UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF TECHNOLOGY EDUCATION, KUMASI

ADOPTION OF CLOUD COMPUTING TECHNOLOGY IN UNIVERSITIES: CONCERNS AND CHALLENGES (CASE STUDY OF WA POLYTECHNIC)

SAEED ALHASSAN

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in the University of Education Winneba, Kumasi

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DECLARATION

Student's Declaration

I, ALHASSAN SAEED, declare that this thesis, with the exception of quotations and references contained in published works which have been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

Signature: ……**Date:** ……

Supervisor's Declaration

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of thesis/dissertation/project as laid down by the University of Education, Winneba.

Supervisor:

Signature: ……**Date:** ……

DEDICATION

Nothing is possible without Allah. This work is therefore dedicated to the Almighty Allah for all HIS blessings and mercies He showered on me through this program. I also dedicate this success story to the entire family of Alhassan Meisallah. May the Almighty Allah bless us all.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

GLOSSARY

ASP	Applications Services Provisions
AWS	Amazon Web Services
CAGR	Annual Compound Growth Rate
CSP	Cloud Service Provider
EMIS	Education Management Information System
ERP	Enterprise Resource Planning
EY	Ernst & Young
GDPR	General Data Protection Regulation
IaaS	Infrastructure as a Service
ICT	Information and Communication Technology
IDC	International Data Corporation
IT	Information Technology
IUG	Islamic University of Gaza
MOOC	Maasive Open Online Courses
PaaS	Platform as a Service
PhD	Doctor of Philosophy
QoS	Quality of Service
R & D	Research and Development
RoI	Return on Investment
RTI	Right to Information
SaaS	Software as a Service
SHS	Senior High School
SLA	Service Level Agreement
SSA	Sub-Sahara Africa
VDI	Virtual Desktop Infrastructure

ABSTRACT

Cloud computing may be referred to as computer resources, both software and hardware available at a location accessible on demand via internet. This source offers different integrated services that are not hosted in-house and made easy to deploy from the remote location. The resource includes data backup, software applications, self-synchronization and storage systems. Task scheduling, push-email, processing capabilities, and remote printing for part the remote resources mad available through the cloud. The aim of this research was to determine the issues and challenges hindering the adoption of cloud computing technology in Higher Education Institution, case study if the Wa Polytechnic. With a descriptive and analytical method, the effects of the five main elements also called independent variables (Top management, Support & integration, Skills of IT human resources, Security effectiveness and Cost reduction) on the adoption of cloud computing the dependent variable was conducted. The research focused on Wa Polytechnic as a case study, which is the first of such institutions to undertake such a study from the Northern Sector of Ghana. The researcher deployed questionnaire as a tool for data collection, administered on a sample size of 63 selected from a population of 172 employees. The MS Excel 2019 was used for coding the Liker results and transferred to the SPSS statistical tool for further analysis and validation. The findings indicate a positive correlation between the adoption of cloud computing and the five independent variables. It was recommended by the research that Wa Polytechnic can adopt the cloud computing technology in its operations, but should provide training for the IT staff, send them on scientific missions to develop their innovative powers.

Additionally, it was recommended that security should be achieved by migrating non-critical application and data to cloud, or by opting for hybrid system so that public cloud

takes up the non-critical application while private cloud hosts the critical and sensitive programs such as data. It was also determined that Top management has peculiar role such as data. It was also determined that Top management has peculiar role in project success through effective decision making and provision of necessary resources.

CHAPTER ONE

INTRODUCTION

1.1 Introduction

Cloud computing is one of the currently trending technologies which make it possible for institutions of higher education in the advanced economies with little budget to undertake technological and innovation projects. This was possible for only bigger institutions with enough funding to implement technology infrastructure (Cloud Special Interest Group, 2018). As a result, the less endowed institutions have the opportunity to compete favorably with the richer counterparts.

Despite the immense benefits in the adoption of cloud computing, there are obstacles associated with its cloud migration in the higher institutions of learning. These barriers are not much different from those linked to implementation of traditional methods of hosting IT systems and infrastructure. These barriers include risks of the technology itself and those emanating from partnerships created by the institutions and cloud computing providers. One of the key challenges when deciding to adopt cloud computing is variation in business models, functionality, quality and cost of the product. The fact is that; the deployment of cloud-based services these days grows with the emergence of expert providers of services. In addition, the diverse nature of IT systems, business processes and the changes required for adoption in the learning institutions has increased the complexity in the decision-making process.

Higher educational institutions stand to benefit hugely from increased network performance and speed, universal accessibility, large storage capacity and significant cost reduction. This would enable the institutions to cut down operational cost, maintenance cost and time, as they invest in both software and hardware systems, as well as all related programs. Cloud computing is also referred to as a scalable form of

computing in which visualized computer resources are distributed among users. For this reason, users do not need to know the origin of the services delivered. This is because the user has the capacity of communicating with several servers across the Internet, since these servers communicate with one another at the same time (Hayes, 2008). Data and applications on the cloud platform could generally be accessed from any location by everyone by connecting to the internet using the required access protocols. Put differently, Shalini (2012) indicated that the Internet forms a large cloud of applications, data and services that are available to customers free of charge or by subscription. The adoption of cloud computing in education is supposed to impact teaching and learning significantly. According to a report by Spreeuwenberg (2012), cloud computing provides an easier platform to access data using many different devices at the same. For instance, mobile devices become more useful when connected to the internet. An example of a cloud computing solution is when various devices such as mobile phone, iPad, Laptop are connected to a server containing database through the internet. Such devices have the capacity for performing a list of functions including, uploading, downloading, processing, storing and forwarding depending on what the user requires at the time. In the cloud setting, some devices like the database and server are positioned virtually and accessed by users remotely with the aid of internet connectivity. This arrangement drastically reduces the cost of operations such as purchase of IT resources. Power consumption and even administration. An effective Service Level Agreement (SLA) pays attention to the time and period the customer uses the resources. Knowing that higher education plays a critical role in developing the socio-economic fabric of Ghana, and the understanding of the difficulty of government to fund all projects of the public universities, cloud provides the leverage for higher institutions of learning to execute big IT projects at less.

1.1 Research Problem Statement

Modern businesses rely immensely on ICT to succeed and contribute significantly to the economic development of nations across the globe. However, the processes and procedures involved in the acquisition, installation, maintenance, and operation of computer systems involves huge financial and human resource commitment from organizations such as tertiary institutions. One way to help reduce the high cost of centralized or in-house computer assets is by adopting cloud computing.

Cloud computing has trended in recent years due to the advantages it offers over the traditional method of owning computers. This has led to its adoption by several institutions even though some of them have little knowledge on what to expect during the implementation (Joint (2019). This concern has assumed urgent prominence as most studies on cloud these days are wading into. According to Rohan and Dhanamma (2017) and Keshavarzi et al. (2020), |while a lot of research is ongoing in the area of cloud technologies, there is equally an urgent need complete understanding of the business-related issues in cloud computing". Mary and Rodriques (2011) indicated that academic research on cloud computing and migration, and assurance of customer trust is practically minimal. In Ghana for instance, literature on migration of computer systems to cloud is very scanty, leading to a limited understanding for the phenomenon. Even though some work has been completed on the model of trust and the strategies needed to adopt cloud computing, the cost of migration and security remain topics on the front burner as the hunger for cloud keep increasing (Faith, 2010). Additionally, when the cost for adoption, benefits and mode of implementation are much clearer, it would help prospective institutions to make informed decisions on the functional area of the technology to consider (Heffner, 2010).

This problem has triggered the need for this study, which is aimed at identifying the challenges faced by higher education institutions in Ghana, especially, The Wa Polytechnic, in their bid to adopt cloud computing.

1.2 Objectives of the Study

Having identified the problems confronting organizations, especially, institutions of high learning in cloud adoption in the previous section, this section is dedicated to the objectives of this research.

Research Objectives

The general objective of the study is to evaluate the issues and challenges involved in the adoption of cloud computing by universities in Ghana with particular reference to the Wa Polytechnic.

Specific Objectives:

The specific objectives for this research are:

- To determine whether Wa Polytechnic has knowledge on the potential benefits of cloud computing on its operations.
- To identify the concerns and challenges in the adoption of cloud computing.
- To determine the main factors that influence the adoption of cloud computing by the Wa Polytechnic.

1.3 Research Questions

This section looks at the questions when adequately answered will lead to the achievement of the objectives set in section 1.2. These questions are:

1. Does the Wa Polytechnic have any knowledge of the potential benefits of cloud computing?

2. What are the challenges involved in the adoption of cloud computing?
3. What factors influence the adoption of cloud computing at the Wa Polytechnic?

1.4 Importance of Research

The significance of this study is directly hinged on the answers got from the key issues to be discussed in *"The main concerns and challenges observed by Wa Polytechnic in deciding to move IT Systems and Operations to the Cloud"*. Cloud computing has several benefits ready for prospective organizations, including higher learning institutions. The significance has been summarized as follows:

First: Wa Polytechnic

- Wa polytechnic through the adoption of cloud computing can develop and optimize its IT processes, minimize network downtime and most importantly, significantly reduce operational cost. This would boost the institution's image and offer the opportunity to compete with other tertiary institutions in the country.

- Provide the IT department with working lessons learned document on the strategies deployed and the recommendations offered through the adoption of cloud by Wa Polytechnic.

- The study would contribute to the world of knowledge since there is limited literature in a specialized area like cloud computing in universities in Ghana.

- Staff of the IT department would learn the importance and skills required for cloud computing in the tertiary institutions.

Second: Society

- This study is the first of its kind in a tertiary institution outside of the capital Ghana, Accra, so would provide the platform for future research in similar institutions, leading to the improvement of IT resource management in universities across the nation.
- Adopting cloud computing by Wa Polytechnic can trigger collaboration and co-operations within the university fraternity not only Ghana but across the globe. This could generate inter work opportunities.

Third: Researchers and Interested Entities

- This investigation could help in drawing the attention of researchers and interested entities to contribute by investing their resources to support future research in cloud computing.
- There are limited studies on cloud computing uptake in institutions of higher education Ghana, this would spur on other people explore the field
- Expand the circle of knowledge in the society by consolidating information to the researcher, by fetching data from both primary and secondary sources

Forth: Self

- The study would increase the knowledge understanding of the researcher in the area of could computing
- Research comes with prestige and could bring workplace promotion to researcher
- This is a stepping stone towards pursuing a Ph.D. degree

1.5 Structure of Research

The dissertation has been divided into six chapters and this section briefly discusses the key areas of each chapter.

Chapter One discussed the general introduction regarding the research, first considering the background information. The problem statement was next, followed by research objectives and the research questions. The significance and relevance of the investigation were discussed after methodology deployed for data collection. Lastly, the scope of work, limitations confronted by researcher as well as the organization of the entire thesis were presented in this chapter.

Chapter Two reviewed relevant literature directly linked to the specific research topic. Definition of key terms used and related theories connected to the objectives of the study were reviewed. The chapter further presented the conceptual framework where the dependent and independent variables were identified, and their relationship established.

Chapter Three discussed the methodology deployed by the researcher to achieve the necessary success during the investigations. It demonstrated how the study was scientifically conducted, including the research design, sampling techniques, sample size and the data collection instruments.

Chapter Four shows data preparation, presentation, analysis and findings from the research.

Chapter Five discussed the results and findings generated in chapter four. Additionally, it provided the summary of findings, conclusions and offered recommendations following the findings made from the study.

1.6 Scope and Delimitation of Research

This section reviews the characteristics that limit the scope, as well as define the boundaries for this study. The boundaries were set in respect of the concerns and challenges of cloud computing in higher learning institutions of Ghana, with specific reference to Wa Polytechnic. Unlike the financial sector, there is scanty literature on cloud computing for universities in Ghana, especially those located in the rural regions. Further, this academic community is well defined, located quite close to researcher, with manageable size of data. Additionally, the participants to be enrolled have been pre-determined in accordance with the objectives set for this research. The participants covered both academic and administrative staff as well as IT professionals within the community. In order to validate the data, some selected professionals including experts within the banking sector, IT experts from the technology industry were used.

1.7 Data Resources

Both primary and secondary data were collected for this thesis.

A. Primary Data

- A semi-structured survey questionnaire on the specific topic of investigation was developed and administered on the appropriate group of persons to collect the right information leading to the achieving the set objectives.
- Experts in the cloud computing world and implementers within the banking sector were contacted to provide expert information that helped in the validation and authentication of the survey data.

B. Secondary Data

- Every research including this requires previously conducted and published literature to help identify existing gaps in the current research area. Pursuant to

that, secondary data was gleaned from articles, magazines, books, websites and the internet.

- Secondary data also helps in giving a better understanding and developing the framework for the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Cloud computing has over the years realized strong growth across the world, offering businesses the leverage to leapfrog in productivity by relieving them from the direct management of computing resources such as software and hardware in house (Masrom and Rahimli, 2015). Researchers such as Microsoft (2019) and Alsanea and Barth (2014) support the increasing usefulness of cloud computing, making it an excellent alternative for various organizations including Higher Institutions of Learning. The International Data Corporation (IDC) which is a renowned entity in analytics and forecasting, provided a forecast in cloud computing from 2015 to 2019. It said that the growth in cloud IT infrastructure spending was determined to be 24.1%, which is approximately $33 billion in 2015, while the annual growth rate for public cloud equipment was expected to 30%. Also, a 1.6% reduction was realized in the traditional IT infrastructure deployment (IDC, 2016), showing that while cloud adoption was in the ascendancy, traditional IT methods or in-house hosting actually reduced.

Cloud computing has continually been adopted by several organizations including higher education institutions across the globe especially in the developed economies. Education is a key function of economic development in the least developed countries where technology is still growing due to poverty. Students have in recent times become technologically inclined making it a key tool in teaching and learning. Due to the dwindling fortunes of universities across the globe, there is a need to find cost effective methods of delivering education, Almajalid (2017). In this case, cloud computing has been identified as the most strategic and appropriate tool in academia to provide the

required benefits. The paper found out that cloud migration improves quality of learning in academic institutions and removes other educational bottlenecks. Additionally, Shana and Abulibdeh (2017) sought to investigate the readiness and the basis for cloud adoption in higher education institutions in the United Arab Emirates with the aid of the Theory of Acceptance Model using 239 preservice undergraduates and teachers. The findings show that the intention to use future technology is affected by perceived ease of use. It was also determined that cloud computing can be used to teach students of higher learning institutions while affecting the behaviors and attitudes of students. Further, Ali, WoodHarper and Mohamad (2018) have determined that even though there is limited literature on the use of cloud in education institutions in Indonesia, the few available studies point to the fact that Universities or tertiary institutions have shown enormous interest for migration to cloud. The paper therefore recommended for further studies to discover the existing systems in the Universities and find best strategies for a cloud-driven educational system for the higher institutions of learning. A research undertaken by Aldakheel (2011) was to investigate the possibility of deploying cloud computing as a learning platform for teaching Computer Science courses so as to remove the geographical constraints as well as improve the understanding of material by students. It was also to compare the traditional e-learning environment with cloud-based virtual classrooms in order to highlight the advantages of moving to the cloud. The study revealed that cloud provides increased infrastructure space, reduces administrative and operational costs, and power consumption. Also, it is expected that school enrollment would likely increase significantly.

2.2 Cloud Computing

Cloud computing may be defined as a combination of technological resources such as hardware and software hosted by a third party and accessed by clients through internet. These servers, networks and applications can be found in a common pool situated somewhere from a few miles to several thousands of miles away and made available to companies and individuals to rent a variety of services including storage to serve specific needs. In over 20 years, students, teachers and faculty have worked with several free mail accounts, with storage space not on user's specific hard drive yet was accessible on the phone and computer. With the same premise now, the range of services available have grown significantly and its integration and use as a tool for academic solutions is undoubtedly very important. Apart from definition provided above, other definitions have surfaced in literature since invention of cloud computing. Organizations such as IBM, Sun Microsystems, Forrester Research and Gartner have proposed various definitions for cloud computing in their white papers. Armbrust et al. (2009) describe cloud computing as the applications provided as services over the Internet, and hardware and system software located in the datacenters of service providers. Vaquero et al. (2009) provided a collective definition for cloud computing by suggesting that cloud is a large collection of easily usable and accessible virtualized resources including hardware, development platforms and services. These resources can be dynamically reconfigured to adjust to different sizes of load, thereby allowing for optimum resource allocation. Traditionally, the pool of resources is typically exploited by a pay-per- use basis as guaranteed by SLAs signed for.

2.2.1 Cloud Computing Architecture

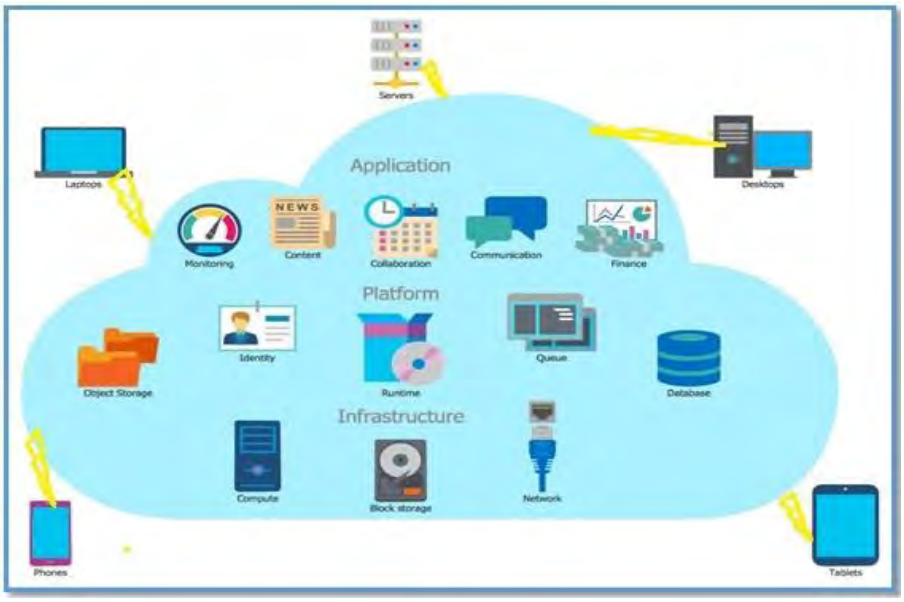

Figure 2.1: Cloud Computing Architecture

The architecture of cloud computing as demonstrated in Figure 2.1 is in two distinct parts, the section in blue color and that in white. The first section or that in blue refers to the storage of various IT resources in an offsite of the service provider's premises. The hardware and software so congregated are available for prospective clients to access. The white section shows various IT tools used in accessing the services from the cloud. These tools include phones, tablets and computers. However, per NIST (2014) the architecture of cloud systems consists of four layers referred to as hardware or datacenter layer, the platform layer, the application layer and the infrastructure layer.

