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A Subsidiary Organ of the Organization of Islamic Cooperation (OIC)

An Investigation of the Challenges Influencing Student's Use of Cloud Computing in Higher Education: Student's Perception

A thesis submitted for the partial fulfillment of the degree of M.Sc.T.E in Technical Education at the Islamic University of Technology in 2022

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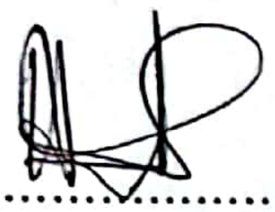

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DEDICATION

I would like to dedicate my thesis to my beloved parents, siblings and cousin. Without their support, inspiration and words of wisdom, it would have been almost impossible to complete my research.

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Thank you all.

DECLARATION

This is to testify that the work presented in this thesis is my original work. This thesis has neither been submitted nor previously been accepted for the award of any degree in the university or elsewhere. I also declare that the sources used in this thesis were explicitly acknowledged with proper citation and references.

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LIST OF ACRONYMS

TAM	Technology Acceptance Model
TRA	Theory of Reasoned Action
TOE	Technology Organization Environment
HOT-fit	Human Organization Technology fit
PU	Perceived Usefulness
PEOU	Perceived Ease Of Use
PEOA	Perceived Ease Of Access
PCOU	Perceived Cost Of Usage
PSC	Perceived Security Concerns
IUT	Islamic University of Technology
IUIU	Islamic University In Uganda
KIU	Kampala International University
BU	Brac University
NSU	North South University
MIU	Metropolitan International University

ABSTRACT

The sudden emergence of Covid19 pandemic halted conventional classes and forced educational institutions to adopt the use of cloud computing as a solution for education continuity. Many challenges emerged from this accelerated change in education which affected both instructors and students that use cloud computing systems. Based on this, the study investigates the challenges that influence students use of cloud computing in higher educational institutes with a major focus on the context of the Covid19 pandemic. The research was centered around students' opinion as they are some of the immediate users of cloud computing systems. A modified Technology Acceptance Model (TAM) was used as a measurement model to find the impact Perceived Ease Of Access (PEOA) has on Perceived Usefulness (PU), Perceived Cost Of Usage (PCOU) has on Perceived Ease Of Use (PEOU) and Perceived Security Concerns (PSC) have on Perceived Ease Of Use (PEOU). A quantitative study was conducted in six universities and a total of 357 participants responded. The questionnaires were validated and then distributed completely online to ensure safety protocols. The findings of the study showed that only PSC and PEOA influenced student's use of cloud computing and not PCOU. This means that security concerns and how difficult they find it to access the cloud platforms were the major challenges that influenced their use. Students may also not have incurred the actual cost of cloud computing applications since they were studying at home. The results are in line with other research in the literature and in addition to providing a Covid19 pandemic context. The outcomes of this study have a significant importance to online educators and cloud service providers who can use the findings to plan and adopt a cloud computing systems that will meet the needs of its users amidst pandemic.

Keywords: cloud computing; TAM; Covid19; challenges cloud computing.

CHAPTER 1: INTRODUCTION

The educational sector has had a sudden change in delivery mechanisms in the recent years. With the unfortunate emergence of the Covid19 pandemic, social distancing measures have been enforced by governments which meant calling halt on physical classes worldwide (Almaiah & Al-Khasawneh, 2020). Due to the difficulty in the continuity of classes and accessing resource materials, higher educational institutes needed to find an alternative to continue teaching and deliver quality materials to the students while maintaining social distance for health measures (Chick et al., 2020).

Given that many educational institutions were not ready to immediately migrate to a complete distance learning, many challenges emerged such as difficulties in conducting conventional classes, teachers unable to share class materials with students, the difference in geographical location and Lack of timely individualized students' feedback from teachers (Almaiah & Al-Khasawneh, 2020). In addition to difficulty in access, students in the classroom would have different engagement levels with the instructor depending on the availability of access to the facilities. The educational institutes had to find a way to try and resolve the above-mentioned problems to ensure quality learning for the students.

A number of studies have proposed cloud computing technologies as a viable solution to mitigate the challenges and facilitate the continuity of teaching and learning process (Agrawal, 2021; U. Singh & Baheti, 2017). The National Institute of Science and Technology (NIST) (2011) defines cloud computing as a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable resources such as networks, storage and applications. With the integration of cloud-based applications and services, both teachers and students found a way to interact and share course materials and carry out classes online. Although teachers have had to adopt different leaning styles and techniques which were quite unfamiliar, the use of cloud computing technologies has greatly improved on the current situation where by there is a certain degree of interaction and feedback between the instructors and students (Zdraveski, D., Janeska, M., Sotiroski, K. and Manceski, 2020).

