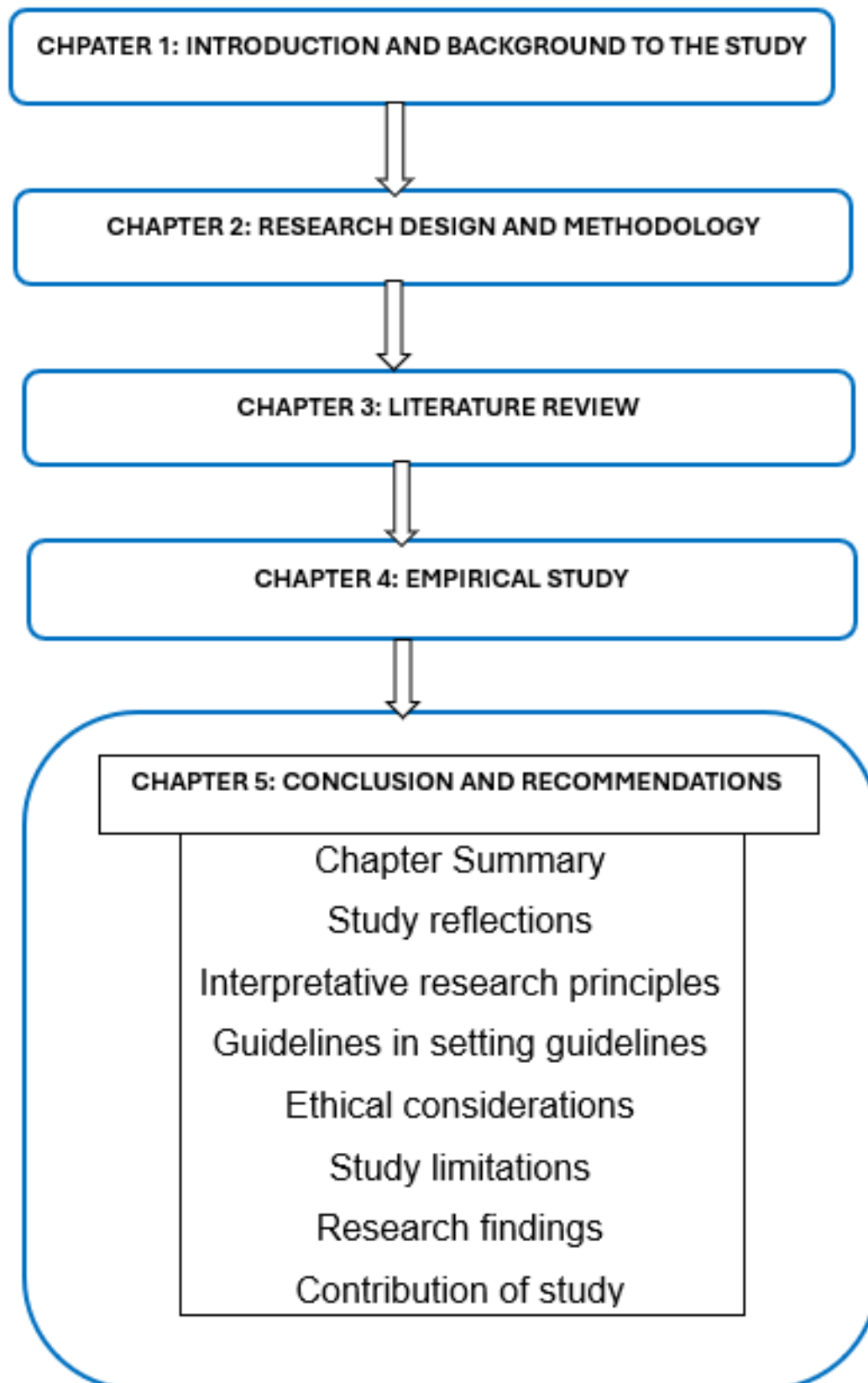
The primary objective of this study that was indicated in Chapter 1 was to develop adoption guidelines of CC in South African HEIs. This study was undertaken to gain an understanding of the IT governance and IT technical staff to get their views, suggestions, knowledge, and perceptions about the CC adoption in HEIs in South Africa. The data were collected from IT governance (as the custodian of the decisions makers in HEI) and technical IT staff who are employed by HEI. Data that were collected from the participants and literature reviews were included in the development of guidelines.

#### **4.9 SUMMARY**

This chapter discusses the data collected from the participants (IT governance and IT staff), research paradigm, methodology and empirical process that were aligned with the reviewed literature. A comprehensive discussion of results is provided based on the collected data and study objectives. The data were analysed using ATLAS.ti software. A set of codes was created and categorised. Using the six steps of qualitative data analysis, a qualitative content analysis process was outlined, where data were prepared and analysed. IT governance and IT staff provided insights into their experiences and perceptions of CC adoption in HEIs, along with valuable suggestions for HEIs considering implementing CC. Based on the empirical data from the participants, the researcher extracted guidelines from the collected data to form empirical guidelines (EG). Then empirical guidelines (EG) were then integrated with the literature review

guidelines (LG) to formulate the final guidelines (FG). This chapter outlines the list of final guidelines (FG) aimed at enhancing the adoption of CC in HEIs.

In the next chapter a conclusion is discussed on reflections, limitations, and recommendations for developing guidelines of CC adoption in South African HEIs.



## **CHAPTER 5: CONCLUSION AND RECOMMENDATIONS**

### **5.1 INTRODUCTION**

The purpose of this study was to develop guidelines for the adoption of cloud computing (CC) in a South African higher education institution (HEI). The research focused on identifying the optimal approach and benefits for HEI to harness the potential of CC. There are several findings and recommendations listed in this final chapter, as well as an overview of the purpose and objectives of this study, and the method of research. In this study, the researcher identified a gap regarding the adoption of CC in HEI. Hence, the researcher investigated this phenomenon to understand the causes and challenges of CC adoption in HEI.

This chapter is divided into 11 parts. Section 5.2 focuses on the chapter summary. Reflections on several study-related topics are included in Section 5.3, including the research objectives, research questions, literature review and methodology. Section 5.4 focuses on how the interpretative research principles were used to guide this study. Section 5.5 focuses on the guidelines on setting guidelines. The ethical considerations of this study have been outlined in Section 5.6. The study limitations were outlined in Section 5.7. Research findings were outlined in Section 5.8. Section 5.9 focuses on the contribution of the study. Recommendations for future research were outlined in Section 5.10. Section 5.11 concludes the chapter by giving the summary.

### **5.2 CHAPTER SUMMARY**

The primary goal of this study was accomplished according to the dissertation chapters.