Hardware layer

This layer is mandated to manage the cloud's physical resources including the networks and server components. Hardware layer is usually implemented at the physical site of the organization hosting the cloud services.

The Infrastructure Layer

In this layer, cloud storage resources are created then the process of virtualization is used to partition the physical resources. The assignment of dynamic resources is a key feature of this layer and it's made possible through virtualization technologies.

The Platform Layer

The platform layer provides an environment for development and running of applications by cloud customers without the client being concerned with building the infrastructure.

2.2.2 Cloud Service Models

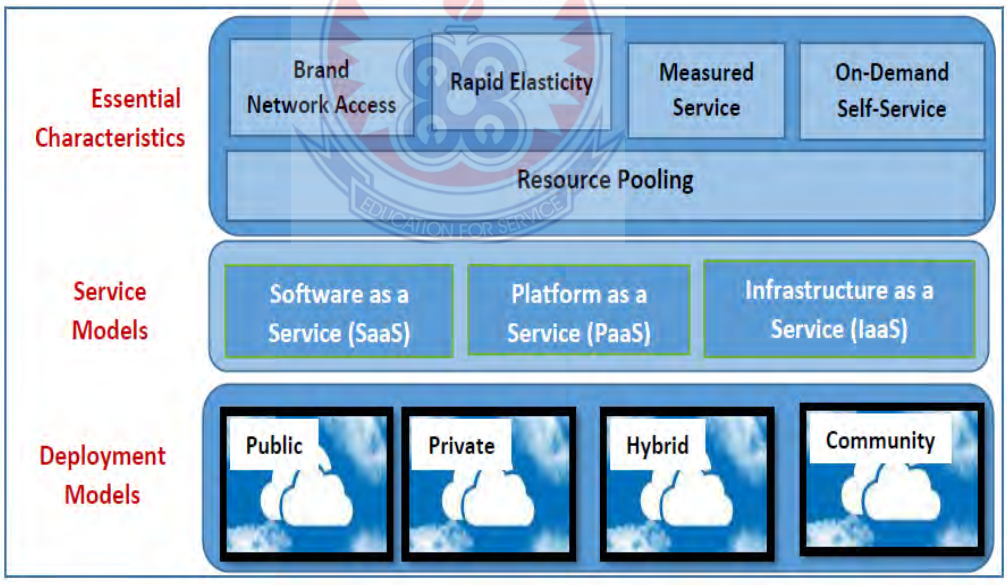

Figure 2.2: Integrated Model for Cloud Computing

The integrated model for cloud computing is represented in Figure 2.2. It depicts the Essential Characteristics, represented by broad network access, rapid elasticity, measured service and on-demand self-service; Service Models, represented by software as service (SaaS), platform as a service (PaaS) and infrastructure as a service (IaaS); and Deployment Models, consisting of public, private hybrid and community.

Under this section only the service models of cloud computing would be discussed.

Software as a Service (SaaS): In the late 1990s, development of software service models came in different forms including Business Services Provisions (BSP) and Application Services Provisions (ASP) (Kern et al., 2002). The ASPs around this period experienced many technical challenges such as low internet speed and bandwidth. This made ASP unaffordable by most IT companies and software vendors were reluctant to push these solutions into the market as the ASP solution did not allow the sharing of IT infrastructure and application codes with their clients. These technical issues gave rise to the emergence of SaaS. According to NIST (2014), SaaS made it possible for applications to be accessible on demand online using web browsers. The cloud infrastructure such as servers, network and storage platforms, is not managed by consumers. Other Authors who talked about SaaS include (Youseff, Butrico, & Da Silva, 2008) who highlighted that SaaS is one of the first levels of abstraction in the three cloud computing layers which provide services to the users and at the same time hides the components of the infrastructure from the users.

Platform as a Service (PaaS): PaaS offers a platform for development and running of applications by cloud customers without the customer being concerned about building the infrastructure (NIST, 2014). Some of the benefits of PaaS is community building as a lot of people are always involved in building cloud applications in PaaS environments. The advantage of this is that it creates a strong supportive environment for development, making it less likely for companies subscribed to it to run any upgrades or patches themselves. These companies are not bothered with upfront investment costs (Rashid and Chaturvedi, 2019).

Infrastructure as a Service (IaaS): Consists of cloud computing resources that is offered as a service, this includes virtualized computers with guaranteed processing power and reserved bandwidth for storage and Internet access. This is usually the lowest level of abstraction offered by cloud providers. The customer does not have the capacity and capability to manage or control the physical infrastructure. The only area the client has control over is in the virtual environment where the customer has access to provision and deploy resources namely network and storage (NIST, 2014). This technology aids to solve compatibility issues because applications and operating systems are supposed to hide hardware from customers. Examples of Infrastructure as a Service, IaaS models are Amazon EC2, Windows Azure, Rackspace and Google Compute Engine (Borko and Amando, 2010).

Even though cloud computing is fast becoming a significant technological tool to provide institutions including education with competitive advantage over the traditional method of IT, many organizations are still stuck with the latter methods of system management. This has significantly increased operational expenditure, for both hardware and software due to storage space, system upgrade and maintenance (Onyango 2016). The author identified three main service models in cloud computing including, Software-as-a Service (SaaS), Platform-as-a Service (PaaS) and Infrastructure-as-a Service (IaaS). According to the paper, these three models may be deployed in one of three ways namely, Public Cloud, Private Cloud and Hybrid Cloud (Community Cloud), depending on existing applications of the institution involved. It also noted that, despite the benefits gained in terms of reduction in total costs of acquisition or ownership (TCO) of software, hardware and skilled labor, there is still a gap in cloud adoption in higher institutions of learning due to security challenges. Trust issues remains critical concern between institutions and service providers, thus, keeping

the solution beyond the reach of the former. It was determined that resources, confidentiality, integrity and availability formed major challenges to cloud uptake in higher institutions of learning. With this beautiful research, the writer recommended that all institutions intending to migrate to cloud must first resolve these issues.

2.2.3 Cloud Deployment Models

Depending on the customer preference, there are key considerations before moving applications to the cloud. Such factors include high availability, secure environment of services and low of operating cost. Different cloud models provide different benefits to the customer. NIST (2014) brought to the limelight different cloud models to handle customer preference such as public cloud, private cloud and Hybrid cloud.

Public Cloud

In this case, CSPs provide resources to the general public. It can be accessed by the customer upon paying a fee as this service is mostly provided over the internet (Jansen and Grance, 2011). A public cloud may be configured as a web service that allows users to manage computing resources hosted by the public cloud via a web interface. The services provided on the public cloud are usually accessed by the customers on demand. The customer through the public cloud can allocate or de-allocate resources at will. The core infrastructure of the public cloud is shared between many organizations however; there is a logical segregation of each organization's application and data. Public clouds are cheaper as they do not require any capital expenditures and it eliminates the challenges organizations face while deploying new applications. Maintenance cost on the public cloud is eliminated (Gunasekaran *et al*., 2019).

Private cloud

is hosted in the customer's datacenter in a private platform. Private cloud is not shared among multiple companies. Private cloud is also known as enterprise cloud or internal cloud. Private cloud provides more control of the infrastructure to customers as it is hosted at the customer's location. It is also scalable as it can offer on demand services to sooth the needs of the customers (Orellana *et al*., 2014). Private clouds have some advantages over the public clouds as it allows organizations to have more control and it gives some organizations especially financial institution higher level of confidence of security for their sensitive data. Private cloud performance is perceived to be faster than that of the public cloud as private clouds are usually deployed inside the organizations firewall, compared to public clouds

Hybrid cloud

is a mixture of the private cloud model and public cloud model. This type of cloud model is normally used by some organizations that want to optimize their resources by controlling and managing the core activities themselves using a private cloud and then deploying non-business critical services to the public cloud (Dillon *et al*., 2010). This type of cloud model was also highlighted by Marston *et al*. (2011) saying that hybrid cloud is a type of cloud model where business critical services are managed by the organization and non-critical services are outsourced to the public cloud.

Community Cloud

is a cloud model where different organizations share cloud computing services to support specific communities having shared policies, values and compliance considerations (Marston *et al*., 2011).

2.3 Cloud Computing Concerns

It has become very certain that cloud computing is the major strength around the success of some businesses especially, in the education front, yet it has some issues when not resolved can destroy the benefits. These challenges according to Paresh Solanki (2020) are real-life ghosts that tend to haunt the cloud computing space. The trend of challenges predicted for 2021 are:

1. Security of Data

Threats such as virus attack and website hacking are the major problems facing cloud computing and data security. Before deploying any cloud computing technology, it significant to make sure that institutional data due to be transferred to a third party has a strong cloud security and management system in place. It is estimated that 9 out of 10 cybersecurity experts have high concerns for the violation of confidentiality issues, privacy of data, data leakage and loss.

2. Insufficiency of Resources and Expertise

It is determined that inadequate resources and skills form part of the cloud migration challenges in 2021. A survey conducted by RightScale shows that while 75% of respondents said it was a challenge, 23% indicated that it was a very serious problem. Despite the efforts by IT staff to improve their level of expertise in the cloud environment, employers are still finding it difficult to recruit personnel with the required expertise. The Robert Half Technology Salary Guide for 2019 reveals that organizations tend to prioritize the tech employees based on their acquired skills in current and trending areas like mobile, cloud, bid data, security and open-source.

3. Complete Governance over IT Services

IT has no way of providing full control over infrastructure delivery, provisioning and operation within the cloud-oriented globe. This has raised the issues on the ability of IT to offer the best of governance, compliance, risk management and data equity. In order to eradicate the various forms of difficulties and uncertainties and surrounding cloud, the conventional methods of controlling and managing IT procedures should be embraced. This has resulted in the diversification of the job description of IT experts to include cloud computing. IT plays a crucial role the mediation process, preference and control of cloud services. Moreover, the third-party CSPs or management providers are eventually giving the best practices and management support to clients.

4. Cloud Cost Management

Also, the RightScale report showed that some organizations identify security as the biggest cloud challenge in terms of expenditure. According to their predictions, companies spend up to 30% of the investment made for cloud migration on security alone. Several mistakes are made by companies that result in the appreciation of project expense. Some IT professionals such as software developers, sometime run time-based programs and forget to turn them off even though the operational period is elapsed. Other companies fail to see some hidden charges provided in packages with several discounts but may never be used. This is to convince clients to pick up packages they do not need by virtue of the fact that some attractive discount has been introduced. There are ways in which clients can help monitor their level of expenses in relation to cloud rollout. For example, the application of server less services, containers, cloud spending management solutions, auto scaling features and several other management tools provide the needed assistance to lower the possibility of mismanagement in terms

of project cost. Furtherance to this, other companies have been very successful in building core cloud management teams, responsible usage and costs.

5. Dealing with Multi-Cloud Environments

Currently, most companies are not operating on only a one cloud system. As revealed in the RightScale report, almost 84% of companies are using multi-cloud mechanism and 58% operate under a strategy that combines both the public and private models. Following this, other organizations are using five different private and public cloud strategies. Therefore, a long-term assessment of cloud computing technology into the future poses more difficulty to IT infrastructure teams. To resolve such a challenge, professionals within the domain have suggested that practices such as training of staff, rethinking procedures, active vendor relationship management and tooling.

6. Compliance

Compliance forms part of the core challenges encountered by cloud implementation in 2021. Especially, everyone using cloud services like storage or backup comes face-to-face with this problem. Anytime a company moves data from its internal storage to cloud completely, compliance with the policies and regulations underlying that sector must be considered. One of the interesting aspects of governing the General Data Protection Regulation (GDPR) stipulates that it will hasten compliance in the not-too-distant future. Most companies need to recruit people with data protection background who can anticipate the privacy and data security requirements in accordance with existing law. If professionals who are very mindful of compliance requirements are recruited, they can concentrate on their responsibilities in compliance which will help organization meet its legal obligations.

7. Cloud Migration

Even though releasing a newly developed app into the cloud space is very simple, the transfer of an existing application to cloud environment is not easy. Per the report in review, 62% indicated that the cloud migration projects they undertook were tougher that they expected. Additionally, 64% of migration projects attracted more time than anticipated, while 55% had budget overrun. Particular migration challenges were encountered by some organizations and they include, data synchronization before cutover (40%), migrated tools working well (40%), downtime during migration (37%), slow data migration (44%), security issues with configuration (46%) and large troubleshooting time (47%). In finding solutions to these migration problems about 42% of IT experts wished they had expended more money, 50% of implementers said a longer project time could have averted the issues, 45% found the solution in an in-house professional and should have therefore recruited one, and finally, 56% wished they had more pre-migration testing conducted.

8. Vendor Lock-In

In this present day, top giants in the cloud business such as Microsoft Azure, IBM Cloud, Google Cloud Platform and Amazon Web Services are ruling the public cloud market. In the view of IT experts from enterprise and analyst groups, this provides security for the vendor lock-in spectre. During a Hybrid Cloud assessment, nearly 90% expressed high to moderate concern for this challenge. In Gartner's Loud Adoption Statistics for 2021, the increasing power in the hyper-scale IaaS providers offer both opportunities and challenges for certain users and market participants. Although a small size of them makes cost advantages and efficacy, organizations need to be more focused towards IaaS providers for possibly procuring unwanted impact over the market and

clients. In respect of the trends in multi-cloud acceptance, some companies ask for an easier way of transferring workload, data, and apps across IaaS service providers space without incurring any penalty. Suggestions from a few professionals indicate that companies must think things over before accepting a specific service no matter how straightforward the offer may appear.

9. Unformed Technology

Most cloud services form the most current and trending technologies such as, virtual reality, machine learning, advanced big data analytics, augmented reality and artificial intelligence. The problem about these interesting and amazing new technologies is that they don't satisfy the needs of the client's expectation in the area of usability, dependability and functionality. However, this can be fixed by managing the expectations of companies by allowing providers to boost services or create a solution.

10. Cloud Integration

Finally, most companies, particularly, those using hybrid cloud systems have issues with the integration of their in-house apps and tools into the public cloud model. According to a survey conducted in line with this issue, 62% of the respondents indicated that integration of legacy systems provide the biggest challenge under a multi-cloud environment. To corroborate this, 39% of the respondents in a Software One report on the cost of cloud survey revealed that the integration of existing systems formed one of the major headaches in the use of cloud. This challenge, just like the others discussed under this subsection are not likely to disappear in the nearest future. A combination of cloud-oriented apps and existing systems requires the commitment

of some level of resources, time and expertise. However, some companies have the opinion that cloud computing dominates the issues raised.

2.4 Current Trends in Cloud Computing

Norah Trent conducted a study into the cloud computing market in 2019 and the results reported as follows. The research was done in two different time periods; the first is referred to as the historic period covering five years, from 2014 to 2018. The second spanned between 2018 and 2022, called the forecast period, and analysis indicate that the total value of cloud market on the global stage was $325.1 billion 2018. This represents a growth by 10.7% since 2014 at a Compounded Annual Growth Rate (CAGR) and is projected to further expand to almost $528.4 billion by 2022 at a CAGR of 12.9%. The cloud service market increased during the historic period because of the growing preference for cloud network instead of the traditional in-house infrastructure, which observed as strategy to reduce cost of operations. Further, reduced interest rates, increased global internet penetration, advanced technology, favorable government regulations and initiatives, and better cyber security environment were responsible for the market expansion within the historic period under discussion (Trent, 2019). The cloud computing technology according to Kumar (2019) has great benefits such as; system efficiency, scalability, business agility, does not require huge capital for initial investment, and more importantly provides a lot of cost savings in terms of operations. The author corroborates the position of Norah Trent that the development of fast internet and advances in technology and the development of intelligent software have created an enormous opportunity for anyone to access technology from any corner of the globe with just a click on a button. He further explained that the cloud is basically a virtualization of software and hardware, and the service architecture associated with it, as well as many more value-added services. As part of the emerging trends in cloud

computing technology, most businesses, irrespective of their size find the phenomenon as a viable option to increase efficiency and productivity. This is mainly due to its flexibility, easy deployment and cost saving effects; however, cloud infrastructure must be properly complemented with a solid security and backup regime.

Another global cloud computing market survey was performed by Adroit Market Research and reported by Globe Newswire on May 30, 2019. The projections according to the report shows that the global market size will grow to a value of $696.25 billion by 2025, recording the fastest CAGR growth over the forecast period compared to that made by Kumar for 2022. The study noted that the factors driving this trend are increased operational cost reduction, enhanced agility via automation and advanced customer experience. The report also highlights that the adoption of cloud technologies by organizations has the propensity of reducing annual operational cost by as much as 35%, apart from its functional capabilities which are leveraged by organizations to increase business performance and returns on investments (Adroit Market Research, 2018).The global market on cloud computing has been categorized under small, medium and large size organizations, as a result, the applications are also divided into Manufacturing, Healthcare (mHealth), IT and Telecom, Aerospace and Defense, Retail, Government, Utilities and Consumer Electronics. In a different market survey on cloud computing in Southeast Asia, the value of the market is expected to reach $40.32 billion by the end of 2015, which is largely driven by the upsurge of demand for the technology by most emerging small to medium business organization in the region. It is believed that cloud computing technology is the springboard for small businesses in small nations such as Indonesia, Myanmar and Thailand to gain better connectivity to the world stage to enable them to compete favorably (Adroit Market Research, 2019).