Cloud computing infrastructure ensures high speed and efficiency in various activities in high educational institutes. Together with a systematic arrangement of resources, teachers and students are able to access email services, workshops and remote servers easily (Olaloye et al., 2019). With the integration of cloud computing in the educational system, teachers and students are able to implement different learning styles like flipped classroom or collaborative learning which are suitable in a setting where no physical classes are being held (Chick et al., 2020).

Though integration of cloud computing into higher educational institutes has greatly transformed the educational system, users of such a platform are exposed to a number of challenges and limitations.

Although a number of studies have tried to examine challenges of cloud-computing in higher education, there has been no study that explicitly examine these challenges in the context of the current pandemic. Covid19 pandemic has exposed institutions, especially new users, to new dimensions: drastic transition to distance learning, lack of proper training facilities, continued social distance restriction, anxiety as a result of Covid19 death and increased infection rates, and so forth (Agrawal, 2021; Almarzooq et al., 2020; Chick et al., 2020). Earlier studies in the literature mainly focused on cloud computing applications in blended learning rather than the full distance learning experience (Al-Samarraie & Saeed, 2018; Arpaci, 2019; Changchit et al., 2014). These studies mainly focused on a few academic institutions that had the facilities which is not the case today as many countries worldwide have embraced cloud computing technologies as a solution to ensure continuity of education during the Covid19 pandemic.

In light of the above, this study aimed at examining students' perceived challenges of using cloud-computing resource amidst pandemic. This study was based on student's opinion for three reasons: Since the objective of teaching is to improve learning outcomes, student's opinion will be significant towards improving the tools adopted. Secondly, statistically, the highest number of cloud computing users in the educational sector are students and therefore, their opinion will play a significant role in its successful adaptation and utilization in high educational institutes like Islamic University of Technology (IUT). Lastly, students also attend classes through video conference platforms like Google meet and zoom and in that way, they can interact with the teacher in real time which means that getting the students opinion and feedback about the cloud technologies in education will significantly contribute: to educators in selecting student-friendly cloud resources, to administrators in formulating policies with technology awareness and to developers in improving their tool to be more efficient and user friendly.

1.1 Aims and Objectives

The major aim of this study was to investigate the challenges that influence students use of cloud computing in higher educational institutes. The following objectives were constructed and used to guide the study towards achieving the above aim:

1. Identify the challenges that discourage students from using cloud computing applications in higher education.
2. To identify how ease of access influences students' usage of cloud computing.
3. To determine security concerns that affect students' use of cloud computing systems.

1.2 Research Questions

Although cloud computing tools have been widely adopted by many educational institutions and seen as the best viable solution for online learning during pandemic, the challenges faced by real users cannot be overlooked. The following are some of the research questions that were used to guide the study:

- What are challenges do students encounter in using cloud computing tools/systems?
- What are some of the security concerns that hinder students' use of cloud computing?
- Are there significant differences between perceived challenges among participating institutions?

1.3 Hypotheses

H1 – Perceived Ease Of Access (PEOA) has a direct effect on Perceived Usefulness (PU).

H2 – Perceived Cost Of Usage (PCOU) has a direct effect on Perceived Ease Of Use (PEOU).

H3 – Perceived Security Concerns (PSC) have a direct effect on Perceived Ease Of Use (PEOU).

1.4 Possible Outcomes

This study explored some of the challenges and issues that influence students use of cloud-based technologies from the students' perspective. The data collected is vital to any academic institute which is hoping to set up or integrate cloud computing services in its system. Knowledge of students' perspective in the use of cloud services can therefore help in setting up a suitable learning environment in terms of having the right resources to ensure better quality education.

The same data can be used by ICT experts in redesigning or developing the next generation of cloud applications for higher education which are in compliance with the needs and preferences of students in order to get the best experience in the new cloud-based learning environment and also add to the literature for further research in similar fields.

Secondly, this study will also inform the university authority about how students perceive the currently adopted cloud computing and how they can improve or adopt a different conducive system. With students' insight, given the current dynamics of Covid19 that require social distance and has resulted into social disconnect between authority and students, authority will be able to notice specific challenges and thereby improve the platform to be improve students' online experiences.

Lastly, by comparing different cloud computing tools, the study will provide merits and demerits of each platform and recommendation with which university may use during decision making on which platform to adopt.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

In this chapter, the researcher reviewed previous works which examined cloud computing or the use of cloud computing applications in the educational system. Many various studies have examined cloud computing and how it is integrated in the educational system with the use of cooperative learning styles like gamification, virtual collaborative e-learning and cloud rendering which offers more incentive to students and enhance the teaching and learning process (Agrawal, 2021). Cloud computing technologies also enable students to work together on documents and modify them at once (Çakiroğlu & Erdemir, 2019) and makes it possible for teachers and students to communicate and share any materials accordingly.