#### **Chapter 1**

The first chapter introduces and provides background information on this study, emphasising its focus on this study's problem, research questions, and objectives. It also outlines key concepts related to this study. Chapter 1 addresses this study's methodology, covering empirical, theoretical, and ethical considerations, with the goal of addressing the research questions.

#### **Chapter 2**

This chapter provides a detailed explanation of the research methodology and paradigms. This study adopted an interpretative approach. It outlines the process of collecting and analysing data according to the presented framework.

## **Chapter 3**

This study's literature review discussed key concepts and researched previous scholars on CC adoptions in HEIs. The chapter outlined the CC characteristics, models, and detailed the benefits of CC. It explored different scholars' views on the adoption of CC in this context and introduced nine key principles to guide the development of guidelines. The literature review guides the development of guidelines in this study and found that adopting CC in HEI is still experiencing challenges.

## **Chapter 4**

This chapter focused on the process of data collection and analysis. It outlined the research methods and steps taken to conduct the empirical study, providing an explanation of the results obtained from interviews and literature. The data were analysis using ATLAS.ti software, involving the formation and categorization of a set of codes. Following the six steps of qualitative data analysis, a qualitative content analysis process was outlined, encompassing data preparation and analysis. Insights into the experiences and perceptions of CC in HEI was provided by information technology (IT) governance and IT technical staff. Recommendations were formulated based on participants' experiences to address identified problems and challenges. This chapter also outlined a list of proposed guidelines aimed at enhancing CC adoption in HEIs.

The findings from participant interviews were discussed and analysed.

### **5.3 STUDY REFLECTIONS**

The primary purpose of this section is to review what the researcher achieved or learned from this study. The reflections will concentrate on the research objectives, research questions, literature review, study limitations, and ethical considerations.

#### **5.3.1 Research objectives**

The research objectives of this study were explained and outlined in Chapter 1. This study's primary objective was to develop guidelines for CC adoption in HEIs in South Africa. The researcher aimed to explore the reasons behind the low adoption rate of CC in HEIs in South Africa. The objective of this study was achieved.

Chapter 4 summaries the challenges and recommendations that can be implemented by HEIs to expedite the adoption of CC. Data collected from the participants through interviews were

analysed by coding and themes emerged. The suggested guidelines align with the main objective of this study, as they were developed following the outlined process in Chapter 3.

The theoretical objective of this study was met when the researcher gained more knowledge and understanding the key concepts of this study, the appropriate methodology of this study. Chapter 2 discusses the methodology of this study where the researcher learnt about the interpretative research (T01) as the appropriate method for this study. The understanding of the CC models and their characteristics were discussed in Chapter 3 (T02). The researcher has gained more knowledge from previous scholars about the CC models and their characteristics. This was met as the researcher gained more knowledge about the adoption of CC in HEIs and the participants were able to express their views during data collection (interviews) about the adoption of CC in HEIs in South Africa (T03). The steps that guided the development of guidelines were outlined in Chapter 3, and the researcher gained knowledge and was able to develop list guidelines (T04 and T05).

The empirical objectives of this study were met when the researcher extracted adoption guidelines on how HEI can facilitate CC adoption from data gathered and analysed – to make sense of it (E02). The incorporated guidelines were created based on the perceptions and experiences of the participants into guidelines extracted from literature on how HEI can facilitate CC adoption (E03). The researcher extracted guidelines from the literature review on how HEI can facilitate CC adoption (E01).

### **5.3.2 Research questions**

Research objectives were stated and explained. The purpose of this section was to describe how guidelines were developed to accomplish these objectives. The following question were answered to address the research problem.

- What would a set of CC adoption guidelines include?

This will be supported by the following sub-questions:

- What are the benefits of CC in HEI?
- What are the challenges faced by HEI?
- What are the recommendations to enhance the adoption of CC in HEI?

A comprehensive set of responses from participants and insights from literature enabled this study to meet its goals. The questions provided participants with the opportunity to express their views on how CC would enhance teaching practices in HEIs. The questions allowed participants to express their views on how the adoption of CC in HEIs could be improved, when the researcher asked participants on question 12 “In your opinion, what are the major

cloud adoptions stumbling block at our institution?” Participants briefly explained the issue of data security, indicating that ensuring the safety of data on the cloud by service providers would enhance the adoption of CC.

The perceptions of the participants regarding the adoption of cloud computing in HEI were met as IT governance and IT staff expressed their views on the adoption of CC in Chapter 4 . In response to question 13, participants were asked to “outline the benefits of cloud computing” in higher education as well as suggest ways to enhance current cloud services. Research objectives have been achieved satisfactorily since the researcher perceives all research questions as sufficiently addressed.

#### **5.4 INTERPRETIVE RESEARCH PRINCIPLES**

In Chapter 2, the principles of interpretive research were introduced and implemented to assess this study's credibility and reliability. A successful interpretive research study was conducted. To improve CC adoption in HEIs, the researcher used interpretive interviews to collect extensive data from IT governance and IT technical staff's perspectives. Listed below are the specific guidelines for conducting thorough interpretive research (Klein & Myers, 1999:72) that were followed in this study.

##### **The fundamental principle of hermeneutics circle**

As a part of data collection, interviews were conducted with IT governance and IT technical staff to obtain and understand their perceptions. Recordings of the expressed experiences, perspectives, and opinions of the participants were iterated and transcribed.

Participants' perspectives were understood rather than explained by the researcher. Several of the viewpoints that emerged in Chapter 3 were also reflected in IT governance and IT technical staff perspectives. In order to apply the other principles effectively, the researcher knows and understands this principle to be crucial.

##### **The principle of contextualisation**

Participant consent consisted of an explanation of this study's purpose and motivation. To gain further historical insight about CC in HEIs, specific questions were asked of the participants during the interview sessions. To interpret the data collected, it was essential to understand the views of the participants. The empirical findings, which were presented in Chapter 4 , It was stipulated that there should be no biased input from the researcher.

##### **The principle of interaction between the researchers and the participants**

Interviews were conducted without judgement or attempts by the researcher to persuade participants to change their opinions. To collect data, the researcher interviewed participants using open-ended questions. It was important for the researcher to ensure that the interviewer's participation was not compromised. The researcher used semi-structured interviews to achieve this goal by asking the participants the same questions and only asking follow-up questions if the answers were unclear. Careful transcriptions were made, and responses were translated where necessary. Throughout the interviews, participants were asked to convey how they viewed cloud adoption guidelines for HEIs. A wide range of views was expressed by participants.

### **The principle of abstraction and generalisation**

Applying the first and second principles, the collected data from participants were consistently reviewed at this stage to identify recurring concepts and patterns indicative of shared perspectives. To find the idea that best reflected the coded data, the researcher clustered thoughts and perspectives following each interview analysis. Developing guidelines involved coding, grouping, and categorising the data.