The team managing the IT resources at the Community College of Denver deployed Cisco Meraki to connect wirelessly 1,200 staff/faculty and 8,000 students across three urban campuses and another network management tools to provide access through the cloud. In another scenario, Western Carolina University in North Carolina used VMware cloud-based Workspace ONE to provide 12,000 students access to academic applications from any part of the campus and from any device. A report generated by Absolute Markets Insights made a prediction on the global market for cloud computing in 2019, indicating that higher education will experience an upsurge in use of cloud resources, hitting $53 billion by the end of 2027 (Blaisdell, 2019). The report further noted that most educational institutions were implementing Software as a Service (SaaS) solutions to satisfy the needs of researchers in the academic space as well as bolster the performance of students. The author further submitted that Ernst and Young (EY) estimated that there exist about 260 international branch campuses across the globe, up from 170 ten years ago. This confirms the fact that institutions with multiple branches are collaborating with CSPs to restructure and design centralization. The report also indicated that most industries, ranging from healthcare to manufacturing and retail are deploying cloud computing to enhance productivity, and explained that many educational institutions of higher learning already have experience in the use of free or low-cost cloud-based tools like Google G Suite to effectively operate.

2.5 Applications of Cloud Computing in Higher Institutions of Learning

In order to resolve today's challenges, education is focused on moving from conventional methods of learning to the development of specialized skills and abilities. This will enable students to apply a newly acquired unique skillset to provide out of the box and innovative solutions to complex problems confronting the world. As indicated in the variety of definitions provided in this study, cloud-based solutions make

hardware and software the sole responsibility of the Cloud Service Provider (CSP). This relieves the migrating educational institution of the procurement and maintenance of expensive IT resources in house. With this arrangement, deploying entities can focus directly on the core business of imparting knowledge. Once migration is complete and all the learning resources have been sent to the cloud, educational entities no longer spend to maintain a large size of hardware on campus. All the hardware procured to run the learning infrastructure is entirely managed by the CSP. This helps in providing significant savings in fixed, administrative and operational costs. Since cloud solutions are provided across the web, the concept of geographical barriers is cured. An institution in Accra can easily offer courses to students in its campus in Wa, just as it can enrol students from other countries. Such courses are managed seamlessly across the cloud where geographical learning barriers have been eliminated. Also, cloud solutions are built around agility which provides educational institutions with the capacity to improve learning material quickly in a minimal period of time at very low costs. The usual elaborate printing resources are cut out as updates and editing of study materials are executed over the cloud infrstructure because they are in digital form. Traditional forms of learning can lead to monotony, which tends to affect the level of motivation for students. However, learning resources on the cloud can be diversified into several multiple media including online tutorials, online assignments, online announcements, quizzes and videos, etc. This learning process would would not only generate more interest and fun but also make students more engaging over a long period of time.

Scalability is one of the characteristics cloud computing and since the demand for resources in the educational institutions is very seasonal in nature, such as admissions, examinations and evaluations, cloud allows to scale resources in real-time. This comes

without any hidden costs, thereby making it as cost effective as it prevents redundancy costs. Additionally, learning materials form one of the most valuable intellectual properties of learning institutions, requiring high level security. SCPs have the mandate to security so they invest heavily in securing the cloud base solutions against any form of intrusion. Students therefore remain connected to the learning environment 24/7 with no fear of data insecurity. Cost savings recorded by institutions due cloud deployment can channel such resources in lucrative ventures such as Research and Development (R&D) which is an initiative core to the engine for innovation. The cost savings can also be used to provide scholarships for knowledge seekers who are brilliant but needy. Because learning material reside in the cloud, students have the opportunity of accessing them around the clock. The greatest advantage in this case is that students are able to access academic resources via multiple devices such as desktop, laptop, tablet or smartphone, anytime anywhere. Cloud is the main enabler of the environment that is conducive for virtual or distance learning. This helps institutions of higher learning to eliminate vast development of campuses and maintaining them. The physical footprints of Colleges, Polytechnics and Universities can be significantly reduced and replaced with the virtual method of delivering courses. For students, this is big relief to physical showing on campus, the struggle to register and stress of finding a hall of residence and paying for it. With a fully virtualized learning infrastructure by courtesy of cloud, students submit their quiz, assignment, examination and any other designated evaluation document over the Internet, from the comfort their office or home.

This provides the opportunity of education access to a new market segment which has the drive to improve their academic credentials but do not have the enabling environment due to administrative and financial constraints. For instance, the job professionals who are unable to leave their jobs due to distance, stay at home moms,

people with some forms of disability, and low-income earners. As learning resources are made available and accessible under cloud computing, parents and guardians can become part of students' progress. They can have a taste of real time access to student's performance and intervene as and when it is necessary.

Finally, most professionals fail to make it to higher education because of financial constraints as already indicated, and others are under compulsion to become financially self-reliant before. However, in most of such cases, by the time they become financially established with an excellent career, it becomes too late and unmanageable for them to pursue such a goal. But thanks to cloud computing, such professionals are able to combine academic work with their career and pay for academic training at a more manageable rate. This gives the right of degrees to the ambitious professionals at every level and phase of life.

According to Hayhurst (2020), cloud-based environments are helping many higher institutions of learning to manage and deliver services across multiple locations and campuses. The study indicates that more than 800 performing artists were enrolled in 2020 from 42 countries and regions of the globe to stage a performance online. The Juilliard School staged the performance with most the audience observing proceedings from nearly 7,000 miles away. This was made possible by the long arm of cloud computing.

2.5.1 Benefits of Cloud Computing in Higher Education

The previous section mentioned some general areas of benefits of cloud computing for higher institutions of learning. This subsection would discuss specific benefits or advantages of cloud migration by educational institutions.

1. Improvement of Institutional Productivity and makes Academic Processes More Efficient

One of the commonest applications of cloud is e-learning, b-learning programs and traditional courses which have the academic resources online. At the same time, access to online text books and academic materials in the cloud has significantly increased as digitization of documents is fast rising. This makes it possible for people from different campuses and institutions to access the same material online simultaneously, thus democratizing the access to information in real-time and decreasing the cost of managing and physical inter-departmental loans. Applying to the management of student's records reveals that management is more effective and efficient for institutions with different buildings and campuses, where students work from different locations at the same time in the same day or from abroad. For example, an academic document can be printed and placed in a central archive for different departments of the university to access copies online from any part of the campus at any time. Students can enroll in courses and participate in group activities as well.

2. Cost Reduction

Cost of information technology and operational investments are significantly reduced, since institutions pay for only services and storage required. Cost of electricity is also reduced as consumption rates go down due to the outsourcing of server and data centers and other hardware to the CSPs. The technical team and software engineers at the IT department can then concentrate on the provision of high-quality campus services, by efficiently managing the cloud operations in campus as well as coordinating and synchronizing all the online services with the rest of the institution's systems. Particular software packages can be rented and used within a period of time, in a particular place

and for a particular program by educational institutions such as the Wa Polytechnic, this reduces the cost compared to acquiring software licenses for a reduced number of computers.

3. Enhances Collaborative Work

Students, faculty and administrators alike can have access to information from individual and personal computers with no need to install specific program. This provides flexibility and collaboration among faculties and departments. As one area supplies records for storage at a common repository, another provides other documents. At the same moment, text files, forms, spreadsheets and presentations can be update or edited by different staff at the same time from other computers located at different parts of the network. This results in the efficient allocation and distribution of tasks, leading to the improvement in the quality of information and quick feedback.

4. Backing Up of Data and Information

People with extensive IT knowledge and software professionals call this "redundancy", a situation where the same data is saved in more than site. Cloud computing offers the opportunity for storage of large information in server farms or data centers across the world. This guarantees the speedy access at any moment, and recovery of data in case of any physical or digital problem that results in malfunction of original systems. In the unlikely circumstances when a particular server or the university network is threatened with damage or loss of critical information, the cloud brings back normally.

5. Improvement Filing and Access

In the traditional method, there is always limited storage for physical digital data, but with cloud, the process of working, filing and delivery historical archives and data are

properly managed. Such records as financial information and alumni records can easily be kept and pulled out when needed.

6. Aids Financial and HR Management

It is possible for lecturers to manage their paycheck online, while a financial management system externally processes payments and manages timestamps. This enhances the proper accountability of financial reports to external parties, and assists in focusing on the employer-employee relationship concerning academic issues. In some jurisdictions, Higher Institutions of Learning deploy cloud for payment and administration.

7. Improves Accountability

As it is imperative on universities to adduce more proof and indicators to show academic quality, cloud provides the platform to facilitate documentation and registration. The staff of universities do not need to spend several man hours trying to collect, select and analyze large amounts of data, all they have to do is upload it to the system for all to access. Additionally, it helps in keeping the confidentiality of reports in the form of academic performance survey as well as in the collection of external assessments such as standard curriculum reviews or requirements for higher education placements and examination. Cloud is very elastic because it has room for increased demand for IT resources by the institutions. This variability provides solutions to increased enrollments at any time, for instance, the demand for applications directly associated with undergraduates and graduates.

8. Minimal Hardware Requirements

Migration to cloud comes with a significant reduction in the use and demand for hardware resources. Such applications can be operated seamlessly on search engines using desktops and mobile devices. This makes it easier for students to learn even on their personal hand-held devices. It is therefore no justification for investing on expensive computers in order to take courses. Also, there is totally no need to acquire huge external storage devices because such resources are provided by the CSP. This leads to a very simplified and easy method of learning for students.

The benefits of cloud computing in the educational environment are quite enormous as outlined above under the eight major headings. It is therefore not surprising that major service providers within industry are turning to cloud technology to enhance the quality and quantum of delivery. In the same way, cloud is becoming the best option for students and institutions in which they learn. Nothing can be compared to the convenience occasioned in the access of learning at the click of a button, made possible through cloud. Irrespective of the size of the university, every institution and students are fast enjoying the advantages of moving to the cloud, it is going to be bigger in the future. These benefits have been amplified as per literature provided by great researchers. A research conducted for the development of an empirical model for adoption of cloud computing in higher education institutions and the strategies for adoption in Somalia revealed that, cost savings is a major factor for consideration during cloud migration Mohammed et al. (2019). This finding was corroborated by Alshamaileh (2013). The paper also found relative advantage over in-house computing as a significant factor that impacts cloud adoption in academic institutions which was supported by Hashim and Bin Hassan (2015). The study further showed that security,

compatibility and scalability are other significant factors affecting cloud adoption within the context. Additionally, cloud computing service providers, technological readiness, speed of availability Internet connectivity and service level agreement are factors limiting the use of cloud service among education institutions.

Attaran (2017) stated that cloud computing is of great value, providing many useful benefits to higher education institutions around the world. The author identified high level capability, reliability, and administration and operational costs reduction as main benefits of cloud adoption. For this reason, parents, teachers and students alike can access information via various devices from anywhere because pricing is often significantly lower than in-house solutions. Lower pricing results in availability, affordability for personalized learning due to 24/7 system accessibility, openness and increase functional capabilities. However, the author was quick to mention the challenges involved in cloud migration which need to be identified, studied, mitigated and overcome before the full benefits can be exploited. These challenges include, security, compliance issues, interoperability, reliability and other implementation challenges. Availability of budget, proper understanding of the system, technology readiness and IT expects seems to hinder the movement to cloud by these academic institutions.

In 2015, Mboungou Mouyabi launched an investigation into the current developments in the adoption of cloud computing at the higher institutions of learning across the globe, with particular reference to universities in Africa. It was determined that the institutions who migrated to the cloud enjoyed some benefits such as operational cost reduction, lower power consumption levels as well as easiness with the management of the IT resources. However, the researcher indicated that the encounters of higher

education with cloud computing is relation that is reflected by the relative newness of the technology and its underdeveloped marketplace in the region Mouyabi (2015).

He is quick to note that the future rate of adoption depends on the resolution of challenges related to resources, risks and best practices. It is also believed that legislation, security, data protection and regional concerns further complicate the widespread adoption in higher education institutions. To succeed therefore, these barriers must be broken for the fulfilment of the journey to cloud. Mahmoud et al. (2015) provided evidence to support the fact that there are numerous benefits in adopting cloud computing by higher institutions of learning but also indicated the constraints that critically limit implementation in such institutions. The paper classified these constraints into managerial and technical and that until they are totally removed it would be difficult to enjoy the benefits. According to the authors, cloud computing facilitates extra learning experiences for students by increasing access to information, thereby enabling data sharing, correlation and collaboration. This is expected to become a more pervasive technology infrastructure component in institutions of learning, but care must be taken so that legal and policy issues do not affect the smooth transition to cloud. In conclusion, higher learning institutions are advised to choose private cloud deployment so that they can enjoy better cloud-based facilities at minimal risk.

To further buttress the importance of cloud to higher institutions of learning, Algelany and Alghabban (2017) in a contribution indicated that the institutions tend to gain benefits such as continuous access to academic materials by students anytime and anywhere, lower cost of operation and access to different types of software and hardware. Also, there would be an increase in academic standards and efficiency. However, just as the previous authors, the paper highlighted the existing limitations and challenges inherent in cloud adoption for higher education institutions. Another study

was conducted in China with the aim of examining the impact of cloud computing, sustainability, performance management and governance in order to develop a cloud computing model for higher education sector. Duan (2016) in this proposed model, identified higher institutions of learning, especially students and academic staff as well as the IT department personnel as the beneficiaries. In addition, software developers, service providers and business entities also stand to benefit from the work.

2.5.2 Use of Cloud Computing to Resolve Challenges in Higher Education

Studies show that cloud elasticity and scalability, and the service models such as IaaS and SaaS provide the perfect ammunition and prescriptions for dealing with challenges and trends in institutions of higher learning at the end of 2018 and beyond. These institutions, by their architecture and design provide an environment that enriches a unique culture of collaboration among faculty, students and administrative staff, which are often displaced by geographical space in various campuses. Currently, nearly 70% of institutions of higher learning in North America have either moved their admin systems to the cloud or in the process of doing so, while 50% have already adopted collaborative systems based on cloud to enable a more efficient transfer and sharing of information across campuses.

Students within the institutions of higher learning are the most demographically networked and highly connected populations. Findings from a recent study reveals university students have 3 to 4 hand held devices they send to campus, and expect to use them seamlessly and synchronized across the IT backbone provided by the university so as to access content as well as fully collaborate with others. In most of the cases, cloud provides the solution towards meeting their expectations. Also, cloud services offer the universities an opportunity to upgrade learning and communication

systems in a most cost-effective manner, no massive capital injection in infrastructure is required. This provides crucial savings in the era of shrinking support from government to institutions of higher learning including the Wa Polytechnic. As pertains in many other sectors, there exist different mechanisms to the provision of technology to the institution. These educational institutions face challenges in the management of ever-increasing data or big data caused by students, faculty information and sophisticated research analytics. Further to that, big data needs high level security governance mechanism to achieve both intellectual and personal property protection. Fortunately, all forms of cloud deployments, whether private, public, hybrid or community have proven to provide the necessary security protection. Another instance of cloud as a tool for providing solutions in the academic institutions is the Massive Open Online Courses (MOOCs) which was first rolled out across the world in 2012 and achieved an enrollment of 1.5 million. However, leveraging on cloud-based technology, the enrollment figures hit 58 million by 2016, with courses offered online by the world's best universities like Harvard, Columbia and Stanford.

Finally, higher education is becoming a very competitive market by the day. As a result, institutions must endeavor to remain attractive to students and faculty by rapidly and continuously introducing new courses and innovative ways of teaching and disseminating learning materials. In this case, the cloud-enabled DevOps is critical for the education sector to maintain agility and competitive edge. Having been identified as a cutting-edge program is very significant for hiring, training and retaining top-level IT personnel with cloud expertise to help sustain the operations.

2.5.3 The Application of Cloud Solutions to Empower the Education Industry

The education sector has experienced great transformation over the years, where teaching and learning are no longer limited to physical hard copy textbooks and four corners of a classroom but reside in computers and mobile devices. Learners in today's world are always connected to academic activities whether they are on or off campus. Technology has been in the canter of this great leap, providing the empowerment to those with career-ready and real-world skills. In the past, it was unimaginable for a student to be in one part of this world and pursue a course in a college located thousands of kilometers away. One of the best technologies responsible for driving innovation for this industry is cloud computing, which is helps in shifting the emphasis from physical resources and interactions to virtual ones. The inherent versatility and flexibility in cloud solutions make them the most suitable tools for many sectors including education which leverages on cloud to deliver great results. The education sector has actually evolved very fast courtesy of technological advancement.

2.6 Factors Conducive for Cloud Migration in Higher Education

The biggest advice from IT specialist based on their collective experience over the years to prospective organizations wishing to migrate to the cloud is that, they must pay real attention to every aspect of change management during transition to the cloud. The factors worth considering during migration include:

- **Cost/benefit Analysis:** Kushida et al. (2015) strongly recommended for a strong review of the transition into cloud so as to determine the potential benefits. A thorough and comprehensive Returns on Investment (ROI) must be strictly conducted at least four months to the actual migration. According this paper, the analysis of the pre-migration analysis revealed that the exercise was going provide savings of 34% over a period of ten years.

- **Communication:** The research also indicated that transparency was critical in the success. There should be open dialogue and collaboration among all stakeholders, especially between the IT team and other staffs to ensure the right things are done.
- **Leadership Buy-In:** Furthermore, the paper indicated that there must be consensus building but most especially, leadership must accept the concept and be ready to make funding available for execution. Due to the enormity of the project and the investment, everything must be done so as not compromise the network. This will make sure that everyone on the project team would properly understand the execution strategy as they move along.
- **Education:** The authors determined that there were feet dragging from the IT department during the transition. There was in fact a struggle because change in job descriptions within the IT domain was going to happen as more people would come in. It was therefore important to educate the staff about the upcoming migration and the opportunity to get training and skills development as they move to cloud. It was also observed that panellist responsible for give approval to the project determined some unexpected benefits from the migration to cloud, which included a more transparent window in the real cost of managing data. Apart from that, the ability introduces the IT team to the current and trending technologies as well as a shift in culture across campuses for more collaboration among them.