The aim of this review was to identify the existing gap in the literature as we try to investigate the challenges influencing cloud computing adoption in context with the Covid19 pandemic. Different aspects of cloud computing were discussed in details for example the meaning of cloud computing, some of its popular services and deployment models, the role cloud computing plays in education and the theoretical framework of the study all in relation to the previous studies.

2.2 Cloud Computing

2.2.1 Meaning of Cloud Computing

Cloud computing is a wide computing technology that has developed rapidly in the 21st century. Almost all devices like smartphones, smart appliances, personal computers and mainframe computers are integrated with cloud computing due to its benefits in terms of access to IT infrastructure resources.

There is no standardized definition of cloud computing agreed upon and the literature consists of various explanations of the concept. Among the most used definitions is one by the American National Institute of Science and Technology (2011) which states: "Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" (p. 2). The main attributes emphasized in this definition are on-demand self-service, broad network access, resource pooling, rapid elasticity and measured service.

Almaiah & Al-Khasawneh (2020) explains cloud computing as a way to provide computing resources such as processing, memory and storage remotely over the internet to the users. Their study emphasized that this kind of set up does not require the users to have any computing resources locally rather than a device to connect to the internet.

Ashtari and Eydgahi (2015) also stated that cloud computing is set of existing technologies like grid computing and software as a service (SaaS) combined together that operate businesses. Based on the concepts of grid computing, cloud computing enables delivery of high computing resources at low costs without dealing with the hardware.

Cloud computing can also be defined as a model for accessing rescources which may include network devices, storage and operating systems distributed as per requirement or operating on a pay as you go system (U. Singh & Baheti, 2017). Additionally, these shared computational resources operate at a remote server and can be accessed at anytime from any device with internet connection.

Futhermore, as technology advances, the access to cloud applications is possible with mobile devices since they have the capabilities and mobile cloud computing is a model where data storage, application and other cloud resources are transferred from mobile devices to cloud servers to provide high level computing (Arpaci, 2019).

Almaiah & Al-Khasawneh (2020) define mobile cloud computing a cloud computing integration infrastructure into a mobile environment that stores and processes data outside of mobile devices. This infrastructures ebnables different types of devices to access computing sources anywhere and at any given time.

This study will be mainly based on the definition of cloud computing by Almaiah & Al-Khasawneh (2020) which emphasises resource sharing and access remotely with only a connecting device on premise just like the educational institutes operate.

2.2.2 Cloud Computing Services and Deployment Models

Based on Olaloye et al. (2019), cloud computing has three main service models through which different companies offer cloud services to the clients. These include Infrastructure as a service (IaaS), Platform as a service (PaaS) and Software as a service (SaaS). Although there are some other models like *Mobile backend as a service, Serverless computing, Function as a service* but their use is not so popular as the main three (Mell & Grance, 2011).

- **Infrastructure as a Service**

  Infrastructure as a service (IaaS) provides the clients with basic computing infrastructures such as storage, virtual machines and networking components to help them run their applications without the need to personally manage the infrastructure. The users (students and teachers) control the software, data and operating system but not the storage and virtual machines and can easily be used in engineering simulations and running CAD software.

- **Platform as a service**

  If an organization only needs to create software, then Platform as a service (PaaS) is the service to use. PaaS provides a platform and runtime environment to enable users (students and teachers) to develop, test and maintain their applications and data while the rest of the architecture like operating system, virtual machines, storage etc. are controlled by the cloud service providers. This model can be used by IT departments to do any tests for student projects and the institution's software.

- **Software as a service**

  Software as a service (SaaS) is the service model which is best for hosting and managing software without any hardware requirements. Higher educational institutes have websites on which they communicate and post information related to the entire institute. This model can be helpful in hosting these websites since all the underlying architecture is managed and maintained by the service provider and there is no IT equipment required to use the SaaS service model.