### **Principle of dialogical reasoning**

In this phase, a continuous review of data obtained from participants was conducted utilising both the first and second principles. The objective was to identify recurring concepts and patterns indicative of similar thought processes. The identified themes served to reinforce the information collected during the literature review. The researcher meticulously considered every data interpretation provided by the participants, recognising its significance in either substantiating or challenging the information derived from the existing literature. All perspectives and expressions of each participant were faithfully represented by the researcher.

Interviewees were given the flexibility to respond in a conversational style, providing comprehensive answers. The data analysis process, outlined in Chapter 4 , was thoroughly followed to guarantee thorough examination. Participants were actively encouraged to express their opinions without any apprehension of judgment.

### **The principle of multiple interpretations**

Every participant articulated their thoughts and viewpoints on the adoption of CC in higher education. The researcher merged these perspectives to identify commonalities and divergent interpretations. According to the findings of this investigation, many participants held

favourable and multifaceted opinions on how the adoption of CC in higher education could yield additional advantages. Participants in this study presented diverse perspectives, and these varied viewpoints have been fully integrated into both the research and the findings outlined in Chapter 4 .

### **The principle of suspicion**

Every piece of data within this study underwent meticulous transcription, with no participant response being overlooked in this procedure. Before the interviews, participants were required to provide their consent by signing a form, signalling their voluntary engagement, and they were guaranteed confidentiality. The development of codes and themes was meticulously undertaken through a comprehensive and thoughtful data analysis process.

Enforcing this principle commenced with the data collection phase. The researcher-maintained consistency throughout the interviews, ensuring that questions were posed uniformly, and that data remained unaltered or modified. Special attention was given to ensuring that the researcher's previous knowledge about the adoption of CC in HEIs did not influence or bias participant responses. In Chapter 4 , this study findings are presented through the conceptualisation of participants' perspectives and relevant literature, emphasising that they do not represent the researcher's own views.

## **5.5 GUIDELINES IN SETTING GUIDELINES**

There were nine key principles that the researcher adopts on the development of the guidelines (NHMRC, 2000:1). The National Health and Medical Research Council of Australia recommend the following guidelines principles. The research involved an analysis of published materials relevant to the study's focus. Based on the information derived from both this literature and the collected data from study participants, guidelines were formulated. The guidelines are for both IT technical staff and IT governance. The participants play a crucial role in evaluating and reviewing procedures. The researchers' guidelines follow the key principles in Section 3.6 from Chapter 3, Table 3.4 and consider the perspectives of those involved.

During the guideline development, the main focuses were standards, consistency, and acceptability. The researcher shows how each principle was followed and put into action based on the data gathered from participants.

- (P01): The focus should be on outcomes when developing guidelines. Based on the results and perspectives of the participants, the researcher assessed options for

recommending CC in HEI. To ensure that the outcome-based principle was met and satisfied, the researcher followed the study's research objective. To ensure that the objectives are met, this principle was revisited throughout the development process.

- (P02): Resource constraints should be considered when developing guidelines. This study relies heavily on interviews conducted for the purpose of collecting data. Guidelines and recommendations aimed at enhancing CC within HEI were based on participant experiences and theoretical data.
- (P03): It is important that guidelines are based on the best scientific evidence and that their recommendations are described as strong. When preparing guidelines, the researcher acknowledged the views and opinions of the participants from HEI, incorporating all the available information. There were times when these viewpoints supported each other and other times when they contradicted.
- (P04): To synthesize the evidence, one of the most valid methods should be used. Research guidelines were developed considering the differing views and opinions of participants from HEI, taking all the available information into consideration. Research findings showed that there are no explicit methods for developing guidelines but rather all perspectives must be considered. Participants provided both supportive and contradictory opinions, so the researcher found that there are no explicit methods for determining guidelines.
- (P05): Consumers must be involved in the guideline development process. Participants, who were the intended users of the guidelines, were interviewed by the researcher. IT governance and IT technical staff provided input and perspectives for the drafting of these guidelines.
- (P06): Flexibility and adaptability should be key characteristics of guidelines. The created guidelines exhibit flexibility for implementation across South African higher education institutions, accounting for diverse demographics and available resources. Derived from participant data, these guidelines were adaptable and modifiable, making them suitable for adjustment to suit various other HEI. Moreover, if tailored to meet specific institution requirements, these guidelines can also be utilised by IT governance from other HEI.
- (P07): A target audience is considered when developing guidelines for dissemination and implementation. Participants were involved in the development process from the start of this study and are the target audience. The how, where, and what of disseminating and implementing guidelines will need to be discussed with other stakeholders.
- (P08): Guidelines should be evaluated for their implementation and impact. As soon as all HEI stakeholders approve and accept the guidelines, this principle will undergo

verification and testing. This study was conducted by continuously assessing the recommendations and viewpoints of the participants.

- (P09): A regular review of guidelines is necessary. The proposed guidelines were implemented and regularly updated once all stakeholders have approved and accepted them to accommodate all cloud-based applications at the HEI. As other researchers may come up with other ideas and information, the guidelines can be improved and updated according to this principle. For example, Microsoft office is one example.

The researcher developed guidelines based on nine key principles from the National Health and Medical Research Council (NHMRC), incorporating literature review and empirical data. Key principles included focusing on outcomes, considering resource constraints, using the best evidence, involving participants, ensuring flexibility, targeting the audience, evaluating impact, and regularly reviewing guidelines. Participants, including IT staff and IT governance, played a crucial role in the evaluation process, ensuring the guidelines were practical and adaptable for HEIs.

## **5.6 ETHICAL CONSIDERATIONS**

This subsection details the procedural steps taken to ensure the adherence of this study to ethical guidelines at North-West university (NWU). The researcher obtained ethical clearance from the Faculty of Natural and Agricultural Science Research Ethics Committee (FNAS-REC), securing the NWU ethics clearance number, which was subsequently approved and included in Appendix D, "FACULTY OF NATURAL AND AGRICULTURAL SCIENCE RESEARCH ETHICS COMMITTEE". To conduct interviews with NWU employees, the researcher sought permission from the NWU Research Data Gatekeeper Committee (NWU-RDGC), and authorisation was granted. All study participants volunteered, and prior to the interview, they were provided with consent forms to sign included in Appendix B , "PARTICIPANT CONSENT FORM". The researcher treated all participants with respect, maintaining confidentiality regarding their identity and provided information. Participants were informed that they could request access to their transcribed data to verify its accuracy. The researcher followed all NWU ethical procedures exactly to ensure compliance with rules and regulations governing research studies.