To further consolidate the factors critical to cloud implementation, some extra literature from different jurisdictions were reviewed and the findings aggregated. An experiential research was conducted by Avish and Sunanda (2016) in the Maharashtra state of India aimed at understanding the factors that affect cloud adoption in higher education

institutions. The statistical program, SPSS was used in analysing the data, and the findings show that three main factors had significant impact on the phenomenon. It was found that relative advantage, complexity and data security were the most critical factors. The findings further provided education institutions and cloud computing service providers a better understanding of the factors affecting cloud uptake. Odeh et al. (2017) conducted a study with the aim of understanding related factors affecting the adoption of cloud computing in higher education institutions in the Kingdom of Jordan. The paper used qualitative research methods with an interpretive paradigm to investigate the main enablers and barriers to adopting cloud computing in Universities of developing countries with particular reference to Jordan. Findings from the study suggests that cloud computing is strongly recommended by technical professionals and academic experts for higher education institutions in developing countries. The authors revealed that enablers of cloud migration as cost effectiveness, improvement in knowledge sharing, ease of use, ability to use cloud applications, compatibility with hardware and software, while barriers of for adopting the technology include, security, privacy, top management understanding of the system and its benefits and limitations.

Sabi (2014) conducted an investigation into the level of awareness and diffusion of cloud computing within universities in the Sub-Sahara Africa (SSA). This was begun on the premise that technology is quite low in Africa compared to the Western world and knowing that we now live in a global village, there is a need to find ways of finding ways to equal the technology advancements of the developed economies. Whereas Africa is challenged with socio-economic and political problems which tend to impede investments in IT infrastructure for universities, the developed countries have an edge in technology required for teaching, collaboration and research work. Using methods of triangulation of constructs from diffusion of innovation theory and technology

acceptance model, the factors affecting diffusion and adoption of cloud computing at universities in developing countries were determined. The finding was to be used in developing a cloud migration model to help decision-makers at the universities take make appropriate choices. Instead of investigating cloud computing implications in regional universities as per the last study, Mansour (2013) opted to limit the research to the Islamic University of Gaza (IUG). The investigations, aimed at identifying the challenges of cloud adoption in this university used descriptive analytical method to study the impact of Top management support, Skills of IT personnel, Support and integration, effectiveness of Security and cost reduction on cloud computing at IUG. It was determined from the results that there exist significant relationships between cloud computing and all the independent variables mentioned above. The writer recommended that IUG can go ahead and migrate to the cloud by first training the IT personnel, migrating only the non-critical applications and data to the cloud and by using the hybrid model of cloud computing.

2.7 Implications of Cloud Computing in Academic Research

Momentum in cloud computing is mounting even among researchers. Amazon Web Services (AWS) and Google have each committed funding worth $ 20 million for research related to COVID-19, while Microsoft pledged some amount of cloud computing resources towards COVID testing and development of vaccines. CSPs are also collaborating more closely with researchers to support in the optimization of cloud-based tools. There appears to higher level of collaboration from CSPs on the understanding of how research is done in the cloud environment.

With the certainty of universities reopening after a long break due to the impact of COVID-19, faculty, staff and students need to be agile enough to evolve the situation changes demanded by the pandemic. In this situation, cloud presents several opportunities to help institutions focus and continue academic operations. Cloud happen to offer businesses the capacity to be responsive to unpredictable moments and the opportunity to significantly reduce or expand the cloud footprint quickly Epstein (2019). For instance, computing technologies for end-users like virtual desktop infrastructure (VDI) solution offers consistent and manageable environment for staff working virtually on any type of platform. Also, cloud enables IT managers and their team to perform some defined responsibilities without being at the data center. Cloud-oriented deployments can be executed from API remotely, according to the author. Cloud migration currently may appear counterintuitive, even though it solves some of the very important challenges which ultimately allow organizations to reduce risk and in innovation.

2.8 Implementation of Cloud in Higher Education

This section looks at the reasons which will compel any institution of higher learning to opt for cloud and how it should be implemented to achieve the utmost success. Not only are the phases of migrating to the cloud is treated but also the components and steps involved in executing the project. During an Oracle sponsored cloud panel at an EDUCAUSE Annual Conference in Chicago in the US, Konrad (2019) indicated that the reason one has for shifting from on-premises to cloud is peer review which is always necessary to make the transition successful. During this conference, IT leaders from institutions of higher learning shared their peculiar experiences. Each provided the reasons for their migration to cloud. The representative from Gonzaga University

indicated that the institution's administrative software platform needed a major facelift but they did not intend to make huge investments in the on-campus data center. An analysis was conducted to that effect and it was concluded that migrating to the cloud was the best option. Peter Murray, the vice president for IT at the University of Maryland, Baltimore, determined that the newest versions of some of their IT tools were incompatible with the existing platform. The university wanted something that will completely transform and provide a state-of-the-art system, so they decided to migrate to the cloud. The Assistant Vice President of the University of Nebraska, Cheri Polenske did a cost benefit analysis and came to the conclusion that maintaining the traditional on-premises was costly especially, with respect to the student information system as enrollment soared. In addition to that, existing hardware was becoming obsolete and needed change. Comparatively, cloud computing was the answer and so it was selected to provide the solution in order to control cost. In order to shake off the financial hit produced by the pandemic, institutions are seriously reviewing cloud solutions, especially Software as a Service (SaaS) to help eliminate duplications. For instance, one way of migrating out of paid storage to that of free under existing contract is through cloud.

To successfully implement a cloud migration project in the institutions of higher education, they are some key steps required of the project team, project owner as well as various stakeholders. In the case of this particular thesis, ten steps are required as represented in Figure 2.3.

1. **Assemble your Team for Cloud Adoption:** After being certain of moving to the cloud**,** the first action to be taken by institutional authorities is form an implementation team to oversee all related activities. This team would be made

of IT or cloud experts, administrators, faculty, students as well as any other stakeholder deemed valuable in the business. The constituents of the working team is very crucial because each member brings a unique touch to the final output. Everyone would be required to make contribution on the benefits or relevance.

2. **Develop a Business case and Enterprise Cloud Strategy:** After assembling a good cloud implementation team, the next step is to develop a business case and enterprise cloud strategy. This will define the mechanisms to be deployed in executing the project, as well as convince management why it is important to embark on this cloud journey. The team must not to only convince institutional heads to accept the project, they must also lay out an excellent plan for the final; works.
3. **Select Appropriate Cloud Deployment Models:** When the executives are well convinced of the benefits of moving to cloud and the strategy for execution, the implementation team would be expected to choose the most appropriate deployment model that will help achieve success. The type of model used depends on the size and orientation of the cloud intended to be undertaken.
4. **Select Appropriate Type of Cloud Service Models:** The appropriate cloud service model should be carefully considered and selected to meet the requirements and needs of the cloud being implemented. This depends on whether the institutions need software services only, infrastructure services only, hardware services only or a combination of all or some of them. It is only when the service requirements have been evaluated that, the best service model can be selected to serve the purpose effectively and efficiently.

5. **Determine who will Develop, Test, Deploy and Maintain the Cloud Services:** AT this junction, the implementation would through procurement processes to select the right CSP to hand the job. It is advised that three capable CSPs should be selected during tendering and the best selected are a final scrutiny. This involves some level investments and requires that the project be properly executed. This can only succeed if the company is selected based on capacity, experience and expertise, because the chosen company should be able to design and develop the solution to meet all the specifications. It should also be able to effectively test every phase and finally deploy in accordance with the objectives. Finally, the implementing company should have the capacity to provide all the necessary after deployment maintenance to help support continuity.

Figure 2.3: Steps for Cloud Migration

6. **Develop Governance Policies and Service Agreements:** This step is very crucial to the continuity of the services provided. Governance policies include but not limited to applications and use of service by staff, the people tasked with the responsibility to manage the project and the sanctions required during failure or negligence. On the other hand, services agreements exist to define and outline the roles of the CSP and the project owner. In this case, maintenance arrangements, down time issues or service outage coupled with non-adherence are put in place to make project delivery more effective.
7. **Assess and Resolve Security, Privacy and Data Storage Issues:** In the service level agreement (SLA) privacy of institutional data, storage and security are well articulated here, so that roles and responsibilities are carefully assigned to owners of the project and CSP. This will help identify defaulting parties during problems and apply appropriate sanctions.
8. **Integrate with Existing Enterprise Systems:** After successfully testing and deploying the project in the field, it would have to be integrated with the existing institution's system. The tying in of the cloud system has to be done after a test for compatibility is conducted and found to be good. This will in the management of the entire system because the new and the old are well synchronized.
9. **Develop a Proof-of-Concept before performing final Migration:** This aspect involves the analysis and interpretation of the results in terms the objective of the services being sought. The solution must go through quality control to determine if it has the capacity to provide the satisfaction desired after

implementation. The proof-of-concept is very critical as it is a method of approving the investment required.

10. **Manage the Cloud Environment:** When everything is said and done, a team has to put in place to perform management duties over the new system. However, before entrusting the role, members of the team must be trained so that they can discharge their duties to the letter. Putting this group in place would facilitate the early identification of faults and their quick resolution.

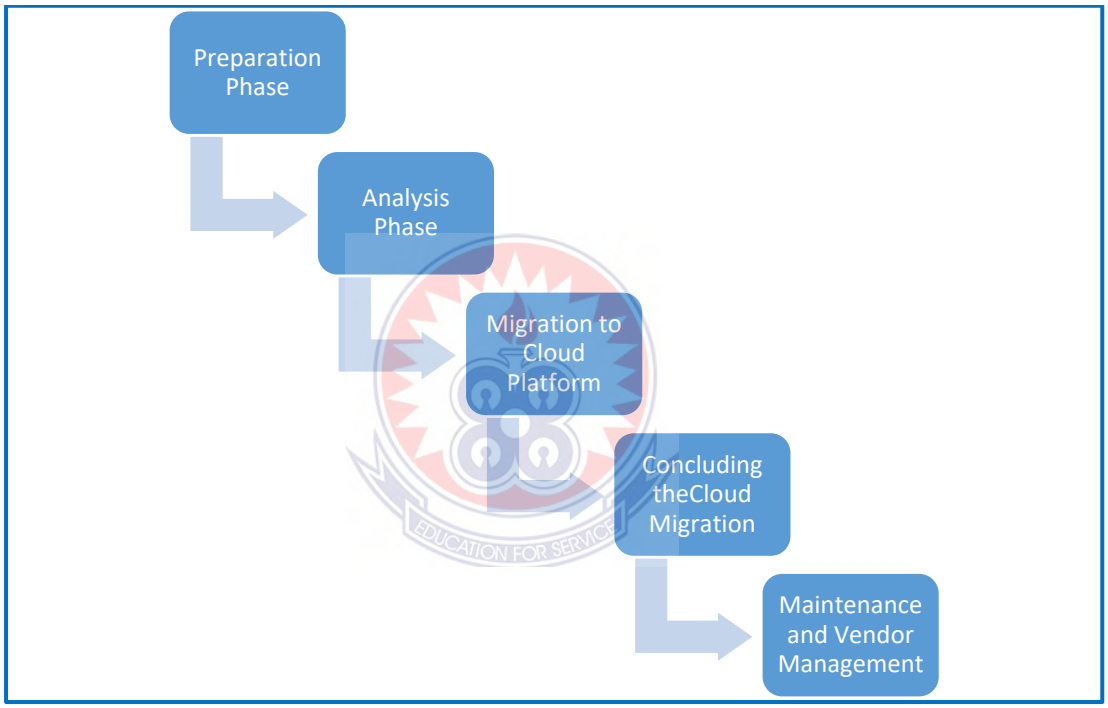

Figure 2.4: Cloud Implementation Phases

The steps taken for cloud migration as discussed feed into the cloud life cycle provided under Figure 2.4. The cycle is made up of five phases namely; Preparation Phase, Analysis Phase; Migration to Cloud Phase; Concluding Cloud Migration Phase; and Maintenance and Vendor Management Phase. The preparatory phase involves hatching the idea to move to the cloud and the necessary documentation and contacts necessary to build the project. The second phase or the analysis phase reviews all the information collected and analysed to determine the feasibility of the project including the cost and

effectiveness of the solution. After being satisfied with results from the analysis phase and setting the environment right, the team then moves into the actual migration to the cloud platform. The next phase is to a conclusion based on the migration. In this phase implementers seek to determine whether or not there are issues or challenges during or after completing the transition. If there are major problems, they have to be resolved before moving to the next stage. The last and final phase deals with maintenance and vendor management where conditions prescribed in the SLA are strictly followed to make sure that downtime is reduced or eradicated.

2.9 Summary

This chapter reviewed literature closely related to cloud computing, especially, its uptake in the institutions of higher learning. The chapter covered areas such as introduction to the cloud phenomenon, definition and concerns in cloud computing. Other areas are, trends in cloud computing, its application and the right conditions for adoption at the universities. The rest of the areas in which literature review was conducted include the implications of cloud in academic research and the implementation of cloud in tertiary institutions.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

There exist several schemes in the design of a research methodology, however, the selection of a particular strategy relies on the researcher and the type of research proposed for investigation. The previous chapter may be considered as part of the methodology since it provided copious secondary data related to the specific research topic. Chapter 3 is used for designing the methodology and techniques employed to successfully prosecute or execute the objectives of this study. The general strategy for the research and technique applied during the collection of the data are illustrated here. According to Perez (2017), research methodology can be defined as the type of activity in research which borders on how to implement and evaluate its progress, as well as the level of success. A research offers a large amount of human knowledge and tools necessary for carrying out the research. The author further reveals that research methodology is a science that studies how research is scientifically conducted.

3.2 Research Methods

The researcher used two of the classic research tools in the social science space, questionnaires and interviews (Sarantakos, 2013). The questionnaire was administered to managers and users of Wa Polytechnic network system including faculty and students. Additionally, some selected IT experts from industry who are good in cloud computing were invited to help validate the data collected. As a complementary technique in the era of the COVID 19 pandemic, the author conducted some interviews over the phone and zoom, and other social media to boost the number of respondents.

Questionnaires

This strategy of questionnaire was selected for this research because, apart from being reliable for data collection, it is fast, more effective and cover any scope of respondents. The incidence of COVID 19 has further promoted the use of questionnaire as the best way of collected data without getting closing to the respondents. In an attempt to respect the protocols of the pandemic especially, social distance, questionnaire provides the needed answers for the purposes of the study because one is not necessarily required to make a physical appearance with people to achieve the object. However, the downside side of this method is its fixed nature, which eliminates the possibility conducting a more in-depth observation (Bell, 2005). The questionnaire is divided into Sections A and B with Section B further divided into Part 1 and Part 2. Also, Part 2 of Section B is grouped under Sections 1 to 5 as published in Appendix A (Questionnaire).

Section A collected the demographic information of the respondents in order to understand the diversity in gender, education, age and years of work experience so as to better understand the biases involved. Part 1 of Section B has several questions asked under Adoption of cloud computing Technology at Wa Polytechnic. This section sought to compare the existing in-house IT system to cloud migration in order to make an informed decision. Section 1 of Part 2 looked at Top Management support for the project and the benefits of cloud computing to the institution. This part was meant to measure the willingness of Management to approve cloud computing, as well as test the knowledge of management on the issue as in research question one. Section 2 of Part 2 considered Support and Integration of the Polytechnic's existing system with cloud computing. This is to determine if the institution was prepared to keep its system as standalone or integrate it with cloud. Section 3 tried to find out if IT staff would gain some additional skills beyond the project implementation as an additional benefit.

Section 4 was concerned with how effective the security would be after moving to the cloud. This was to evaluate the challenges of cloud as questioned in research question two. Finally, Section 5 intended to measure cost implications of migrating to the cloud. In this case the factors influencing adoption, as well as the benefits of cloud come into focus. Both Part 1 and 2 of Section B were measured using the Likert scale, and then validated using Cronbach's alpha in SPSS.

3.3 Population and Sampling Strategy

According to a definition provided by Fraenkel and Wallen (2000), population is a complete set of objects, individuals or events which possess similar properties in which a researcher has interest. Kiwia (2014) also defined population of a research as general items or objectives with common characteristics that can be studied. A population is actually a lot from which a sample size can be drawn. The population of this study was evaluated based on the unique nature of this study coupled with its geographical boundaries. The total employee strength of Wa Polytechnic is 172 as shown in table 3.1, from which the sample size was drawn. By reason of this research, the author examined two distinct groups of respondents: IT staff, faculty and management of Wa Polytechnic on one side and IT (cloud) experts from the industry on the other. A stratified sampling technique was deployed to enable the observation and identification of sub-group relationships. With respect to the IT experts, ten individuals with vast knowledge in cloud computing were selected from top companies in the country to participate in the survey by providing validation and authentication to the data collected.

3.3.1 Sample Size

The sample size for this research drawn from the population was 63 as indicated in Table 1. The sample size was evaluated using the sample calculator represented by:

$$\mathbf{n=N/1 + N(e)^2}$$

Where, n= Sample size

N= Population (number of elements)

e= Level of precision or 10%, since level of confidence is 90%

Therefore, the sample size is:

$n=172/1 + 172(0.1)^2$

n=63.

Table 1: Population and Sample Size

DEPARTMENT	Population	Sample
ACADEMIC DEPT		
ACCOUNTANCY	7	3
AGRIC ENGINEERING	12	5
BUILDING TECHNOLOGY/ ESTATE MANAGEMENT	15	6
HOTEL, CATERING & INSTITUTIONAL MANAGEMENT	3	1
CIVIL ENGINEERING	8	2
COSMETOLOGY	3	1
DISPENSING TECHNOLOGY	7	4
ELECTRICALS/ELECTRONICS	4	2
GENERAL AND LIBERAL STUDIES	7	3
INFORMATION AND COMMUNICATION TECHNOLOGY	7	5
INDUSTRIAL ART	6	2
MECHANICAL ENGINEERING	7	1
PURCHASING AND SUPPLY	4	1
SCEINCE LABORATORY	4	3
SECRETARYSHIP AND MANAGEMENT STUDIES	5	1
ADMINISTRATION		

INTERNAL AUDIT UNIT	2	1
PROCUREMENT UNIT	2	1
FINANCE	8	2
LABRARY	1	1
DEVELOPMENT UNIT	2	1
PLANNING UNIT	1	1
QUALITY ASSURANCE	1	1
REGISTRY	21	5
ESTATE UNIT	30	8
TRANSPORT UNIT	4	1
INDUSTRIAL LIASON	1	1
TOTAL	**172**	**63**

Source: Survey Data (Alhassan Saeed, 2021)

3.4 Data Collection Methods

Data was of two types, primary data and secondary data. The secondary data was gleaned from journals, online magazines and directly from websites which publish papers directly related to the specific topic area. Some of the important websites from which data was collected include, SciHub, CORE, ScienceOpen, oaDOI, Library Genesis, CSULB, PDF Drive and direct Google searches. More than 100 results were returned and subjected to scrutiny in accordance with the research topic. This criterion of selection demanded the use of key words such as cloud computing, cloud migration, cloud security as well as adoption of cloud computing in higher institutions of learning. At the end over 50 papers, journals and thesis met the criteria. These papers were further subjected to critical review by evaluating their abstracts, introductions and conclusions, leading to the identification of the research gaps.