Figure 1 shows different level components offered by each service model as compared to on-premise cloud management

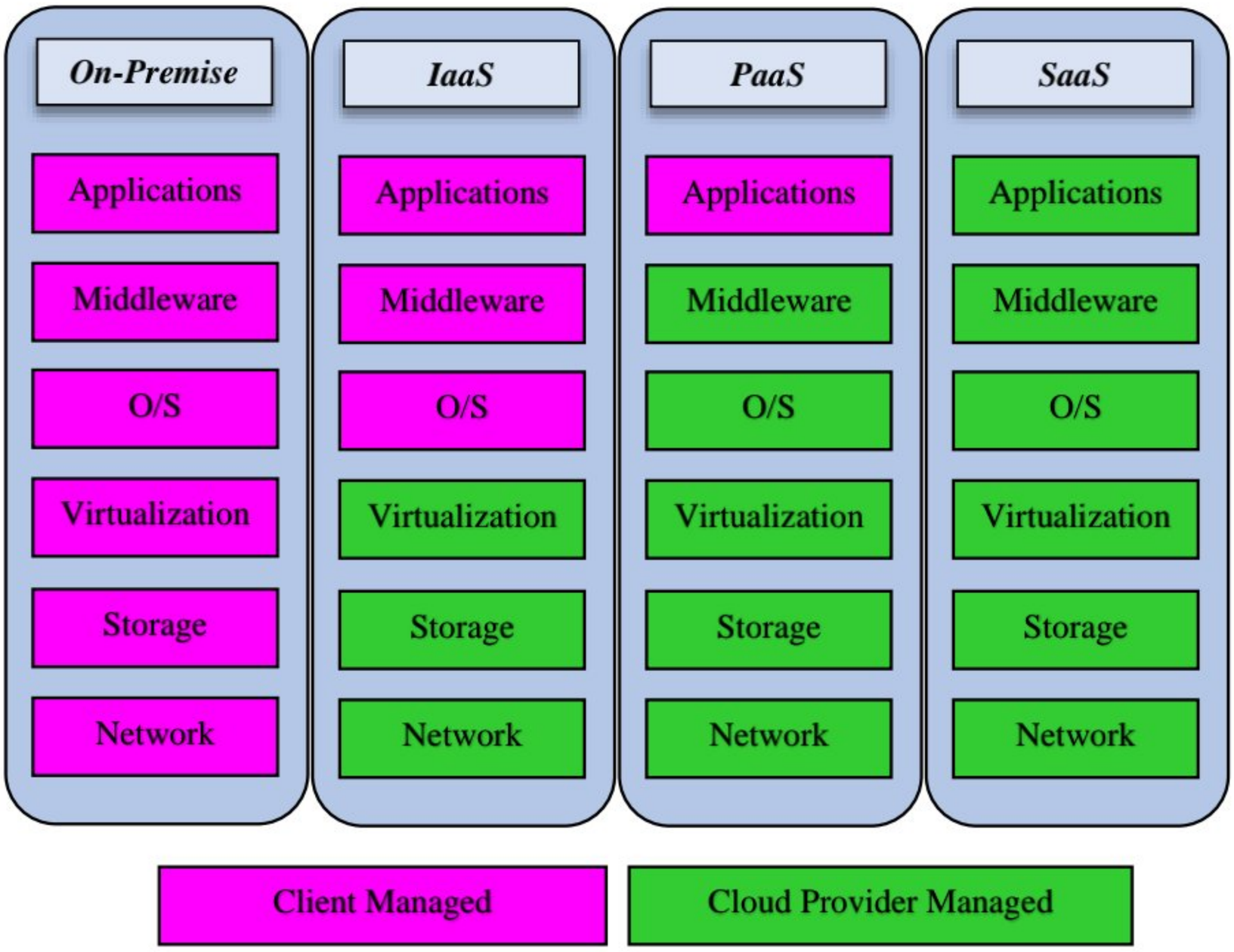

Figure 1 Cloud Computing Service Models

In the research from Attaran et al. (2017), there are three major models through which cloud computing can be deployed and an institution can deploy using any model depending on the needs.

- **Public:** The public cloud model is where the cloud infrastructure is available to the general public and is normally owned by the cloud service providers.
- **Private:** Private cloud is where the cloud infrastructure is owned by the individual company (institution) and can be managed by the company or a third-party organization.
- **Hybrid:** Hybrid cloud combines both public and private where some features can be from the public while others are private to the company.

The three deployment models are illustrated in figure 2.