## **5.7 STUDY LIMITATIONS**

Research has some limitations. Additionally, there were a limited number of IT governance and IT technical staff. There was a higher number of male participants than women due to the prevailing representation of men dominating in the IT industry. Interpretive research operates

within a paradigm founded on the belief that social reality isn't singular or objective; instead, it's moulded by human experiences and social contexts. Although interviews were conducted until no new information emerged, there were no new codes or categories emerged. Subjectivity, interpretations of data can be influenced by researchers' biases or preconceptions, potentially affecting the validity and reliability of findings in an interpretative study. The researcher derived generalisations from personal interpretations and reasoning, which may lead to subjectivity and social bias in the research outcomes.

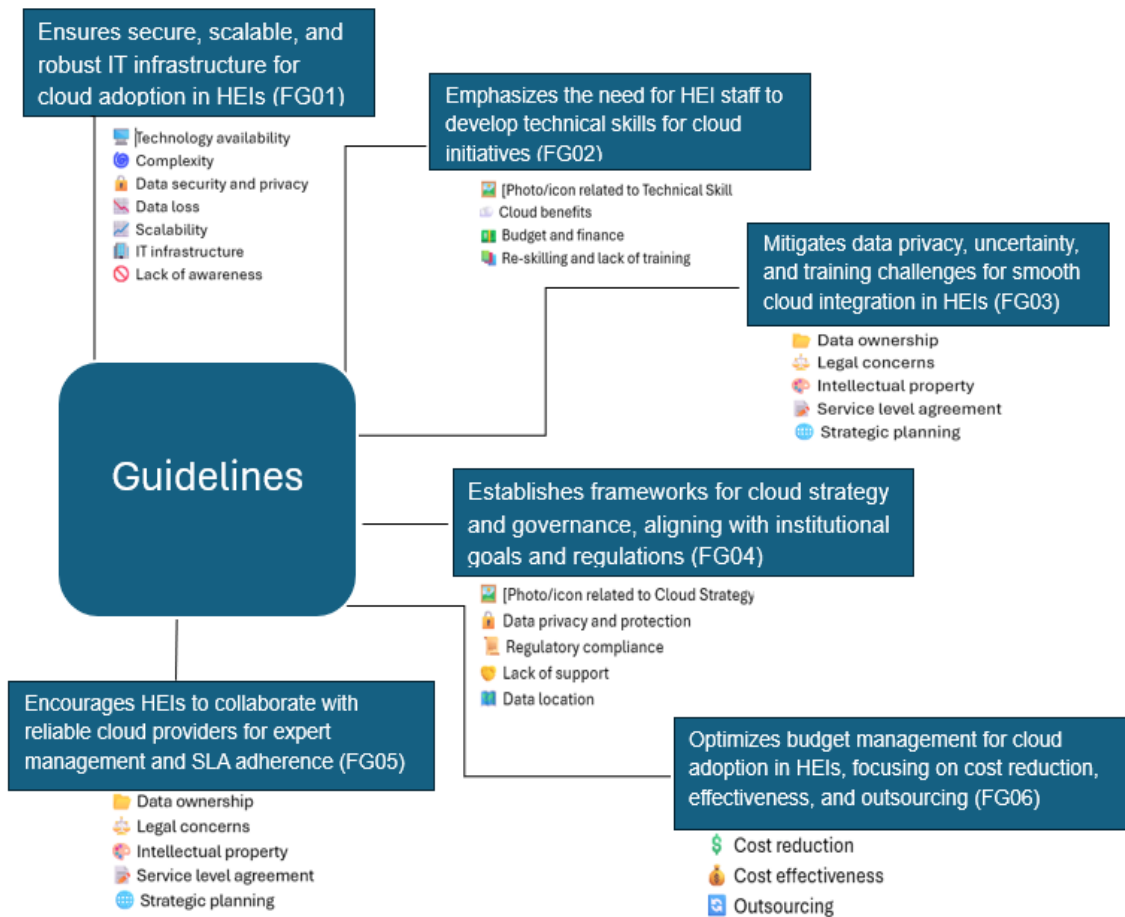
## 5.8 RESEARCH FINDINGS

Cloud computing adoption guidelines were developed based on the results of the data analysis of data that have been collected from the participants. Although the guidelines do not contain technical specifications, the participants' views on what could/should be done to optimise the adoption of CC at HEIs in South Africa are incorporated into the guidelines. The following themes that emerged from the data collected from the participants were developed in Chapter 4 .

- **Technological factors:** On this basis it has been suggested that HEIs need to evaluate data protection and recovery, to ensure that data are protected and can be transferred within the cloud infrastructure, and it is important to ensure that there is access to a cloud service provider that will be able to provide a disaster recovery plan. It has also been suggested that intellectual property is very important and remains a concern and needs to be taken into consideration before the adoption of CC in HEIs.
- **Environmental factors:** It has been recommended that HEIs need to upskill their IT staff to enhance their knowledge and skills that will assist them to operate in the CC environment. Prioritising security and carefully selecting service providers are crucial steps when deciding on a service provider before HEIs adopt CC. The safeguarding of sensitive data, including intellectual property, student records, and research data, must be given the utmost priority.
- **Governance factors:** It has been suggested that HEIs need to consider the SLA and vendor selection that will be able to determine the choice of the cloud service providers. Their service providers need to make sure that there will be no data leaks or compromises, and HEIs need to carefully review their intellectual property to be aligned with HEI policies and requirements. The development of a cloud smart strategy needs to be well defined and HEIs need to emphasise its importance to assist on the HEIs' digital migration to the adoption of CC.

- **Financial factors:** HEIs need to understand the use of resources outside their own infrastructure before adopting CC as it has a financial impact. It also recommends that HEIs need to explore partnerships with reputable cloud service providers that could host the internal cloud solution on premises with the aim of ensuring access to services. Therefore, the recommendation emphasises that HEIs need to explore the pay-as-you-go model, carefully assessing the cost reduction, and developing internal cloud solutions and evaluate the total cost of the ownership. The adoption of a budget strategy within HEIs needs to align with the consumption of the selected cloud services model. The HEIs strategy needs to change so that it can be aligned with the migration of CC adoption in the HEI sector.
- **Organisational factors:** It has been recommended that HEIs need to enquire about additional skills before adopting CC, meaning that training and hiring new staff members with expertise skills of cloud technology need to be considered. HEIs need to have a continuous learning adoption culture that needs to promote learning among staff members who will be involved in the adoption of CC. Therefore, HEIs need to encourage a proactive approach to the development of skills. A collaborative approach with other IT industries needs to be considered as a way of cross-functioning with other teams to ensure the successful adoption of cloud technologies.
- **Challenges of CC in HEIs:** The trust between the service providers and HEIs need to be acknowledged with the importance of taking into consideration the legal aspects such as POPIA. The cost needs to be considered. Exchange rates can impact the feasibility of adopting CC in HEIs. Variations in exchange rates may influence the costs associated with cloud services, potentially influencing HEIs' decisions regarding their adoption. The researcher recommends that staff training is required for both IT staff and end-users to keep them updated with new technologies. It is further recommended that a continuous learning culture embedded in new technology within HEIs should be mandatory to IT staff. Higher education needs to acknowledge that there is a challenge with IT literacy among both staff and students, therefore awareness and training is also required.