With respect to the secondary data, questionnaires and interview questions were sent to respondents via email and WhatsApp. Others were conducted through mobile voice and

Zoom technology so as to avoid physical contact due to the protocols provided under the laws of COVID 19. To set the grand agenda towards engaging the respondents, the participants were first contacted by phone and email on the purpose of impending exercise. This was to gain their consent before commencing the collection of data from them. Interviews conducted over the phone and Zoom were later transcribed by the researcher and the questionnaire administered and collected within 2 weeks.

3.5 Methods of Data Analysis

Thematic analysis technique was employed for the questionnaire due to the small number of respondents who participated in the study. Also, the design and answer sets for the questions, and the fact that a qualitative research approach was used, provides reasons for the use of this technique. The author used MS Excel 2019 for coding the results from the IT experts, which was then fed into SPSS for final analysis. Coding for research data is an analytic activity involving the assignment of codes to non-numeric data. In terms of qualitative data analysis, coding is considered a task that creates assigns a phrase or word to summarize, symbolize, or even capture an attribute of part of a language-oriented or visual data (Saldana, 2016). The main aim of coding verbal data is to systematically and reliably label segments of such data in a manner that represents the phenomenon in which the researcher is interested. Magnitude coding also serves as one way for the transformation or quantitation of qualitative data.

The statistical measure called the Cronbach alpha was deployed to validate the results. However, results of the questionnaire administered to the network managers, faculty, students and administrators were interpreted using tables and charts. Details of the key findings for the study have been captured in the next chapter.

3.6 Ethical Consideration

Many ethical challenges tend to appear during the execution of a research projects, and this research is no exception. Personal consent of research or survey participants has over the years been identified as one of the most critical ethical issues. It is completely illegal to use people on a project without first seeking their express consent. With this knowledge, the author pre-informed the participants about the impending study and its objectives as well as their responsibility towards achieving success. The names and identity of the department, organization or place of work of those who took part was kept strictly latent, to conform with the requirements for the code of ethics of Wa Polytechnic and research in general.

Also, the privacy and confidentiality policies of the companies from which the IT experts were selected were not disclosed since most companies have strong policies concerning the use of their staff for research purposes. Finally, all the data collected during the period of this dissertation was used purposely for the study and nothing else.

3.7 Problems and Limitations

Several challenges were encountered by the researcher while conducting the research for this dissertation. The number one problem was the recruitment of participants. The initial database envisaged from the beginning of the study had to change drastically due to the pandemic. Also, the IT experts who supported the validation of information kept turning down the invitation to participate because it came at a very short time. However, with persistence the few agreed to lend their support. Secondly, the research was limited by cost and time leading to the choice of more effective and efficient method like the questionnaire instead of the more laborious technique, the participant observation or focus groups.

These limitations resulted in a small sample size used in collecting the data and the analysis, resulting in findings that could have been better.

3.8 Conclusion

The objectives of this chapter have been achieved by outlining and justifying the research methodology used in the successful execution and validation of this work. The nature of the research encourages the author to choose qualitative strategy which is hinged on interpretivist approach. The key research tools used in this occasion were questionnaire coupled with interviewing of IT experts. Respondents were deliberately targeted and selected via stratified sampling technique. Analysis of the data was conducted using MS Excel 2019 and SPSS. The key results and findings of this thesis have been published in the next chapter.

CHAPTER FOUR

ANALYSIS OF RESULTS

4.1 Introduction

This chapter deals with results generated from analyzing the data collected from respondents. The analysis is divided into three parts; demographic representation, the main survey and reliability test to validate the data. Table 2 depicts the demographic data collected from the questionnaire.

Table 2: Distribution of Demographic Data from Survey

S/N	DESCRIPTION	SAMPLE SIZE
1	**GENDER**	
	MALE	51
	FEMALE	12
2	**QUALIFICATION**	
	SHS	14
	BACHELORS	36
	MASTERS	9
	PH.D	4
3	**AGES**	
	BELOW 30	30
	30-39	18
	40-49	15
	50-59	0
	60 AND ABOVE	0
4	**TYPE POSITION**	
	ADMINISTRATIVE	39
	ACADEMIC	
	ACADEMIC WITH ADMINISTRATIVE POSITION	24
5	**POSITION**	
	DEAN	1
	VICE DEAN	
	HEAD ICT DEPT	1
	DIRECTOR OF WORKS	0
	LECTURER	26

	ENGINEER	1
	OTHERS(ACCT)	31
	ASSISTANT DIR	3
6	**YEARS OF EXPERIENCE**	
	LESS THAN 5	39
	5-9	18
	10-14	6
	15-19	0
	20 AND ABOVE	0
7	**UNDERSTANDING OF THESIS TOPIC**	
	VERY HIGH	0
	HIGH	1
	MEDIUM	2
	LITTLE	5
	VERY LITTLE	25
	NONE	30

Source: Field Survey (Alhassan Saeed, 2021)

4.2 Analysis of Demographic Data

This section is reserved for the analysis of demographics in the research.

4.2.1 Gender Distribution

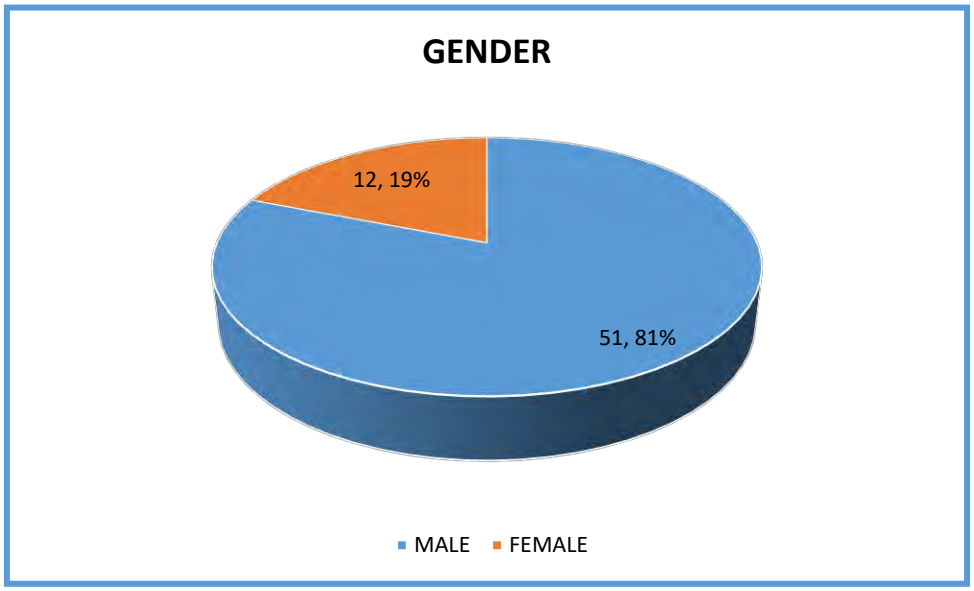

Figure 4.1: Gender Distribution for Respondents (Saeed Alhassan, 2021)

Gender distribution for respondents is shown in Figure 4.1 where males are the majority, with 81% of the total number representing 51 of the respondents. Females recorded 19% or 12 respondents, meaning the gender gap is too wide.

4.2.2 Education

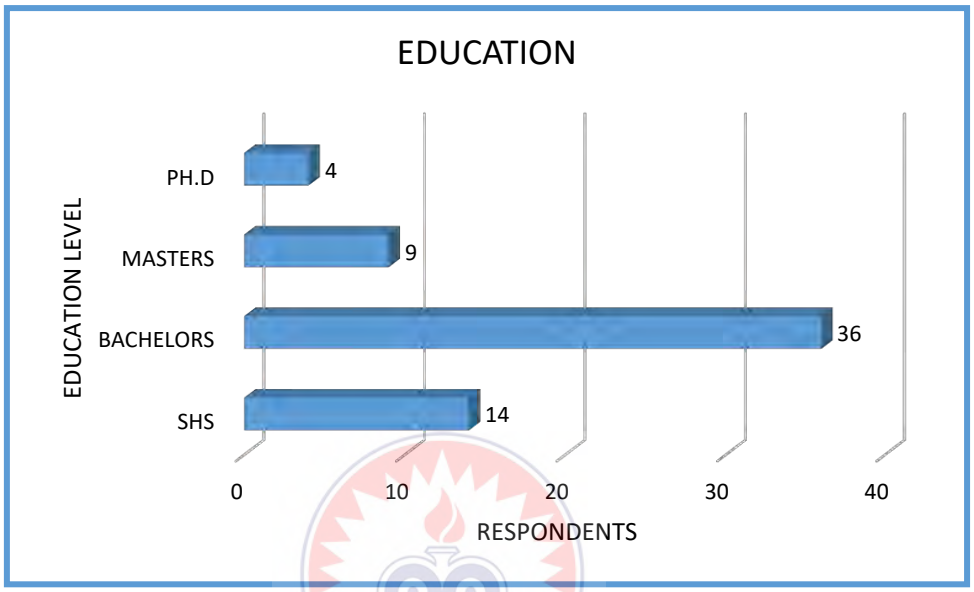

Figure 4.2: Education Level of Respondents (Saeed Alhassan, 2021)

According to the demography in education indicated in Figure 4.2, majority of the sample used, 36 out of 63 had bachelor's degree, followed by SHS with 14, and Masters recording 9. The terminal degree level, Ph.D. was the least and had only 4 participants. With the policy to get most lecturers to attain the terminal degree, this can be said to lag so much.

4.2.3 Age Distribution

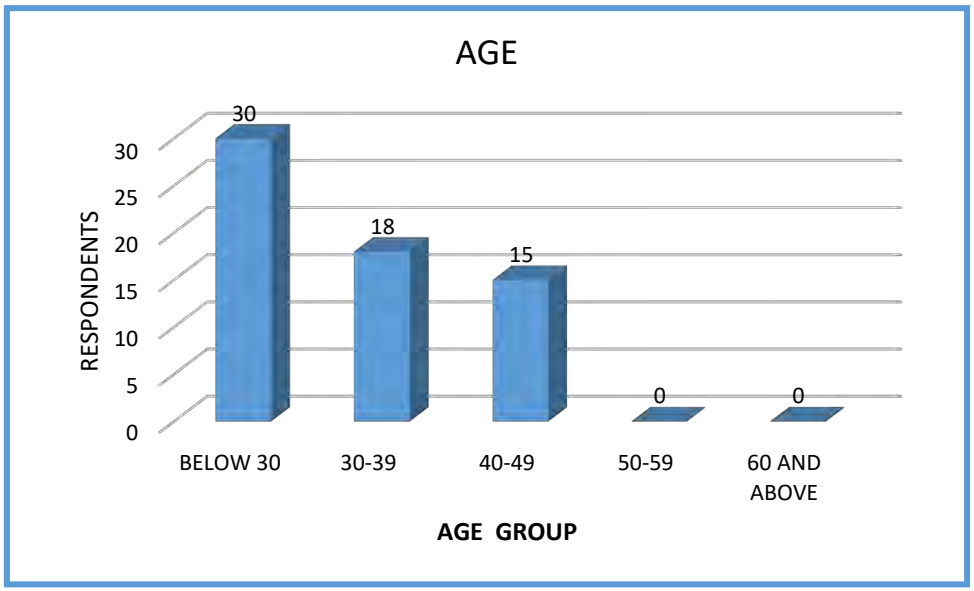

Figure 4.3: Age Distribution for Respondents (Saeed Alhassan, 2021)

Figure 4.3 reveals the distribution of the interviewees in which 30 out of 63 are younger than 30 years old. Whereas ages from 30 to 39 and 40 to 49 recorded 18 and 15 respectively, no respondent was recorded for age range from 50 to 59 and above 60. This distribution can only mean that the staff are youthful which goes to confirm the fact that Wa Polytechnic was converted to a Technical University in April 2020.

4.2.4 Distribution of Positions

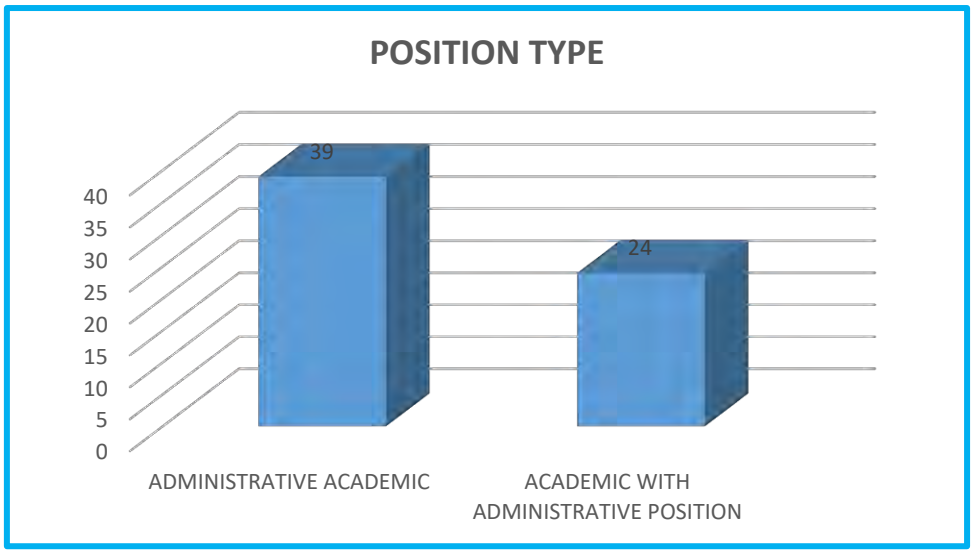

Figure 4.4: Type of Position Occupied by Respondents (Saeed Alhassan, 2021)

The respondents were divided into purely administrative and general positions and academic with administrative positions. In Figure 4.4, administration consist of 39 of the respondents while academic with administrative responsibilities are made up 24.

4.2.5 Distribution of Respondents According to Positions Held

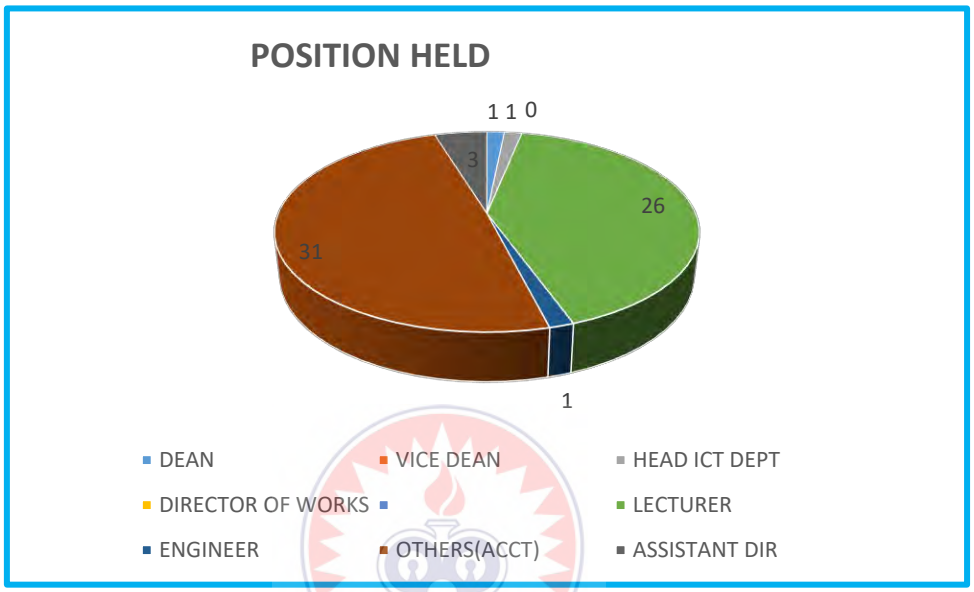

Figure 4.5: Position held by Respondents (Saeed Alhassan, 2021)

Data collected was also classified according to the position held by participants as published in Figure 4.5. Other departments including Accounts recorded the highest value of 31 respondents, followed by Lecturers with 26. There was no one in the Director of Works position, but there was 1 Dean, 1 Vice Dean, 1 Engineer and 3 Assistant Directors for various sectors of the community. These statistics are a true reflection of what pertains other universities where all other workers are more than the Lecturer population with even fewer top management.