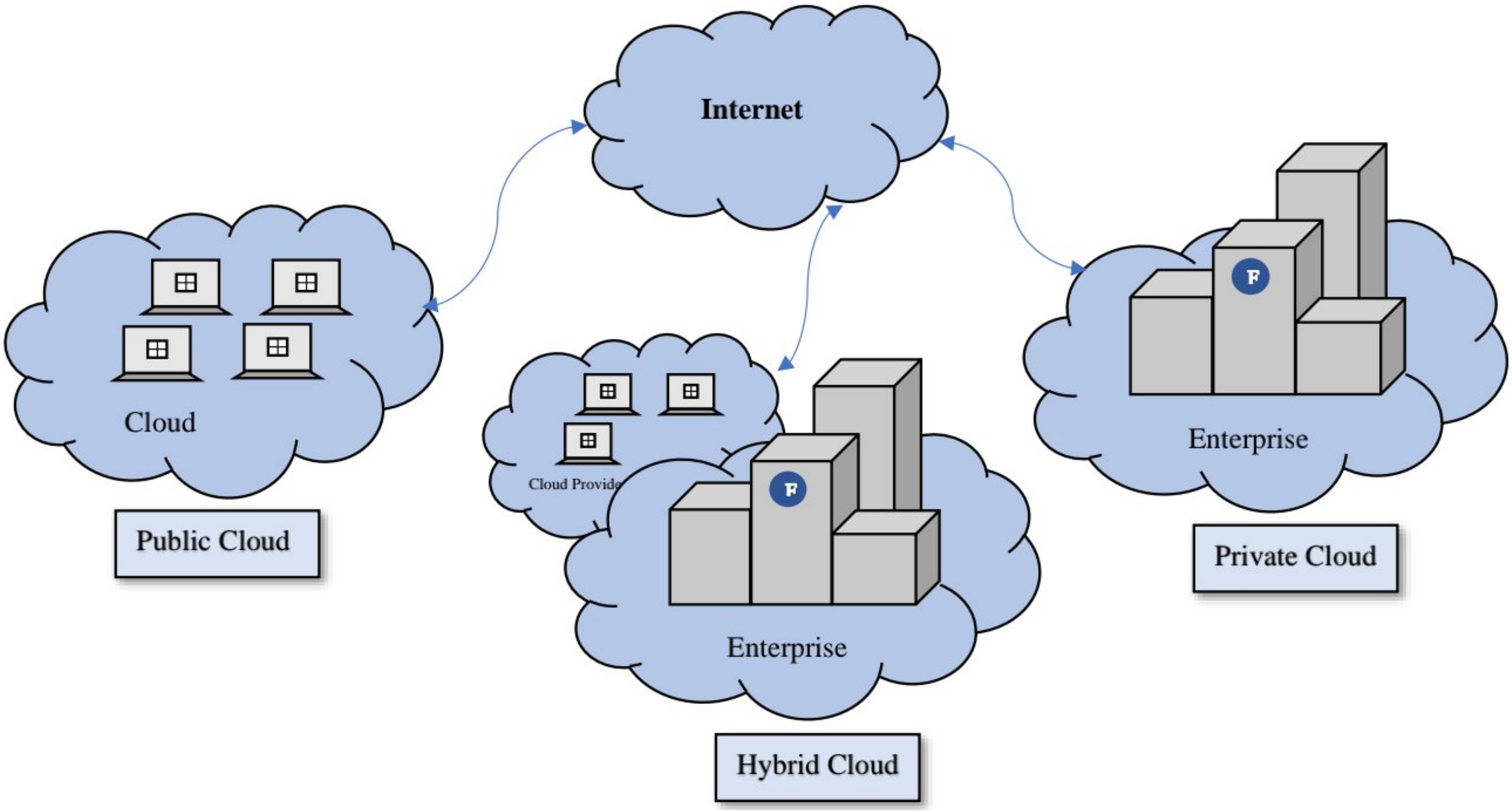

Figure 2 Cloud Computing Deployment Models

The knowledge of the models, figure 1 and figure 2 discusses different ways users access cloud computing. It was important especially when the researcher wanted to identify at what point in cloud computing models do users (student) face challenges.

2.2.3 Cloud computing in Higher Education

There is no doubt that cloud computing has a lot to offer for it provides different service and deployment models as discussed in the prior sections and they have been adopted in various sectors of private business and government facilities. The education sector is not any different as it has also benefited greatly from the integration of cloud computing into Higher institutes and several studies have been carried out about cloud computing and the role it plays in higher education.

2.2.4 Role and Application of Cloud Computing in Higher Education

The education sector has transformed greatly with the advancement in technology and cloud computing has contributed significantly to the transformation.

Agrawal (2021) pointed out the that major advantage of cloud computing in education is virtual collaborative learning. This kind of learning style is beneficial to both teachers and students for it can be used to integrate other IT technologies into the learning process. She also explained how cost-effective cloud computing is for users of the systems since they can do their specific works simultaneously without extra power needed and in addition, cloud computing does not require the hefty IT expenses of the traditional on-premise systems.

Some of the applications of cloud computing technologies in education according to (2021) include;

- Cloud rendering
- Gamification
- Collaborative eLearning
- Mobile cloud computing

2.2.4.1 Cloud rendering

Cloud rendering enables students to carry out virtual experiments remotely using virtual reality technology. This virtual reality technology, with the help of high-end graphics, provides a realistic environment for students to work with and fulfill the required practical part of the courses.