Figure 5.1 shows the final list of guidelines that has emerged from the data collected from the participants and literature review. This visual representation organizes the guidelines and their associated factors as outlined below on the Figure 5.1. Each guideline is represented as a box, and associated factors are depicted with relevant icons to provide a quick visual reference. Flow lines connect the guidelines to their respective factors, showing their relationships and dependencies.



**Figure 5.1: Final list of guidelines**

Below are explanations for each guideline associated with the adoption of CC in the HEI sector:

**FG01: Ensures secure, scalable, and robust IT infrastructure for cloud adoption in HEIs**

- Establishes a secure and adaptable IT foundation that supports cloud services.
- Addresses outdated system concerns and ensures compatibility with modern cloud technologies.

**FG02: Emphasizes the need for HEI staff to develop technical skills for cloud initiatives**

- Highlights the importance of upskilling IT staff in CC knowledge and implementation.
- Recommends workshops and training programs to enhance staff proficiency in cloud technologies.

**FG03: Mitigates data privacy, uncertainty, and training challenges for smooth cloud**

### **integration in HEIs**

- Identifies and addresses major obstacles like data privacy concerns and lack of trust in cloud providers.
- Suggests awareness campaigns and benchmarking with developed institutions to build confidence in cloud adoption.

### **FG04: Establishes frameworks for cloud strategy and governance, aligning with institutional goals and regulations**

- Develops clear strategies and governance frameworks for cloud adoption.
- Ensures alignment with institutional goals and compliance with regulatory requirements.

### **FG05: Encourages HEIs to collaborate with reliable cloud providers for expert management and SLA adherence**

- Promotes partnerships with experienced cloud service providers to ensure reliable services.
- Addresses concerns about support and trust by establishing strong SLAs.

### **FG06: Optimizes budget management for cloud adoption in HEIs, focusing on cost reduction, effectiveness, and outsourcing**

- Recommends financial strategies to efficiently manage the costs of cloud adoption.
- Focuses on reducing expenses, enhancing cost-effectiveness, and leveraging outsourcing where beneficial.

## **5.9 CONTRIBUTION OF STUDY**

This study has the potential to play a pivotal role in shaping the adoption guidelines for CC within HEIs in South Africa. The guidelines aim to augment the current knowledge base on CC within HEIs in the South African context. The guidelines developed in this study will aid HEIs in adopting CC, providing benefits in teaching and learning. Additionally, this study will offer guidance to IT governance on essential considerations such as the chosen service provider, and data security issues when HEIs transition to CC.

This study significantly advances HEIs in adopting CC by ensuring the establishment of secure, scalable, and robust IT infrastructure tailored for effective integration. It emphasizes enhancing technical skills among HEI staff in CC, promoting readiness crucial for successful implementation. Addressing challenges such as data privacy, uncertainty, and training gaps, the study recommends strategies like awareness campaigns and collaboration with experienced service providers to facilitate smoother CC integration. Additionally, it highlights

the importance of aligning cloud strategy and governance with institutional goals and regulations, involving IT governance for strategic alignment and effective decision-making. Encouraging partnerships with reliable cloud providers enhances management capabilities and ensures adherence to SLA, addressing concerns about service quality and support. Lastly, the study advises on optimizing budget management through cost reduction, effectiveness, and outsourcing strategies to enhance financial efficiency and promote sustainable CC adoption practices within HEIs.

## **5.10 RECOMMENDATIONS FOR FUTURE RESEARCH**

Following are areas recommended for possible future research.

1. The current study focused on one HEI, but future research could expand to include other HEIs.
2. Engaging participants such as administrators, academic staff, and students from various institutions would facilitate exploration of alternative approaches to understanding how HEIs in South Africa could accelerate the adoption of CC.
3. Demographic data, specifically gender, was considered, while age was omitted from collection and analysis for this study. However, it could be valuable to include age in future research.
4. For future investigations, it is advisable to explore how various genders, given the current male dominance in IT, and age groups might be influenced by CC.

## **5.11 SUMMARY**

In this chapter, an overview of the research and thoughtful reflections on this study were presented. It outlines the development of guidelines based on a thorough exploration of existing literature and the valuable input obtained from interview outcomes. This process resulted in the formation of a set of guidelines meticulously designed to realise the primary objectives of this study. The main purpose of this study was to develop the adoption guidelines of CC in South African HEIs. The developed guidelines facilitate HEIs in adopting CC.

The primary and theoretical objectives of this study were successfully accomplished. The researcher showcased the ability to systematically apply an appropriate methodology to investigate a defined research problem. Furthermore, the chapter reaches into the identification of recommendations for future possible research.

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## **APPENDIX A: INTERVIEW QUESTIONS**

### **Interview Questions**

Dear Participant

I appreciate the opportunity that you grant me to interview you. I am Robert Azwidowi from North-West University, Vanderbijlpark campus. I am currently busy with my Master studies in Computer Science and Information Systems. My research study is based on developing guidelines for the adoption of Cloud Computing in a South African higher education institution.

To complete this interview, you must be an IT technical staff or member of the IT governance group within the NWU. There will be no identification of you in any of the published information. All answers to the interviews will be kept strictly confidential.

Before we begin the interview, do you have any questions about this study?

#### **Part 1: Basic questions\ Demographic details**

- What is your position?
- How many years and experience do you have in the field of IT?

#### **Part 2: Interview Questions**

1. How would you define Cloud Computing in your own words?
2. In terms of IT Services, how is the university embracing Cloud-Computing?
3. Does the NWU have any plan to adopt Cloud Computing?
4. Regarding the current level of ICT development, would it affect Cloud Computing adoption?
5. Do you have confidence on migrating NWU services to the cloud? Do you trust cloud services?
6. What factors would you consider while selecting a cloud service provider?
7. Do you consider cloud computing to be cost-effective??
8. In your opinion does the use of Cloud Computing can impact teaching and learning experience?
9. Does the university have any IT services that are currently running on the cloud? If yes, what is the experience.

10. Do you believe that by utilising Cloud Computing, can put improve availability of services in IT?
11. Do you think training is required for related positions when Cloud Computing can be introduced?
12. In your opinion, what are the major cloud computing adoption stumbling blocks in your institution?
13. How do you view the benefits that Cloud Computing can offer to your university?

Thank you for your participation.