4.2.6 Work Experience

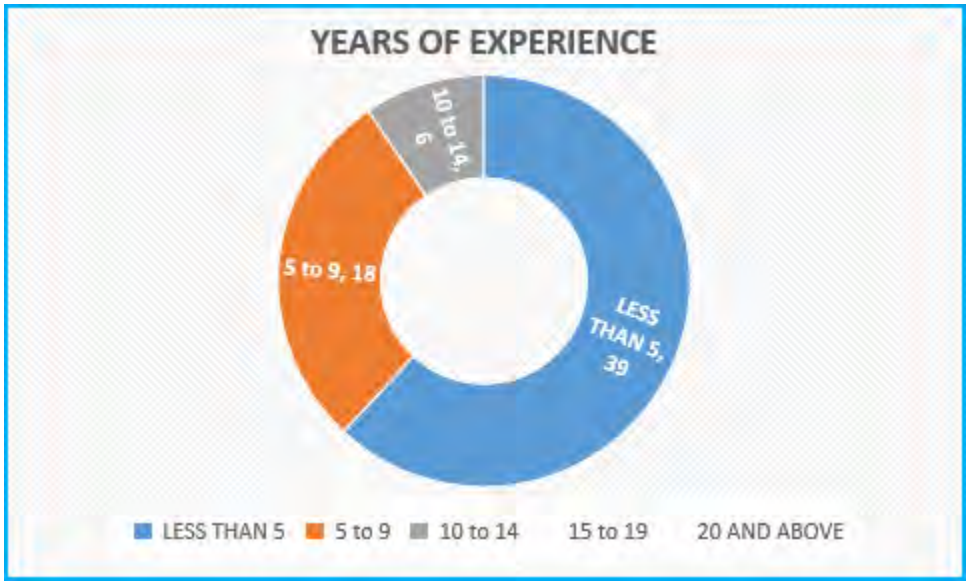

Figure 4.6: Number of Years Worked by Respondents (Saeed Alhassan, 2021)

In a research project, the level of experience of participants in the topical area is very significant to the outcomes. As such, this study categorized the participants according to their working experience and how that may impact the quality of work. In this case, staff with less than 5 years' experience were 39, the highest compared to the others as in Figure 4.6. Experiences between 5 and 9 years were next with a value of 18, those who worked from 10 to 14 years were 6. There were no respondents with experience of 15 years and above. The reason for this situation could be attributed to the young nature of the institution.

4.2.7 Knowledge of Thesis Topic

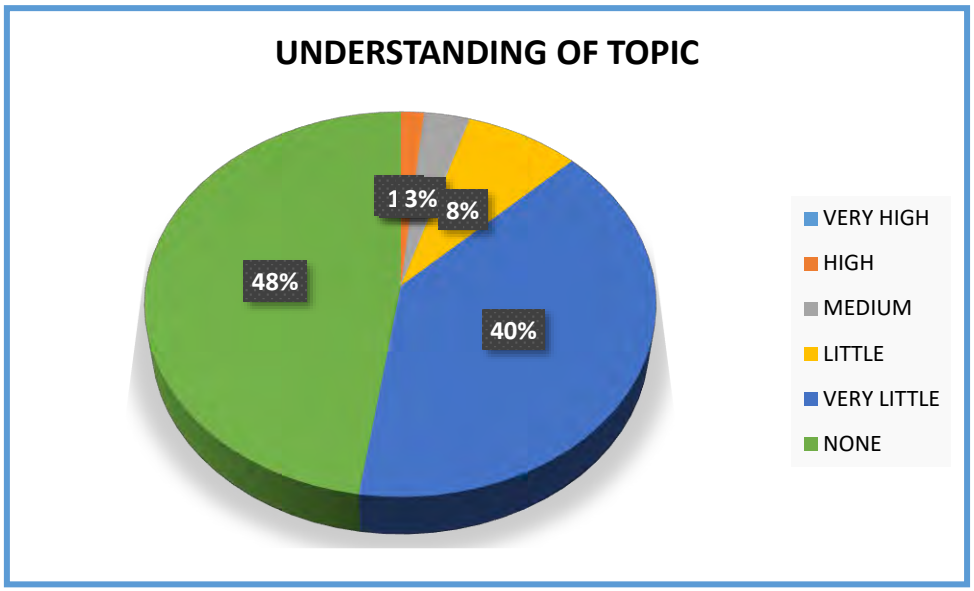

Figure 4.7: Level of Understanding of Thesis Topic by Respondents (Saeed Alhassan, 2021)

According to Figure 4.7, 48%, representing about 30 of the respondents did not have any knowledge of the topic under investigation. Those with little knowledge were 40% or 25 persons, the little knowledge category had 8% while the medium level recorded 13%. On the other hand, on one had very high knowledge about the topic, but only one participant had classified under high. These results means that the percentage of the respondents do have any understanding of the topic discussed.

4.3 Analysis of the Main Survey

The findings made in the study regarding various parts of the survey conducted are available under the following subsections:

4.3.1 Part One

Adoption of cloud computing technology: This field was deployed to test the extend to which Wa Polytechnic can incorporate a new technology such as Cloud Computing in its operations. Even though the respondents unanimously believe that Cloud Computing is an attractive venture for the institution, about 54% of them indicated that there is lack of fast internet connectivity which is not available all times. It can therefore be concluded based on the statistic that respondents accept the adoption of the Cloud Computing technology.

4.3.2 Part Two

This is the second part of the main survey which is further divided into five sections.

4.3.2.1 Section 1

Top Management support for the Cloud Computing Technology: This subsection was meant to understand the support of top management for the adoption of the cloud computing technology. It was determined that the administration took a decision in favor of the uptake of the new technology. According to most of the respondents, top management were prepared to offer the right support and requirements to ensure the adoption of cloud computing. About 64.45% of the respondents agree to the adoption but a low percentage made of the top management could not say its impact on Wa Polytechnic's operations. This means that top management lack knowledge in the benefits of cloud migration to the institution's operations, which shows that there is strategic plan for its implementation. Meanwhile, most top international institutions of higher learning adopt the technology through the support of top management in the form of financial provisions and other resources. This study is therefore consistent with findings of a research conducted by (Chinyao et al., 2011), in which it was concluded that top management support is critical for creating the enabling environment through

adequate resources for the adoption of new technologies (Lee, 2005; Wang et al., 2010). The role of top management is very crucial due to the integration of resources, reengineering processes, and relocation of human resources.

4.3.2.2 Section 2

Support and Integration of the Polytechnics systems with Cloud Computing: This subsection was to demonstrate the possibility of moving existing services of the IT Department and integrating it with cloud computing. The results show that 78.20% of the respondents agree on the support and integration of the institution's service with cloud computing, where email services from the old system or local server is transferred to new system provided by the cloud service provider. This research is in consonance with the findings from Chinyao et al. (2011) which indicated that organizations are likely to adopt new technology if they are fund to compatible with existing applications.

4.3.2.3 Section 3

Skills of IT staff at the Polytechnic: This part was used to find out if the Skills set of the IT staff of the institution is commensurate with cloud computing requirements. More than 85% of the respondents said that IT staff required training in cloud, especially, in the design, construction, development, deployment and maintenance of cloud services. It was also revealed by the respondents that the institution provides training programs for employees in other departments and would therefore do same for the IT department. Apart from the lack of awareness creation among staff about the impending technology, there is little motivation which does not generate competition among staff to effectively serve the institution. This research compares favorably with the study conducted by Angela and Nan-Chou (2012), which concluded that many professionals in the IT sector neither have the requisite expertise nor are conversant with cloud benefits to enterprise.

4.3.2.4 Section 4

Security effectiveness in the adoption of Cloud Computing: This portion was meant to provide understanding of the security effectiveness in the adoption of cloud computing at Wa Polytechnic. Preliminary analysis of the respondent data revealed that data security was the biggest challenge facing the Polytechnic in the adoption of cloud computing even though most of them have confidence in the new technology. In all, 78.32% of the respondents had agreement on the security effectiveness in the adoption of cloud computing and suggested two ways improving institutional data with cloud. First was to overcome the challenge by selecting a stronger service provider with capacity secure the system, or secondly, give non-sensitive portion of the system to Public Cloud while committing the rest to Private Cloud service provider to maintain data security and confidentiality. This provides the consistency of this research with the one conducted by Isaila (2014), which found out that security issues are seen as one of the main bottlenecks to cloud adoption.

4.3.2.5 Section 5

Cost reduction through the adoption of Cloud Computing: This subsection was to solicit the cost reduction effect through adoption of cloud computing at Wa Polytechnic. I was identified from respondents that cloud computing service providers offer some free services to institutions of higher learning which constitutes reduction in cost. A total of 84.30% of the respondents agreed that there is cost reduction in the adoption of cloud computing at the Polytechnic, in the form of reduction in electricity, pay-per-use, procurement of fewer hardware terminals.

A review of the results provided in this section reveals that the Wa Polytechnic is ready and willing to adopt Cloud Computing Technology due the inherent benefits to be enjoyed**.**

4.4 Findings in Relation to Research Questions

This section discusses the results from the main survey of the study where a likert scale was used to measure the degree of agreement or disagreement of respondents. Findings linked to the research questions were extracted from the questionnaire and used as interview questions as published in Table 3. The scale is represented Strongly Agree (1), Agree (2), Neutral (3), Disagree (4) and Strongly Disagree (5).

Table 3: Responses to Research Questions

Research Question	**1**		**2**		**3**		**4**		**5**	
	F	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**
RQ1: Wa Polytechnic has knowledge of the potential benefits of Cloud Computing	10	15.9	32	50.6	21	33.3	0	0	0	0
RQ2: There are challenges involved in the adoption of Cloud Computing	32	50	19	30	3	5	3	5	6	10
RQ3: Several factors influence the adoption of Cloud Computing at Wa Polytechnic	22	35	16	25	6	10	9	15	10	15

Source: Field Survey (Saeed Alhassan, 2021)

4.4.1 Findings from Research Question One

This question sought to determine if Wa Polytechnic as a high education institution had any knowledge on the potential benefits of adopting the cloud computing technology. The results in Table 3 reveal that 66.5% of the respondents agreed that the institution had some understanding of the phenomenon. Some of the benefits identified include the improvement of academic processes and efficiency, increase collaborative work, backing up of data and information, operational cost reduction among others. However, 84% of the respondents in management position were unable indicated the benefits of cloud computing.

4.4.2 Findings from Research Question Two

The second research question was designed to solicit information on the challenges facing the adoption and implementation of cloud computing at the Wa Polytechnic. Out of the 63 respondents, 80% noted that cloud migration comes with some difficulties if it has to be effectively implemented. Choice of the right cloud system, data security and privacy, lack of resources and expertise, compliance, service quality and interoperability issues were the hindrances mentioned.

4.4.3 Findings from Research Question Three

The third research question meant to collect information on the factors that are likely to influence the adoption of cloud computing technology at Wa Polytechnic. The data in Table 3 show that 60% of the respondents are aware of some factors that must be satisfied or put in place to enable cloud migration. The first condition is a cost/benefit analysis report to determine the success of the project should be ready.

Communication and transparency come next, followed by leadership buy-in or management support. Also, education and should be organized to sensitize staff and other stakeholders.

4.5 Validation of Data Collected

After administering the questionnaire, the data was extracted and coded with MS Excel 2019 and later transferred to SPSS for analysis. Using the Cronbach's coefficient alpha, the reliability of the various parts and sections of the questionnaire were measured. Cronbach's coefficient ranges from 0.0 to +1.0, with the minimum reliability beginning from 0.50 and the higher values reflecting higher degree of internal consistency.

Table 4: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
871	**872**	**6**

Source: Survey Data (Alhassan Saeed, 2021)

Table 4 shows the Cronbach's alpha value of 0.871 for the internal reliability of the entire questionnaire and the number of sections represented by N = 6. This Cronbach's coefficient value (0.871) is considered high which indicates an excellent reliability of the questionnaire.

Table 5: Item Statistics

	Mean	Std. Deviation	N
Part1	3.20	1.317	10
Part2Section1	3.00	1.414	10
Part2Section2	3.40	1.430	10
Part2Section3	3.20	1.476	10
Part2Section4	3.20	1.317	10
Part2Section5	3.00	1.414	10

Source: Survey Data (Alhassan Saeed, 2021)

The mean and standard deviations for the for the various sections are published in Table 5, also indicated is the number of experts (N= 10) used to validate the questionnaire in this study.

Table 6: Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Part1	15.80	30.622	.708	.	.844
Part2Section1	16.00	31.778	.557	.	.869
Part2Section2	15.60	28.489	.795	.	.827
Part2Section3	15.80	29.067	.718	.	.841
Part2Section4	15.80	30.622	.708	.	.844
Part2Section5	16.00	31.778	.557	.	.869

Source: Survey Data (Alhassan Saeed, 2021)

In Table 6, the individual Cronbach's alpha coefficient values for the individual sections have been shown. The values range between 0.827 and 0.869, which are all considered very high and therefore depicting reliability. This proves that the questionnaire used was valid, reliable and consistent for generalization.

4.5 Chapter Summary

Chapter four was mandated to analyze and publish the results of the research which it successfully delivered. The chapter opened with an introduction followed by analysis of demographic data. Analysis of the main survey was next, after which the data was validated.

CHAPTER FIVE

DISCUSSION OF RESULTS, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The aim of this study was to determine the challenges of adopting cloud computing at Wa Polytechnic, and to measure the impact of top management support as well as the other subsections of the questionnaire including the demographics on the new technology. The findings of the research were obtained from collected data from the field survey, followed by the conduct of appropriate statistical analysis, extraction, validation and presentation of results in the previous chapter.

5.2 Research Findings

Pursuant to the results adduced from the statistical analysis of the respondents' views, the key findings of the research have been summarized as follows:

5.2.1 Research Variables

A. Findings related to "The adoption of Cloud Computing Technology at Wa Polytechnic"

Statistical analysis in this area has resulted in the following conclusions:

1. Less than 46% of the respondents indicate that Wa Polytechnic has fast internet and uninterrupted services, meaning the majority think otherwise. Since fast internet connectivity is one of the preconditions to cloud adoption, the institutions must improve the service prior to the uptake.
2. Wa Polytechnic believes in new IT projects, with approval from 84.50% of respondents, suggesting such projects increase data and information security.

Similarly, majority of the participants indicated that new technological projects tend to increase the quality and efficiency of services enjoyed by beneficiaries.

3. Apart from being an attractive technology, most respondents see cloud computing as the best economic option to the institutions.
4. Almost 72% of the respondents see the project as a source of satisfaction to students and employees alike by making teaching and learning very effective.
5. In all there 84% of respondents believe that Wa Polytechnic can adopt the Cloud Computing Technology.

B. Findings related to "Top Management Support for the Adoption of Cloud Computing Technology".

Statistical Analysis under this section have resulted in these conclusions:

1. A majority portion of the participants see that administration made a wise decision in considering some part (Gmail) of the cloud system as an important application to the institution.
2. Top Management were observed by a greater portion of the respondents to seeking to create competitive advantage for the institution by adopting cloud.
3. In accordance with enhancing teaching and learning activities on campus, most of the respondents say that top management support the new technology.
4. However, majority of participants are not sure if top management is ready to remove obstacles hindering the use of new technology such as cloud computing. At the same time, they cannot find the adoption of cloud computing in the institution's Strategic Plan for the IT Department.
5. There is also disagreement regarding top management's wiliness provide the necessary requirements to adopt cloud migration.

6. The overall position of the respondents shows that 64.45% of them agree that top management support the adoption of cloud computing

.

C. Findings related to "Support and Integration of Existing System with Cloud Computing Technology"

The following are conclusions adduced from the analysis conducted under this section:

1. In general, 78.20% of the respondents believe that the Polytechnic has the capacity to support the integration of existing services with cloud computing technology.
2. The respondents determined that it is possible to access their services when migrated to the cloud, just as it would help improve the quality of service (QoS) and at the same time distinguish the institution from similar ones, because it would bring new services to support them.
3. Additionally, most respondents agree that cloud computing providers offer certain services such as storage space, shared data and email free of charge to students to enhance the learning enterprise.

D. Findings related to "Skills of IT Staff at Wa Polytechnic to adopt Cloud Computing Technology"

Statistics provided by the analysis under this section provide the following conclusions:

1. Majority of the respondents believe that the IT staff require training to make them ready for cloud computing uptake, especially, in areas related to development, construction and deployment cloud services. It was agreed upon that new technology enhance healthy competition among staff that motivate them to put in their best performance for the benefit of the institution.

2. It was found that over 70% of respondents see new technologies as way to increase the spirit of creativity and innovation as such, IT administrative staff are continuously searching for technologies such as cloud computing.
3. There is however, disagreement among 60.23% of the respondents that staff go on scientific missions in order take advantage of emerging technology. They also disagree that the institution provides training opportunities to employees on new technologies.
4. In general, over 85% of the respondents concluded that the IT department lack the requisite skills to handle cloud computing and therefore require training in that area.

E. Findings related to "Security Effectiveness in the adoption of Cloud Computing"

Analysis under this section provides the following conclusions:

1. With respect to data security, 85.52% of the respondents identify it as the biggest challenge to new technology adoption, also think that the level of security and insecurity largely depends on the service provider. As a result, about 80% of the participants root for hybrid cloud, where Public cloud would host the non-sensitive applications while the Private cloud would concentrate on the security of data including confidentiality.
2. Also, 67% of the respondents indicate that adoption and deployment of cloud computing would lead to the development of data security and information confidentiality strategy.
3. According to 65% of the respondents, it is very important to know where in the cloud the institution's data is stored and believe that their confidence in cloud services providers would increase if there were clear contractual agreements in terms of system downtime and security breaches including hacking.

4. Based on these considerations over 78% of the sample used concluded that there is security effectiveness in adoption of cloud if and only if the necessary precautions are adhered to, as indicated in subsection 4.3.2.4.

F. Findings connected to "Cost reduction through the adoption of Cloud Computing"

The statistical analysis conducted under this section led to the following conclusions:

1. In total, 84.30% of the respondents agree that cloud migration would ultimately lead to operational cost reduction for the institution
2. This is because most respondents perceive that the Polytechnic desires modern IT projects which are likely to result in cost reduction, especially, in electricity, usage time reduced equipment acquisition and maintenance.
3. Over 75% of the respondents believe that migration of operations and services to the cloud automatically reduce costs.

5.1.2 Relationship among Research Variables

According to the validation results published in Table 4.4 in section 4.4 of chapter 4, there is a correlation between the independent variables in sections 1 to 5 of Part 2 and the dependent variable in Part 1 (the adoption of cloud computing at Wa Polytechnic). In the correlation column of Table 4.4, the correlation values range between 0.557 and 0.795. This means that there is statistical relation between the dependent variable and all the independent variables.

5.3 Summary of Findings and Original Contributions

In lieu of the results adduced by the researcher during the filed survey and the statistical analysis conducted in Chapter 4, it can be concluded that the adoption of Cloud

Computing Technology at Wa Polytechnic has several benefits but comes with some challenges.

5.3.1 Original Contributions

A research contribution may be defined as the creation of new knowledge from existing knowing through innovative methods to conduct scientific research. The main aim of this study was to evaluate the issues and challenges involved in the adoption of cloud computing by universities in Ghana with particular reference to Wa Polytechnic.