2.2.4.2 Gamification

Gamification highly boosts problem solving abilities among students and improves the motivation for learning when using cloud facilities by use of game-like environments like challenges and rewards. It is among the new techniques of teaching and can enhance the learning experience for students.

2.2.4.3 Collaborative eLearning

Collaborative learning is one of the major characteristics of cloud computing applications in the education sector. Students use collaborative learning tools to edit work such as projects, share class material and have any discussions or communication.

2.2.4.4 Mobile cloud computing

Mobile learning (m-learning) makes it possible for students to access cloud services using mobile devices like smart phones and tablets. Since mobile devices are a part of our daily lives, users can get access to valuable education information close at hand anytime and anywhere irrespective of geographical location.

In an investigation of the determinants of mobile cloud computing adoption, it was reported that due to the flexibility and convenience of mobile cloud computing, students are able to learn and study anywhere and at any time without the complication of installing software and hardware because only internet is required to run the cloud systems (Almaiah & Al-Khasawneh, 2020). He also added that mobile cloud computing

helps students to access their academic materials, videos, libraries and assignments or exams over the cloud via mobile devices.

The use of cloud computing technologies in higher education offers a much more increased computing performance as compared to setting up hardware manually, better accessibility to learning since access can be from anywhere through the internet, more storage capacity as provided by the service providers and all of these at a reduced cost (Almaiah & Al-Khasawneh, 2020).

Çakiroğlu & Erdemir (2019) explore ways in which cloud computing is beneficial in education in their study about online project based learning via cloud computing. Their research explained how cloud applications enable planning, collaboration and communication which makes it possible to attain quality learning goals with the use of electronic boards, emails and chat messages for students to share ideas and build cognitive knowledge.

Çakiroğlu & Erdemir (2019) also noted that with cloud computing, students can digitally work on documents simultaneously and modify artifacts. This, therefore, can support interaction between students and teachers through flexible learning scenarios, communication and sharing among students.

Olaloye et al. (2019) in his research supported cloud computing as being beneficial to educational institutes in diverse ways, some of which are;

- Diversified learning, where the learning environment becomes more dynamic and effective as students get more exposed to a variety of software and relevant resources in the cloud.
- Elasticity and scalability, where the resources available can meet the changing demand without need for supply of more IT infrastructure and ensuring high quality services.

2.2.5 Challenges of Cloud Computing in Higher Education

The use of cloud computing in higher education changed many aspects of teaching and learning in a positive way but it was not without some drawbacks.

Somya Agrawal (2021) in his study discussed three major issues of concern when it comes to implementing cloud computing in the educational system.

Firstly, she pointed out the security concerns of using cloud computing applications. The security, protection and integrity of the data handled is very important especially for the departments that deal with research and development. There is a lot of intellectual property which must be well protected when using a system that can be accessed remotely.

Secondly, the awareness of the different opportunities that can be utilized by adopting to cloud computing is at a minimal. Many universities do not have all the necessary information about these systems and hence lack in terms of preparedness to cloud computing.

Thirdly, despite cloud computing not requiring much of the IT infra structure to operate, it still needs a few facilities like a basic computer for the users and good broadband internet for proper connectivity which was supported in another study by Zdraveski, Janeska, Sotiroski and Manceski. This is a major problem in some of the universities and can hinder the smoothing working of the system (Zdraveski, D., Janeska, M., Sotiroski, K. and Manceski, 2020).

Olaloye et al. (2019) addresses some of the data security concerns of cloud computing in education in his study, Cloud Computing in Education Sector: An Extensive Review. Their study emphasized two main challenges: vender lock-in and reliability, as the other problems faced by institutions when dealing with cloud applications. Vendor lock-in is where the institution cannot transfer its data from one service provider to another even if better services are offered elsewhere whereas reliability focusses on the system's proneness to failure or crushing which can deny the clients access to their data until the system is restored (Olaloye et al., 2019).

While the deployment models and services cloud computing offers can transform the education system today as discussed above although it may have with some challenges to overcome. This study mainly has a chance to focus on these challenges in the context of Covid19 which was a main turning point of many institutions to transform to using various cloud applications (Agrawal, 2021).

Students opinion in this research is also important in addition to the context of Covid19 as they are the direct users and beneficiaries of the cloud computing applications chosen by the institution and today's education should be more focused on the students, their requirements and expectations (Zdraveski, D., Janeska, M., Sotiroski, K. and Manceski, 2020).