## **APPENDIX B: PARTICIPANT CONSENT FORM**

### **Participant Consent Form**

#### **Consent form participate in research study.**

Name and contact details of researcher : Robert Azwidowi

Email address : [Robert.Azwidowi@nwu.ac.za](mailto:Robert.Azwidowi@nwu.ac.za)

Contact number 016 910 3332

**TITLE: Cloud computing adoption guidelines in a South African higher education institution**

**Purpose of Study: To develop adoption guidelines of cloud computing in a South Africa higher education institution.**

The purpose of this letter is to ask your permission to conduct interviews with IT governance and IT technical staff. This will enable me to conduct virtually (Microsoft Teams) interviews with the participants. This should not take a large amount of time and can be arranged at a convenient time and date to be arranged. All I need is to arrange a convenient time for us to agree on time and conduct interviews.

You can rest assured that your answers will remain confidential. In any published information, your identity will not be revealed. It is our policy to keep all information confidential.

Please note of the following:

- There are no adverse consequences or academic penalties associated with my participation since it is voluntary.
- This study has been approved by the Natural and Agricultural Sciences Research Ethics Committee at the North-West University and is conducted according to the ethical guidelines of this committee.
- An anonymous interview will be conducted as part of the study. Your identity will not be disclosed in the findings.
- The answers of participants and the results will be kept strictly confidential.
- Researchers may use the findings only for academic purposes in their dissertations, conference papers, articles, etc.

- Audio recordings may be made of me with my consent.

Researcher is a member of the category of researchers who are employees of the institution.

As stated in the above information, I confirm that I have read and understood it. As a result of having an opportunity to consider the information and ask questions, I have received satisfactory responses.

If you have any questions or comments regarding the study, you can contact me or my study supervisor, Dr Imelda Smit, [Imelda.smit@nwu.ac.za](mailto:Imelda.smit@nwu.ac.za)

Your assistance is greatly appreciated.

Yours sincerely,

Mr Robert Azwidowi

[Robert.Azwidowi@nwu.ac.za](mailto:Robert.Azwidowi@nwu.ac.za) – 016 910 3332

In signing below, you acknowledge that you have read and understood the information provided and that you consent to participate in the study.

-----  
Participant Name

-----  
Date

-----  
Signature

## APPENDIX C: LIST OF CODES FROM EMPIRICAL DATA

Codes	P1	P2	P3	P4	P5	P6	P7	P8	Total
Ability to adopt CC: Adjustment	0	0	0	0	0	0	1	0	1
Ability to adopt CC: Agility	0	0	0	0	0	1	0	0	1
Ability to adopt CC: Change management	0	0	1	0	0	0	1	0	2
Ability to adopt CC: Complexity	3	0	0	0	0	0	1	0	4
Ability to adopt CC: Compliance	1	0	0	2	0	0	0	0	3
Ability to adopt CC: Efficiency	4	1	0	0	1	3	4	2	15
Ability to adopt CC: Governance	0	0	0	0	1	0	0	0	1
Ability to adopt CC: Policy and regulations	1	0	0	0	0	0	0	0	1
Ability to adopt CC: Regulatory compliance	2	0	0	0	0	0	0	0	2
Ability to adopt CC: Reliability	1	0	0	0	0	0	0	0	1
Ability to adopt CC: Responsibility	0	1	0	0	0	1	0	1	3
Ability to adopt CC: Scalability	2	1	2	1	0	2	0	0	8
Ability to adopt CC: Strategic planning	0	0	0	0	1	0	0	0	1
Ability to adopt CC: Sustainability	0	0	0	0	1	0	0	0	1
Ability to adopt CC: Teaching and learning experience	0	0	1	0	0	0	0	0	1
Ability to adopt CC: Training requirements	1	0	0	0	0	0	0	0	1
Ability to adopt CC: Transparency	1	0	0	0	0	0	0	0	1
Ability to adopt CC: Work experience	0	0	0	0	0	0	1	0	1
Ability to adopt CC: Work flexibility	0	0	1	0	0	0	0	0	1
Business: Business negotiation	1	0	0	0	0	0	0	0	1
Business: Industry partnership	0	0	0	0	0	0	1	0	1
Challenges: Barriers to adoption	0	0	0	0	1	0	0	0	1
Challenges: Communication challenges	0	0	0	0	1	0	0	0	1
Challenges: Confidence	0	1	2	0	0	1	1	2	7
Challenges: Dependence	0	0	0	0	0	0	1	0	1
Challenges: Fear of complexity	0	0	0	0	0	0	1	0	1
Challenges: Lack of awareness	0	0	0	0	0	1	1	0	2
Challenges: Lack of clarity	0	0	0	0	1	0	1	0	2
Challenges: Lack of engagement	1	0	0	0	0	0	0	0	1
Challenges: Lack of information	0	0	0	0	0	0	0	1	1
Challenges: Lack of knowledge	1	0	0	0	0	0	0	0	1
Challenges: Lack of organization	1	0	0	0	0	0	0	0	1
Challenges: Lack of support	0	0	0	0	0	0	1	0	1
Challenges: Lack of training	0	0	0	0	1	0	0	0	1
Challenges: Limitations	1	0	0	0	0	0	0	0	1
Challenges: Negative impact	0	1	0	0	0	0	0	0	1
Challenges: Redundancy	0	0	1	1	0	0	1	0	3
Challenges: Stumbling blocks	0	0	0	1	0	0	0	0	1
Challenges: Uncertainty	6	3	3	2	7	7	9	6	43
Cloud computing Platforms	2	0	0	1	0	1	0	0	4
Cloud computing Platforms: Amazon EMR	0	0	0	1	0	0	0	0	1
Cloud computing Platforms: AWS	1	0	0	0	0	0	0	0	1
Cloud computing Platforms: Azure	1	0	0	0	0	1	0	0	2