The original contributions and novelties of the research topic are published in this section.

- Empirical evidence of the challenges facing the adoption of cloud computing technology at Wa Polytechnic
- Empirical data on the conditions of service and IT requirements for cloud uptake at Wa Polytechnic
- A novel document produced for the Wa polytechnic community which can be used:
    - ✓ As a reference for similar institutions in the rural regions of Ghana
    - ✓ To contribute to the expansion of existing knowledge in the topical area
    - ✓ As the bases or foundation for future research in related topics
    - ✓ By the Ministry of Education and the legislature for the creation of policies and laws to govern the uptake of emerging technologies by universities.
    - ✓ As a reference document for key stakeholders and actors within the new technologies space to enable them profile effective guidelines for their adoption

5.4 Recommendations of the Research

Bases on the conclusion arrived at in section 6.1, some strategies are required to mitigate the challenges inhibiting the uptake of cloud computing at Wa Polytechnic. The strategies are embedded in the following recommendations:

1. Wa Polytechnic should migrate its operations to the cloud since it is one of the best technological and economic option the institution has.
2. In the wake of student registration of courses at the beginning of the semester, the institution's website become very slow making the exercise very laborious due to latency issues. Adopting cloud computing would completely cure this challenge and make students more comfortable and ready for lectures in a short time.
3. Top management should be educated to understand the innovation and benefits cloud brings when adopted, and then develop a flexible strategy to accommodate changes required during migration to the cloud.
4. To generate the required competition among IT staff, top management should strive to support the adoption of emerging technologies that are cut out for higher institutions of learning.
5. Top management should deliberately develop plans to rid off any obstacle that is a hindrance to the uptake of emerging technologies by making all the necessary provisions reflect in the strategic plan for the IT sector.
6. In this case, top management should provide effective training programs on cloud computing and incentivize the IT staff by sending them out to participate in scientific missions to enhance their technological edge.

7. To maintain confidentiality and data security, the institution should adopt the hybrid cloud system while promoting the operational aspect of the IT department to attract the best technical hands to promote high efficiency.

5.5 Limitations of the Study

As a human endeavor, this research was not conducted devoid of challenges, some limitations were recorded during, especially during the data collection stage. The incidence of COVID-19 hindered smooth data collection because the lecturers of Wa Polytechnic conducted online teaching and were not present for face-to-face interaction. Researcher had to resort to sending questionnaire social media and mail, which was very difficult to recover. The rest of the staff of the institution proved difficult to get in touch with due to the COVID-19 protocols, who those who claim to be in sensitive positions such as accounts and HR failed to provide important information to the study. This information they claimed was classified despite the passing of the Right to Information (TRI) bill into law a few years ago.

It was also difficult to meet top management at the initial stages but with persistence and tact, they finally yielded to provide useful information for the success of this research. Additionally, finance inadequacy was a limitation to this study, as it was very difficult to move freely and meet the industry experts the number of times proposed at the beginning to discuss and solicit information to enrich the thesis.

Notwithstanding these limitations faced by the researcher and the team, some good strategies were employed to collect the relevant data required for the research as reflected in the quality demonstrated by this thesis.

5.6 Future Research

The researcher deemed this study as novel because cloud computing technology and other emerging technologies are fairly new across Africa in general and Ghana in particular. As a result, there is a huge opening for more academic investigations in this specific area. The researcher therefore finds the following recommendation appropriate for future work:

1. To be able to generalize this study, the topic should be conducted in other institutions of higher learning, both big and small.
2. A study be conducted to measure the impact of cloud computing technology on education process.
3. Conduct a study to measure the effects of cloud computing technology on Electronic Measurement and Education Management Information System (EMIS).
4. Conduct a study to investigate the impact of cloud computing technology on Enterprise Resource Planning (ERP).
5. Conduct a research that will create a prototype to use cloud computing technology for e-government.
6. Design a framework for monitoring and tracking the activities and performance of institutions of higher learning using cloud computing by the Ministry of Education

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APPENDICES

APPENDIX A: QUESTIONNAIRE

Dear Sir / Madam, this is a research and investigative study being conducted at the Wa Polytechnic in the Upper West Region of Ghana. The study is meant solely for academic research purposes and complete confidentiality is guaranteed. It will take approximately 10 minutes to complete the questionnaire. Kindly extend your cooperation in filling up this questionnaire. Your participation in this study is completely voluntary. There are no foreseeable risks associated with this project. However, if you feel uncomfortable answering any of the questions, you can withdraw from the survey. If you have questions at any time about the survey or the procedures, you may contact the researcher on 0209116214. Thank you very much for your time and support.

Section A: Demographic Information

Please tick (√) beside the appropriate answer

1. Gender:

Male ( ) Female ( )

2. Qualification:

SHS ( ) Bachelors ( ) Masters ( ) Ph.D. ( )

3. Age (in years):

Below 30 ( ) 30–39 ( ) 40-49 ( ) 50-59 ( ) 60 and Above ( )

4. Type of Position:

Administrative Academic ( ) Academic with administrative position ( )

5. Position:

Dean ( ) Vice Dean ( ) Head of ICT Department ( ) Director of Works ( )

Assistant Director ( ) Lecture ( ) Engineer ( ) Other, Define…...

6. Years of Experience:

Less than 5 ( ) 5 – 9 ( ) 10-14 ( ) 15-19 ( ) 20 and Above ( )

7. Level of Understanding of Thesis:

Very High ( ) High ( ) Medium ( ) Little ( ) Very Little ( ) None ( )

Section B: Main Survey

This section is made up of Part 1 and Part 2, with Part 2 further divided into sections 1 to 5. It seeks to get respondents to provide answers by agreeing at various levels provided below, on cloud competing technology adoption.

Level of Agreement:

Extremely High (1); Very High (2); Fairly High (3); Low (4);Very Low (5)

	Items	1	2	3	4	5
	Part One					
Adoption of Cloud Computing Technology.						
1	Cloud Computing technology is an attractive technological option to the Polytechnic.					
2	Cloud Computing technology is a better economic option to the Polytechnic.					
3	Polytechnic Focuses on new IT system projects, which aim to increase the efficiency and quality of services provided for the beneficiaries.					
4	The Polytechnic Focuses on new IT system projects, which seek to maintain competitive advantage.					
5	The Polytechnic has high speed internet Connectivity, and uninterrupted services.					
6	The Polytechnic Focuses on new IT system projects, which seek to increase students satisfaction					
7	The Polytechnic Focuses on new IT system projects, which aim to increase employees' satisfaction.					

8	The Polytechnic Focuses on new IT system projects, which seek to increase data and information security.					
9	The adoption of Cloud Computing technology in IT operations will support and enhance the teaching and learning process					
10	Knowledge of the potential benefits of cloud computing at the Wa Polytechnic					
Part Two						
Section 1: Top Management Support for the Cloud Computing Technology						
1	Top management informed of ongoing developments of Cloud Computing technology and the importance of its use					
2	Top management concerns to provide the staff with the needed trainings and skills for any new technology so as to keep up with development.					
3	Top management develops plans which are flexible enough to accommodate any changes required by the adoption of Cloud Computing technology					
4	Top management supports the new technologies which serve the learning process, and the university students.					
5	Top management seeks to maintain competitive advantage through the adoption of new technologies, and its uses in its operations					
6	There is a support from top management in IT field to adopt everything new such as Cloud Computing technology.					
7	Top Management has a future plan to adopt Cloud Computing, and its uses in IT operations					
8	Top management has plans to get rid of obstacles that hinder the use of any new technology at the Polytechnic such as Cloud Computing technology.					
9	Top management provides the support and the needed requirements to adopt Cloud Computing technology.					
10	The adoption of Cloud Computing technology is included in Strategic Plan for the IT Department					
11	The administration's decision is wise in the use of Cloud Computing applications at the Polytechnic					
12	Top management supports a shift policy in all or some of the IT operations towards Cloud Computing technology.					
13	Challenges facing the adoption of cloud computing at the Wa Polytechnic					
Section 2: Support and Integration of Polytechnic System with Cloud Computing						

1	There is a possibility of moving existing applications and services provided by IT Department at the Polytechnic to the cloud.					
2	Systems, technological services and applications at the Polytechnic are continuously updated to keep pace with technological development					
3	Technological services and applications at the Polytechnic are characterized by sufficient flexibility.					
4	The adoption of Cloud Computing technology at the Polytechnic helps to activate new services					
5	The adoption of Cloud Computing technology at the Polytechnic helps to improve quality of its services.					
6	The adoption of Cloud Computing technology at the Polytechnic helps in distinguishing it in its provided services, which is different from that provided by other tertiary institutions.					
7	The adoption of Cloud Computing technology at the university helps to improve the performance of current Polytechnic applications and services					
8	The transfer of e-mail service from the old system to one of Cloud Computing applications (Gmail) is easy and without suffering.					
9	The facilities for integrating current services and IT applications with the services provided by Cloud Computing (e.g. Gmail) are available					
10	Cloud Computing providers offer free training services to students, to help them in the learning process.					
11	It's possible to access to the services provided in the cloud from anywhere and any device.					
Section 3: Skills of IT Staff at the Polytechnic						
1	Cloud Computing technology helps in the development of IT staff abilities and skills.					
2	IT Training provided to staff is enough, and makes them sophisticated and look forward to some extent to the latest technology					
3	Cloud Computing technology helps on the development of the spirit of creativity and innovation.					
4	The Polytechnic provides training programs for employees relating to the new technologies (such as Cloud Computing Technology)					

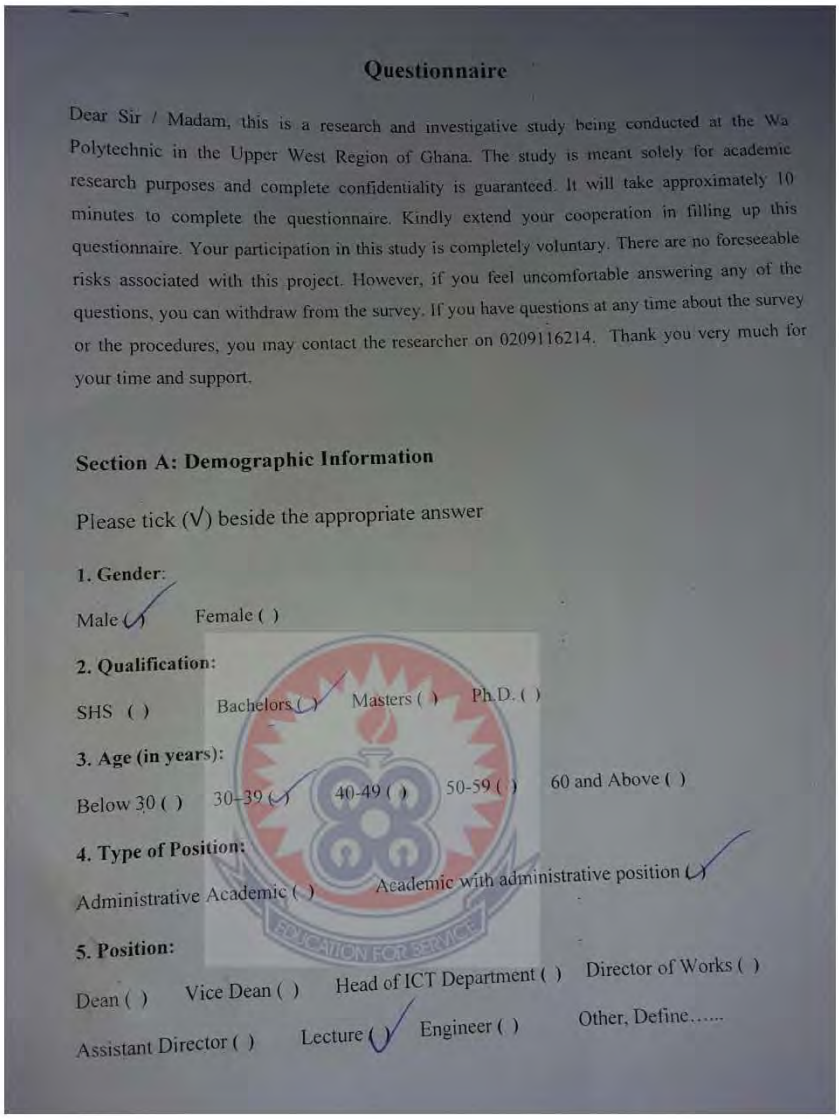
5	IT staff realize the importance of the adoption of Cloud Computing at the Polytechnic					
6	IT Management staff are continuously on the lookout for new technological developments (such as Cloud Computing Technology)					
7	The staff dissatisfaction and opposition to change is one of the challenges that hinder the adoption of any new technology (such as Cloud Computing Technology)					
8	I do not need high effort to inquire or to identify any new technology such as Cloud Computing Technology					
9	Technological developments encourage positive competition among staff to motivate them to serve the general interest of the institution					
10	The Polytechnic holds meetings, lectures and materials for the definition of human resources on the importance and the use of Cloud Computing Technology					
11	IT staff needs training in the Cloud Computing, especially in the (construction, development, deployment) cloud services.					
Section 4:Security Effectiveness in the Adoption of Cloud Computing						
1	The data security is the biggest challenge facing the Polytechnic to adopt any new technology					
2	We must know where the data is stored in the Cloud Computing					
3	The strength of data security depends on the strength of service provider in terms of security					
4	It should be considered a contract agreement between the Polytechnic and the service provider to offer safety and reliability of the data.					
5	There is confidence in new technologies and the providers of these services such as Google, Microsoft, Amazon etc.					
6	The adoption and use of Cloud Computing Technology leads to the development of a plan to improve the security and confidentiality of the information					
7	The confidence increases with companies Cloud Computing					

	service providers in the event of clear agreements related to hacking and electronic security breaches					
8	The services and applications of Cloud Computing provided by service providers' companies (e.g. Google, Amazon, Microsoft, ...) are difficult to hack and pirate					
9	The cloud for students is safer than traditional methods (Flash, the device profile and student portal) in putting their research, report and homework together and summiting.					
10	The things that will help the Polytechnic to overcome fears of safety should be linked to sensitive data or applications in the cloud					
11	The Polytechnic could adopt a hybrid cloud, which consists of a Public Cloud to put non-sensitive and public applications and the Private Cloud to maintain the Confidentiality and security of data.					
Section 5: Cost Reduction Through the Adoption of Cloud Computing						
1	The Polytechnic focuses on modern IT system projects, which aim to reduce costs.					
2	Transfer the operations and services of Polytechnic to the cloud will reduce costs					
3	The service of Cloud Computing provided by Google Inc., (e.g. an e-mail service - Gmail) at the Polytechnic is less Expensive than the old system.					
4	Many Cloud Computing service providers offer free services to higher education institutions					
5	There are free services in the cloud to help students communicate with one another, save and share data in real time					
6	Cloud Computing helps to reduce the cost of buying hardware, servers, software or maintenance in-house					
7	The most important feature of Cloud Computing, is the ability to control costs by use.					
8	The most important feature of Cloud Computing, is getting rid of unnecessary costs (place - electricity - air ... etc.).					

9	The Cloud Computing Technology provides innovative Polytechnic services without increasing the cost or the price of the service.					
10	The cloud service provides the needs of lab such as (special specifications of high expensive computers, or scientific applications), which it needs to work for a few hours or days continuously to bring out the desired results					
11	The adoption of Cloud Computing Technology greatly reduces cost and capital expenditure is converted into IT operations to ongoing expenses.					
12	Factors influencing the adoption of clod computing					

APPENDIX B

SAMPLE FILLED QUESTIONNAIRE



Questionnaire

Dear Sir / Madam, this is a research and investigative study being conducted at the Wa Polytechnic in the Upper West Region of Ghana. The study is meant solely for academic research purposes and complete confidentiality is guaranteed. It will take approximately 10 minutes to complete the questionnaire. Kindly extend your cooperation in filling up this questionnaire. Your participation in this study is completely voluntary. There are no foreseeable risks associated with this project. However, if you feel uncomfortable answering any of the questions, you can withdraw from the survey. If you have questions at any time about the survey or the procedures, you may contact the researcher on 0209116214. Thank you very much for your time and support.

Section A: Demographic Information

Please tick (√) beside the appropriate answer

1. Gender:

Male (✓) Female ( )

2. Qualification:

SHS ( ) Bachelors (✓) Masters ( ) Ph.D. ( )

3. Age (in years):

Below 30 ( ) 30-39 (✓) 40-49 ( ) 50-59 ( ) 60 and Above ( )

4. Type of Position:

Administrative Academic ( ) Academic with administrative position (✓)

5. Position:

Dean ( ) Vice Dean ( ) Head of ICT Department ( ) Director of Works ( )

Assistant Director ( ) Lecture (✓) Engineer ( ) Other, Define.....