2.3 Theoretical Framework

Based on literature review, researchers adopt different models to investigate behaviors of users as they adopt to new technologies (Arpaci, 2019; Khan Afridi et al., 2020; Olaloye et al., 2019). According to Arpaci (2019), the original model, "Theory of Reasoned Action" (TRA), which explains the relationship between attitudes and behaviors within the context of human action, and is usually modified based on the study's preferences.

Olaloye et al. (2019) in their research discuss some of the common frameworks analyzing technology adoption which include;

I. Technology organization environment (TOE) model which elucidates the adoption of technology in an organization explains how the adoption and implementation of technological innovations are controlled by different technological, organizational and environmental context.
II. Human organization technology fit (HOT-fit) model. This particular model is used for evaluating technology adoption for health their information systems
III. Technology acceptance model (TAM) model, used to model user acceptance and usage of technology.

There different reasons and theories upon which people accept or adopt to different kinds of technology. In 1989, Davis developed a model of technology acceptance called Technology Acceptance Model (TAM) which was widely used to determine users' acceptance of technology (Almaiah & Al-Khasawneh, 2020; Khan Afridi et al., 2020; Ma & Liu, 2011). This model looks at the students' perceptions towards the usefulness of technology, ease of use, and attitudes to predict technology use and challenges they face during its implementation.

This study will be based on the TAM with modifications to suite the purpose of the study. Some of the factors included are; Perceived Usefulness (PU); Perceived Ease Of Use (PEOU); Perceived Ease Of Access (PEOA); Perceived Cost Of Usage (PCOU); Perceived Security Concerns (PSC).