<b>Codes</b>	<b>P1</b>	<b>P2</b>	<b>P3</b>	<b>P4</b>	<b>P5</b>	<b>P6</b>	<b>P7</b>	<b>P8</b>	<b>Total</b>
Cloud computing Platforms: External HPC vendors	1	0	0	0	0	0	0	0	1
Cloud computing Platforms: Google	1	0	0	0	0	0	0	0	1
Cloud computing Platforms: Google Big Query	0	0	0	1	0	0	0	0	1
Cloud computing Platforms: Microsoft 365	0	0	0	1	0	0	0	0	1
Cloud computing Platforms: Microsoft Azure	0	0	0	1	0	0	0	0	1
Cloud computing Platforms: OneDrive	0	0	0	1	0	0	0	0	1
Cloud computing: Big data	0	0	0	0	0	0	1	0	1
Cloud computing: Cloud architect	0	0	0	0	0	0	1	0	1
Cloud computing: Cloud service provider	0	0	0	1	0	1	0	0	2
Cloud computing: Cloud storage	1	0	0	0	0	0	0	0	1
Cloud computing: Data centres	0	0	2	0	0	0	0	0	2
Cloud computing: Multi-cloud strategy	0	0	0	0	0	2	0	0	2
Cloud computing: Next cloud	0	0	0	1	0	0	0	0	1
Cloud computing: Remote data centre	0	0	0	0	1	0	0	0	1
Cost management: Affordability	0	0	0	0	1	0	0	0	1
Cost management: Allocation of resources	1	0	0	0	0	0	0	0	1
Cost management: Cost effectiveness	3	0	1	0	0	1	0	0	5
Cost management: Cost efficiency	0	0	0	0	0	0	1	0	1
Cost management: Cost savings	0	0	0	1	0	0	0	2	3
Cost management: Cost-effectiveness	0	1	0	0	0	0	0	1	2
Cost management: Resource constraints	1	0	0	0	0	0	0	0	1
Data security: Access controls	0	0	0	1	0	0	0	0	1
Data security: Backup procedures	1	0	0	0	0	0	0	0	1
Data security: Big data and analytics	0	0	0	1	0	0	0	0	1
Data security: Concerns about privacy	0	0	0	0	0	0	0	1	1
Data security: Cybersecurity	1	0	0	1	0	0	0	0	2
Data security: Data access	0	0	1	0	0	0	0	0	1
Data security: Data availability	0	0	1	0	0	0	0	0	1
Data security: Data backup	1	0	0	0	0	0	0	0	1
Data security: Data breach	0	0	0	0	1	0	0	0	1
Data security: Data compliance	1	0	0	0	0	0	0	0	1
Data security: Data governance	0	0	0	1	0	0	0	0	1
Data security: Data loss	1	0	0	0	0	0	0	0	1
Data security: Data management	0	0	1	0	0	0	0	0	1
Data security: Data ownership	0	0	1	0	0	0	0	0	1
Data security: Data privacy	1	0	0	0	0	0	0	0	1
Data security: Data processing	0	0	0	0	1	0	0	0	1
Data security: Data protection	0	0	0	1	0	0	0	0	1
Data security: Data security	1	1	1	2	0	0	0	0	5
Data security: Data transfer speed	0	0	1	0	0	0	0	0	1
Data security: Due diligence	1	0	0	0	0	0	0	0	1
Data security: Excessive security	1	0	0	0	0	0	0	0	1
Data security: Firewall restrictions	1	0	0	0	0	0	0	0	1
Data security: Information security	0	1	0	0	0	0	0	0	1
Data security: Legal concerns	0	1	0	0	0	0	0	0	1
Data security: Potential data loss	0	0	0	1	0	0	0	0	1

<b>Codes</b>	<b>P1</b>	<b>P2</b>	<b>P3</b>	<b>P4</b>	<b>P5</b>	<b>P6</b>	<b>P7</b>	<b>P8</b>	<b>Total</b>
Data security: Privacy concerns	0	0	1	1	0	0	0	2	4
Data security: Challenge management	1	0	0	0	1	0	1	0	3
Data security: Security assurances	1	0	0	0	0	0	0	0	1
Data security: Security breach	1	0	0	0	0	0	0	0	1
IT infrastructure: Advantages of outsourcing	0	0	0	0	0	0	1	0	1
IT infrastructure: Data center management	0	0	1	0	0	0	0	0	1
IT infrastructure: E-learning	0	0	0	0	0	0	1	0	1
IT infrastructure: Financial services	0	0	0	0	0	0	1	0	1
IT infrastructure: HPC (High Performance Computing)	1	0	0	0	0	0	0	0	1
IT infrastructure: Infrastructure as a Service	0	0	0	0	0	1	0	0	1
IT infrastructure: Infrastructure development	0	0	0	0	0	0	1	0	1
IT infrastructure: Infrastructure maintenance	0	0	0	0	0	1	0	0	1
IT infrastructure: Infrastructure management	0	0	0	0	0	1	0	0	1
IT infrastructure: Integration with existing systems	0	0	0	1	0	0	0	0	1
IT infrastructure: Internet access	0	0	1	0	0	0	0	0	1
IT infrastructure: IT services	1	0	1	0	0	1	0	0	3
IT infrastructure: On-premises	0	0	0	0	0	0	2	0	2
IT infrastructure: Online learning	0	0	0	0	0	1	0	0	1
IT infrastructure: Outsourcing	1	0	0	0	1	0	1	0	3
IT infrastructure: Pay-as-you-go	0	0	0	1	0	0	0	0	1
IT infrastructure: Platform as a Service	0	0	0	0	0	1	0	0	1
IT infrastructure: Remote learning	0	0	2	1	1	0	0	0	4
IT infrastructure: Remote work	0	0	1	0	1	0	0	2	4
IT infrastructure: Service agreement	1	0	0	0	0	0	0	0	1
IT infrastructure: Service availability	0	1	0	0	0	0	0	0	1
IT infrastructure: Service level agreements	1	0	0	0	0	0	0	0	1
IT infrastructure: Service provider dependence	0	0	0	0	0	0	1	0	1
IT infrastructure: Service providers	1	0	0	0	0	0	0	0	1
IT infrastructure: Software as a Service	1	0	0	0	0	1	0	0	2
IT infrastructure: Software development	0	0	0	0	0	0	1	0	1
IT infrastructure: Subscription-based model	0	1	0	0	0	0	0	0	1
IT infrastructure: System administration	1	0	0	0	0	0	0	0	1
IT infrastructure: Technical support	0	0	1	0	0	0	0	0	1
IT infrastructure: Technology as a service	0	0	0	0	0	0	1	0	1
IT infrastructure: Virtual computing	0	0	1	0	0	0	0	0	1
IT infrastructure: Virtual infrastructure	0	0	0	0	1	0	0	0	1
IT infrastructure: Virtualization	0	0	0	1	0	1	0	0	2
Technology: Authentication	0	0	1	0	0	0	0	0	1
Technology: Availability	1	0	1	1	0	1	1	0	5
Technology: Benefits	0	1	0	0	0	1	0	1	3
Technology: Digital divide	0	0	1	0	0	0	0	0	1
Technology: Digital strategy	0	0	0	0	0	0	1	0	1
Technology: Intellectual property	0	1	0	0	0	0	0	0	1
Technology: Internet	0	0	1	0	0	0	0	0	1
Technology: Legacy	0	0	0	0	0	0	2	0	2
Technology: Ownership	0	0	0	0	0	1	0	0	1