Less than 5 ( ) 5 – 9 ( ) 10-14 ( ) 15-19 ( ) 20 and Above ( )

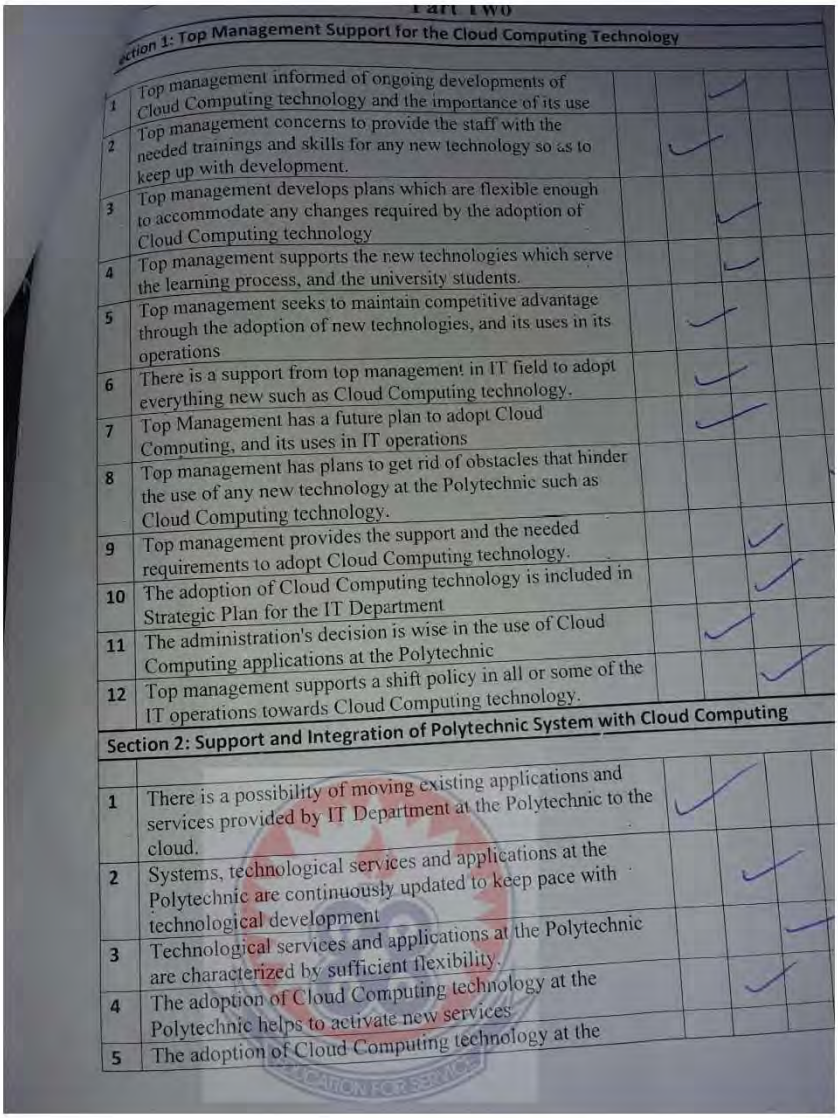
Section B: Main Survey

This section is made up of Part 1 and Part 2, with Part 2 further divided into sections 1 to 5. seeks to get respondents to provide answers by agreeing at various levels provided below, cloud competing technology adoption.

Level of Agreement:

Extremely High (1); Very High (2); Fairly High (3); Low (4);Very Low (5)

	Items	1	2	3	4	5
	Part One					
	Adoption of Cloud Computing Technology.					
1	Cloud Computing technology is an attractive technological option to the Polytechnic.	✓				
2	Cloud Computing technology is a better economic option to the Polytechnic.	✓				
3	Polytechnic Focuses on new IT system projects, which aim to increase the efficiency and quality of services provided for the beneficiaries.		✓			
4	The Polytechnic Focuses on new IT system projects, which seek to maintain competitive advantage.		✓			
5	The Polytechnic has high speed internet Connectivity, and uninterrupted services.				✓	
6	The Polytechnic Focuses on new IT system projects, which seek to increase students satisfaction				✓	
7	The Polytechnic Focuses on new IT system projects, which aim to increase employees' satisfaction.				✓	
8	The Polytechnic Focuses on new IT system projects, which seek to increase data and information security.				✓	
9	The adoption of Cloud Computing technology in IT operations will support and enhance the teaching and			✓		



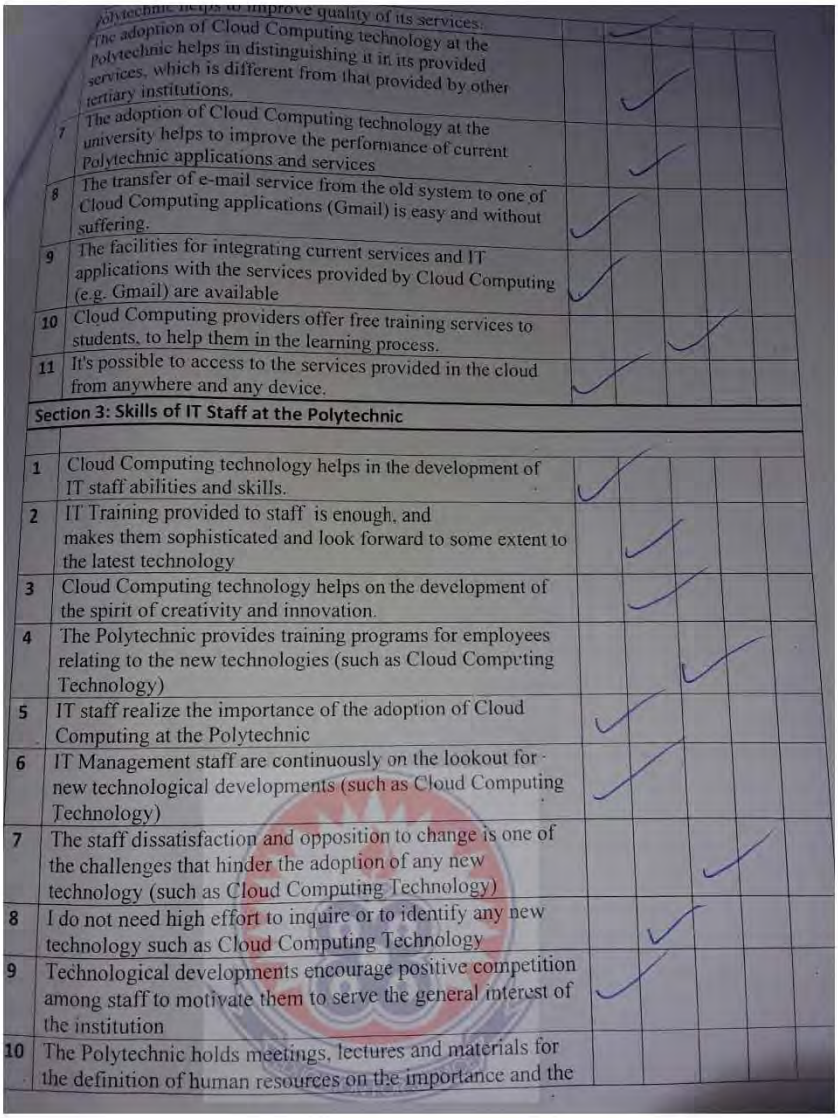
Part Two

Section 1: Top Management Support for the Cloud Computing Technology

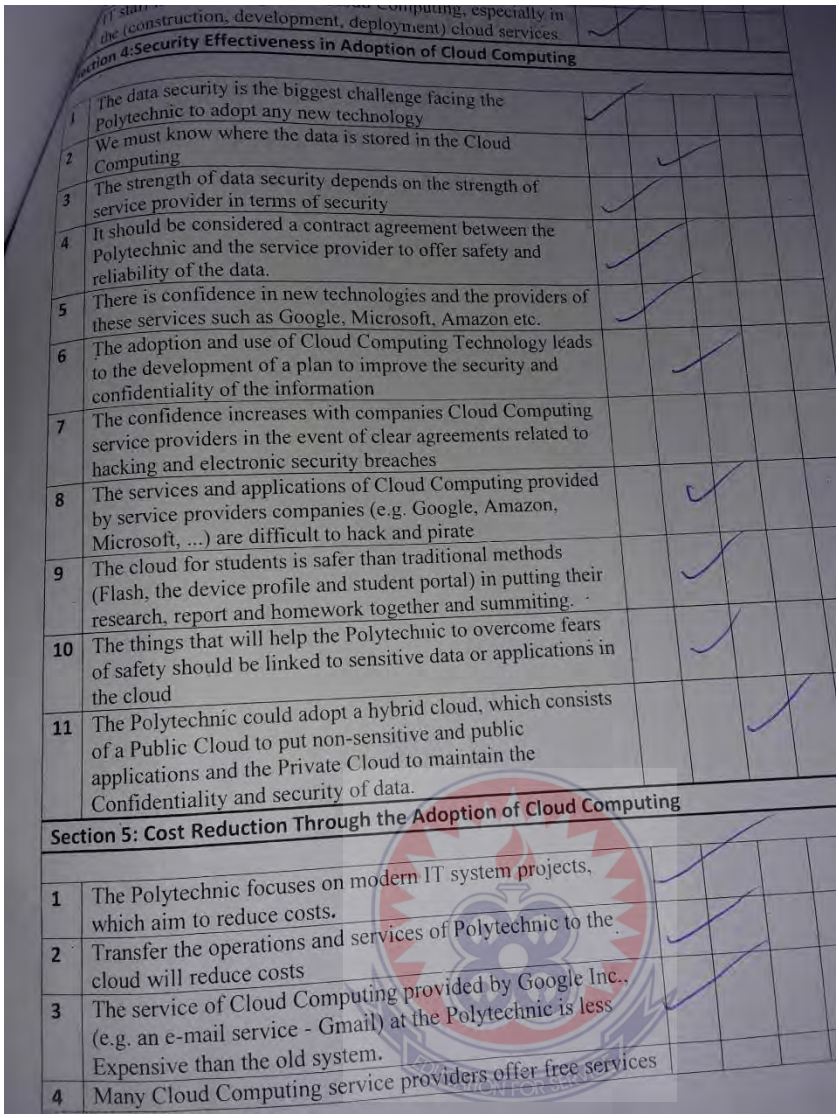
1	Top management informed of ongoing developments of Cloud Computing technology and the importance of its use			✓		
2	Top management concerns to provide the staff with the needed trainings and skills for any new technology so as to keep up with development.		✓			
3	Top management develops plans which are flexible enough to accommodate any changes required by the adoption of Cloud Computing technology			✓		
4	Top management supports the new technologies which serve the learning process, and the university students.			✓		
5	Top management seeks to maintain competitive advantage through the adoption of new technologies, and its uses in its operations		✓			
6	There is a support from top management in IT field to adopt everything new such as Cloud Computing technology.		✓			
7	Top Management has a future plan to adopt Cloud Computing, and its uses in IT operations		✓			
8	Top management has plans to get rid of obstacles that hinder the use of any new technology at the Polytechnic such as Cloud Computing technology.					
9	Top management provides the support and the needed requirements to adopt Cloud Computing technology.				✓	
10	The adoption of Cloud Computing technology is included in Strategic Plan for the IT Department				✓	
11	The administration's decision is wise in the use of Cloud Computing applications at the Polytechnic			✓		
12	Top management supports a shift policy in all or some of the IT operations towards Cloud Computing technology.				✓	

Section 2: Support and Integration of Polytechnic System with Cloud Computing

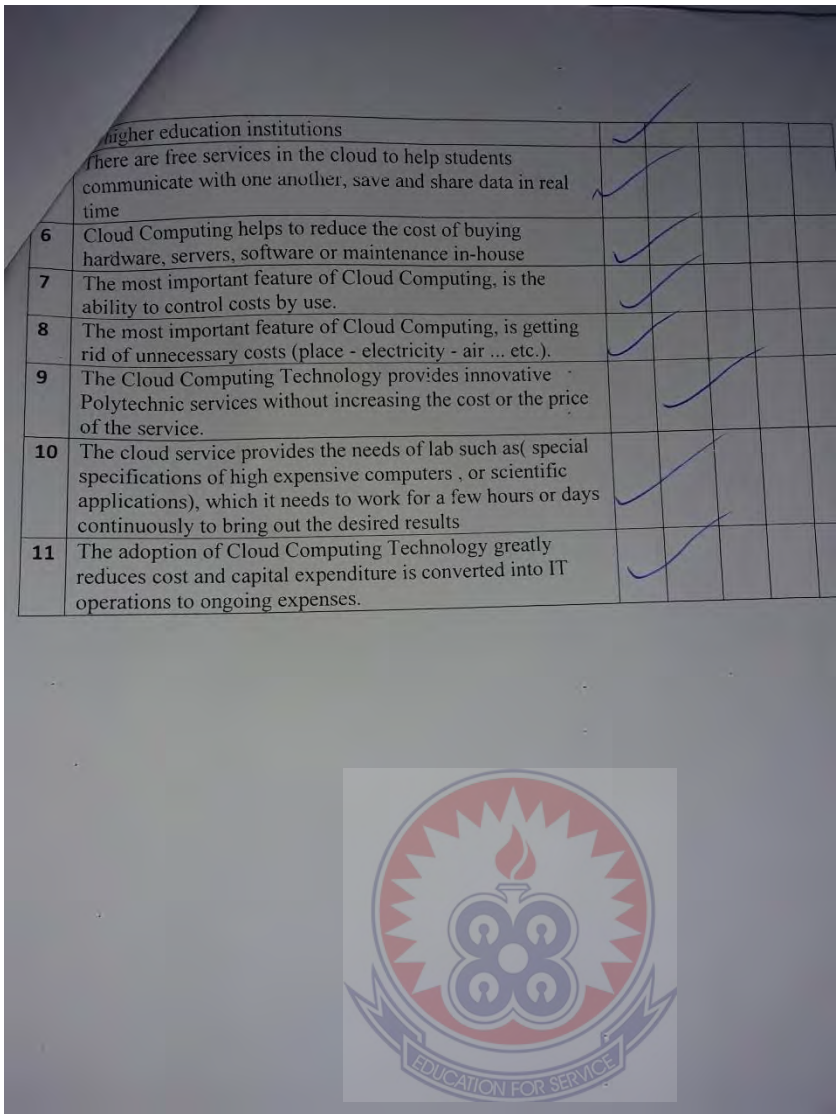
1	There is a possibility of moving existing applications and services provided by IT Department at the Polytechnic to the cloud.		✓			
2	Systems, technological services and applications at the Polytechnic are continuously updated to keep pace with technological development				✓	
3	Technological services and applications at the Polytechnic are characterized by sufficient flexibility.					✓
4	The adoption of Cloud Computing technology at the Polytechnic helps to activate new services				✓	
5	The adoption of Cloud Computing technology at the					



	Polytechnic helps to improve quality of its services.					
	The adoption of Cloud Computing technology at the Polytechnic helps in distinguishing it in its provided services, which is different from that provided by other tertiary institutions.					
7	The adoption of Cloud Computing technology at the university helps to improve the performance of current Polytechnic applications and services					
8	The transfer of e-mail service from the old system to one of Cloud Computing applications (Gmail) is easy and without suffering.					
9	The facilities for integrating current services and IT applications with the services provided by Cloud Computing (e.g. Gmail) are available					
10	Cloud Computing providers offer free training services to students, to help them in the learning process.					
11	It's possible to access to the services provided in the cloud from anywhere and any device.					
Section 3: Skills of IT Staff at the Polytechnic						
1	Cloud Computing technology helps in the development of IT staff abilities and skills.					
2	IT Training provided to staff is enough, and makes them sophisticated and look forward to some extent to the latest technology					
3	Cloud Computing technology helps on the development of the spirit of creativity and innovation.					
4	The Polytechnic provides training programs for employees relating to the new technologies (such as Cloud Computing Technology)					
5	IT staff realize the importance of the adoption of Cloud Computing at the Polytechnic					
6	IT Management staff are continuously on the lookout for new technological developments (such as Cloud Computing Technology)					
7	The staff dissatisfaction and opposition to change is one of the challenges that hinder the adoption of any new technology (such as Cloud Computing Technology)					
8	I do not need high effort to inquire or to identify any new technology such as Cloud Computing Technology					
9	Technological developments encourage positive competition among staff to motivate them to serve the general interest of the institution					
10	The Polytechnic holds meetings, lectures and materials for the definition of human resources on the importance and the					



	the (construction, development, deployment) cloud services.
	Section 4:Security Effectiveness in Adoption of Cloud Computing
1	The data security is the biggest challenge facing the Polytechnic to adopt any new technology
2	We must know where the data is stored in the Cloud Computing
3	The strength of data security depends on the strength of service provider in terms of security
4	It should be considered a contract agreement between the Polytechnic and the service provider to offer safety and reliability of the data.
5	There is confidence in new technologies and the providers of these services such as Google, Microsoft, Amazon etc.
6	The adoption and use of Cloud Computing Technology leads to the development of a plan to improve the security and confidentiality of the information
7	The confidence increases with companies Cloud Computing service providers in the event of clear agreements related to hacking and electronic security breaches
8	The services and applications of Cloud Computing provided by service providers companies (e.g. Google, Amazon, Microsoft, ...) are difficult to hack and pirate
9	The cloud for students is safer than traditional methods (Flash, the device profile and student portal) in putting their research, report and homework together and summiting.
10	The things that will help the Polytechnic to overcome fears of safety should be linked to sensitive data or applications in the cloud
11	The Polytechnic could adopt a hybrid cloud, which consists of a Public Cloud to put non-sensitive and public applications and the Private Cloud to maintain the Confidentiality and security of data.
	Section 5: Cost Reduction Through the Adoption of Cloud Computing
1	The Polytechnic focuses on modern IT system projects, which aim to reduce costs.
2	Transfer the operations and services of Polytechnic to the cloud will reduce costs
3	The service of Cloud Computing provided by Google Inc., (e.g. an e-mail service - Gmail) at the Polytechnic is less Expensive than the old system.
4	Many Cloud Computing service providers offer free services



	higher education institutions	✓				
	There are free services in the cloud to help students communicate with one another, save and share data in real time	✓				
6	Cloud Computing helps to reduce the cost of buying hardware, servers, software or maintenance in-house	✓				
7	The most important feature of Cloud Computing, is the ability to control costs by use.	✓				
8	The most important feature of Cloud Computing, is getting rid of unnecessary costs (place - electricity - air ... etc.).	✓				
9	The Cloud Computing Technology provides innovative Polytechnic services without increasing the cost or the price of the service.		✓			
10	The cloud service provides the needs of lab such as(special specifications of high expensive computers , or scientific applications), which it needs to work for a few hours or days continuously to bring out the desired results		✓			
11	The adoption of Cloud Computing Technology greatly reduces cost and capital expenditure is converted into IT operations to ongoing expenses.		✓			

APPENDIX C:

SURVEY DATA CODED WITH MS EXCEL 2019 FOR VALIDATION

S/N	Part 1	Part2Section 1	Part2Section 2	Part2Section 3	Part2Section 4	Part2Section 5
1	2	3	2	3	2	3
2	4	1	4	4	4	1
3	3	4	2	2	3	4
4	5	3	5	5	5	3
5	3	2	4	4	3	2
6	5	3	3	3	5	3
7	1	1	1	1	1	1
8	4	5	5	4	4	5
9	2	3	3	1	2	3
10	3	5	5	5	3	5