<b>Codes</b>	<b>P1</b>	<b>P2</b>	<b>P3</b>	<b>P4</b>	<b>P5</b>	<b>P6</b>	<b>P7</b>	<b>P8</b>	<b>Total</b>
Technology: Security	0	1	3	1	3	0	0	1	9
Technology: Technical skills	0	0	1	0	0	0	0	0	1
Technology: Technological challenges	1	0	0	0	0	0	0	0	1
Technology: Technological innovation	0	0	0	0	0	1	0	0	1
Technology: Technological transition	0	0	0	0	0	0	0	1	1
Technology: Technology integration	0	0	2	0	0	0	0	0	2
Technology: Technology usage	0	0	0	0	0	1	0	0	1
Technology: Training	3	1	1	2	0	0	2	2	11
Technology: Trust	1	0	3	0	2	2	0	0	8
<b>Totals</b>	<b>66</b>	<b>18</b>	<b>43</b>	<b>33</b>	<b>29</b>	<b>37</b>	<b>45</b>	<b>25</b>	<b>296</b>

## APPENDIX D: FACULTY OF NATURAL AND AGRICULTURAL SCIENCE RESEARCH ETHICS COMMITTEE



Private Bag X1290, Potchefstroom  
South Africa 2520

Tel: 018 299-1111/2222  
Fax: 018 299-4910  
Web: <http://www.nwu.ac.za>

**Senate Committee for Research Ethics**  
Tel: 016 910 3445  
Email: [Fazwa.Msoloni@nwu.ac.za](mailto:Fazwa.Msoloni@nwu.ac.za)

### ETHICS APPROVAL LETTER OF STUDY

Based on approval by the **Faculty of Natural and Agricultural Sciences Ethics Committee (FNAS-REC)**, the Faculty of Natural and Agricultural Sciences Ethics Committee hereby **approves** your study as indicated below. This implies that the North-West University Senate Committee for Research Ethics (NWU-SCRE) grants its permission that, provided the special conditions specified below are met and pending any other authorisation that may be necessary, the study may be initiated, using the ethics number below.

<b>Study title: Cloud Computing Adoption Guidelines in a South African Higher Education Institution</b>															
<b>Study Leader/Supervisor: Dr I Smit</b>															
<b>Student: R Azwidowi</b>															
<b>Ethics number:</b>	<b>N</b>	<b>W</b>	<b>U</b>	<b>-</b>	<b>0</b>	<b>1</b>	<b>4</b>	<b>6</b>	<b>2</b>	<b>-</b>	<b>2</b>	<b>2</b>	<b>-</b>	<b>A</b>	<b>9</b>
	Institution				Study Number					Year		Status			
Status: S = Submission; R = Re-Submission; P = Provisional Authorisation; A = Authorisation															
<b>Application type: Single</b>					<b>Risk Category:</b>					<b>Minimal</b>					
<b>Commencement date: 01/02/2022</b>															
<b>Expiry date: 31/01/2025</b>															
<b>Approval of the study is initially provided for a year, after which continuation of the study is dependent on receipt and review of the annual (or as otherwise stipulated) monitoring report and the concomitant issuing of a letter of continuation.</b>															

Special in process conditions of the research for approval (if applicable):

- The following documentation are archived by FNASREC and should be complete and kept up to date:
  - Research proposal
  - Signed approval from the scientific committee indicating the proposed risk category
- All researchers involved in the study should submit signed NWU code of conduct statements annually.
- All researchers of low risk studies should submit proof of relevant ethics training every two years.
- All researchers that take part in activities that pose a safety and security threat to the researchers or the environment should submit a risk assessment form annually.
- All research involving human interaction should follow best ethical practise and keep documents as proof. This includes informed consent, questionnaires, incorporation of risk-benefit, and responsible data management.
- Any research at governmental or private institutions, permission must still be obtained from relevant authorities and provided to the FNASREC. Ethics approval is required BEFORE approval can be obtained from these authorities.

**General conditions:**

*While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, the following general terms and conditions will apply:*

- *The study leader/supervisor (principal investigator)/researcher must report in the prescribed format to the FNASREC:
  - *annually (or as otherwise requested) on the monitoring of the study, whereby a letter of continuation will be provided, and upon completion of the study; and*
  - *without any delay in case of any adverse event or incident (or any matter that interrupts sound ethical principles) during the course of the study.**
- *The approval applies strictly to the proposal as stipulated in the application form. Should any amendments to the proposal be deemed necessary during the course of the study, the study leader/researcher must apply for approval of these amendments at the FNASREC, prior to implementation. Should there be any deviations from the study proposal without the necessary approval of such amendments, the ethics approval is immediately and automatically forfeited.*
- *Annually a number of studies may be randomly selected for an external audit.*
- *The date of approval indicates the first date that the study may be started.*
- *In the interest of ethical responsibility, the NWU-SCRE and FNASREC reserves the right to:
  - *request access to any information or data at any time during the course or after completion of the study;*
  - *to ask further questions, seek additional information, require further modification or monitor the conduct of your research or the informed consent process;*
  - *withdraw or postpone approval if:
    - ✦ *any unethical principles or practices of the study are revealed or suspected;*
    - ✦ *it becomes apparent that any relevant information was withheld from the FNASREC or that information has been false or misrepresented;*
    - ✦ *submission of the annual (or otherwise stipulated) monitoring report, the required amendments, or reporting of adverse events or incidents was not done in a timely manner and accurately; and / or*
    - ✦ *new Institutional rules, national legislation or international conventions deem it.***
- *FNAS-REC can be contacted for further information or any report templates via [Roelof.Burger@nwu.ac.za](mailto:Roelof.Burger@nwu.ac.za) 018 299 4269*

The FNASREC would like to remain at your service as scientist and researcher, and wishes you well with your study. Please do not hesitate to contact the FNASREC or the NWU-SCRE for any further enquiries or requests for assistance.

Yours sincerely,



Prof Roelof Burger  
Chairperson Faculty of Natural and Agricultural Sciences Ethics Committee (FNASREC)

## APPENDIX E: EDITOR'S DECLARATION



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### TO WHOM IT MAY CONCERN

This serves to confirm that I have edited and proofread the dissertation entitled

**Cloud Computing Adoption Guidelines in a South African Higher Education Institution**

prepared by Mr R Azwidowi, submitted in partial fulfilment of the requirements for the degree Master of Science in Computer Science at the North-West University, according to the specifications of the University, where available, and the latest standards for language editing and technical (computer-based) layout.

Editing was restricted to language usage and spelling, consistency, formatting and the style of referencing. No structural writing of any content was undertaken.

As an editor I am not responsible for detecting any content that may constitute plagiarism.

To the best of my knowledge, all references have been provided in the prescribed format.

I am not accountable for any changes made to this dissertation by the author or any other party after the date of my edit.

*(Electronically signed – actual signature withheld for security reasons)*

**MONICA BOTHA**

22 March 2024

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Sole Proprietor: Monica Botha

*Business Planning    Corporate Systems Engineering    Corporate Document Standards  
Business and Academic Document Technical and Language Editing*