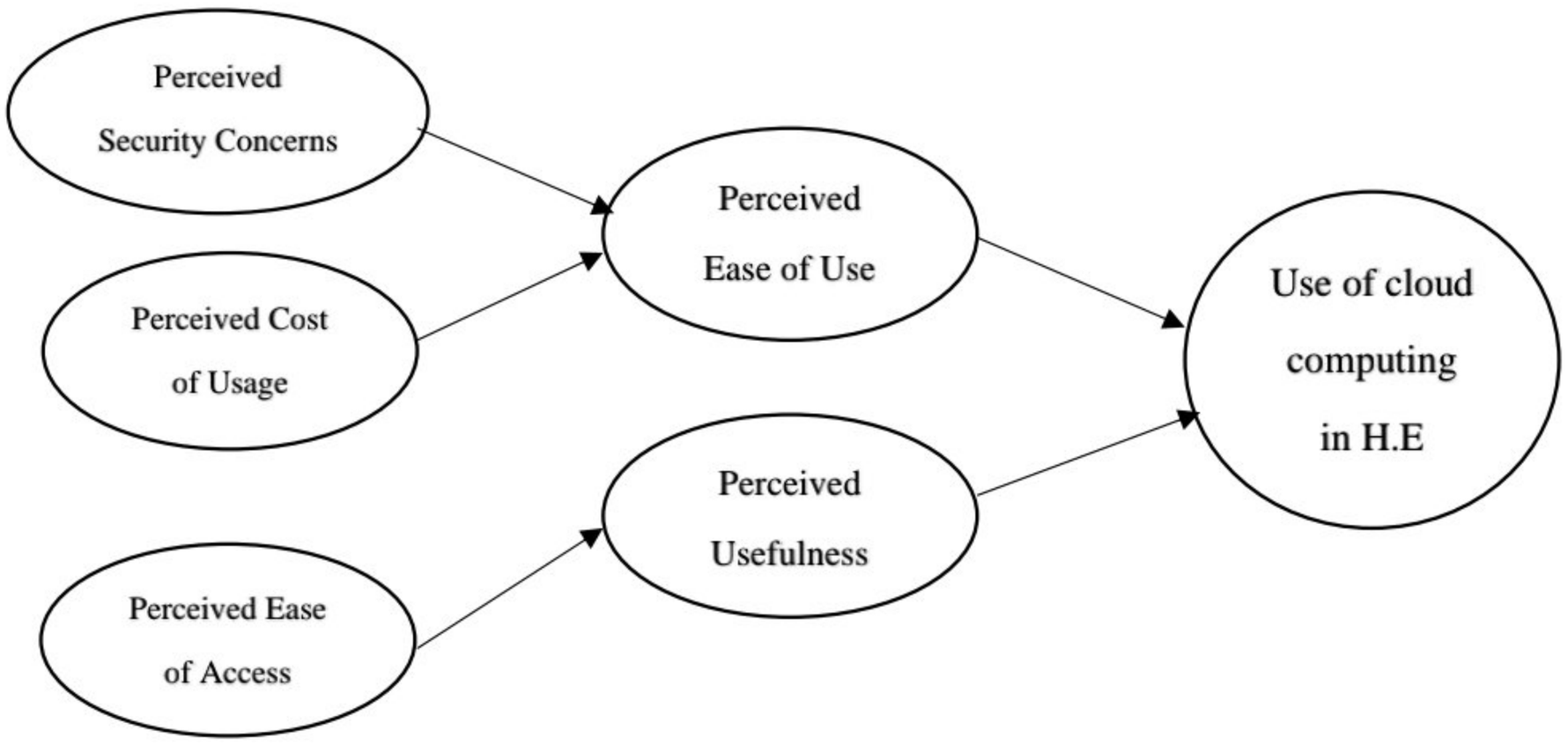

Figure 3 Proposed Measurement Model

- **Perceived Usefulness (PU):** the user's expectation to work more effectively and faster when using a specified system which plays a big role in a student's intension to use.

- **Perceived Ease Of Use (PEOU)**: This important for many users new to a technology. It's the degree to which a student expects the system to be clear and fairly understandable to use.
- **Perceived Ease Of Access (PEOA):** The level to which the student expects a system to be ubiquitous. This is really important for the student's convenience.
- **Perceived Cost Of Usage (PCOU):** This is usually in terms of internet required, accessories and other expenses which can also influence greatly how much a student accepts the technology.
- **Perceived Security Concerns (PSC):** Also influence technology acceptance since there is a lot of sensitive data to deal with. Students concerns regarding his/her security while using technology.

This model was customized to suit the study by including Perceived ease Of Access (PEOA), Perceived Cost Of Usage (PCOU) and Perceived Security Concerns (PSC) These were the independent variables and challenges effected Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) as shown in figure 3. It was recommended by Elkaseh et al. (2016) to revise the model and later proved and supported by Ibrahim et al. (2018).

CHAPTER 3: METHODOLOGY

3.1 Research Procedures

This quantitative study was conducted to investigate the challenges and issues that influence students use of cloud computing technology in higher education. Survey research was adopted to provide great accuracy in the data collected from which a conclusion or generalizable findings can be reached. Through this approach, the study collected enough data that was denoted with numerical values to each of the responses collected for ease analysis with the help of IBM Statistical Package for Social Science (SPSS). The result from the analysis was reported in form of charts and graphs for easy understanding.

3.2 Participants

Participants of this study were chosen amongst students from higher education institutions that were using cloud resources for their online education during the Covid19 pandemic. Cloud computing resources considered included online virtual classes, learning management systems, google educational suite and many more cloud-based learning applications and systems. The sample selection was specified to reachable engineering institute which included Brac University (BU), Islamic University In Uganda (IUIU), Islamic University of Technology (IUT), Kampala International University (KIU), Metropolitan International University (MIU) and North South University (NSU). The sampling method of choice was purposive sampling which was the most highly recommended method for selecting participant who bear specific traits, which in our case was the use of cloud computing resources during pandemic. The Covid19 social distancing protocols did not give room for easy access to participants of the study during lockdown (Agrawal, 2021; Juma & Tjahyanto, 2019; Zdraveski, D., Janeska, M., Sotiroski, K. and Manceski, 2020) and thereby, the study adopted online survey forms. Cochran's formula shown in Equation: 1 was used to estimating the sample size in order to reduce sampling errors (Etikan & Babatope, 2019).

$$\frac{\frac{Z^2 . p(1-p)}{e^2}}{1 + (\frac{Z^2 . p(1-p)}{e^2 N})}$$

Equation: 1

The equation parameters are as follows: *Z-score at 95% confidence is 1.96; Population proportion p is 0.5; Margin of error e is 0.04*

The sample size is calculated to be 350 of the total population which represents 11%.

3.3 Research Tools/Instrument

There are many various methods of data collection for both quantitative and qualitative studies as stated by Basavanthappa (2007) in his research. These include interviews, focus group discussions, questionnaires, observation, case study and many more but for this study, the questionnaire was the instrument of choice to fit the quantitative nature of the data. The questionnaire was best fit for data collection to obtain the most accurate data with less bias and since the sample size is quite large, which ensured collection of much data in a short period of time. Distributing the instrument online also proved very convenient given the health precautions of social distancing in the Covid19 period set by the local government to ensure safety of people (Almarzooq et al., 2020).

The study adopted from an existing validated questionnaire which was developed for the TAM model and after an extensive literature review, it was customized based on the research objectives (Ashtari & Eydgahi, 2017). The final instrument consisted of two parts: part A dedicated to 3 demographic questions and part B for 20 Likert scale (1=strongly disagree to 5=strongly agree). Items of the perceived challenges were grouped into five categories based on TAM theoretical model to construct questions that explored perceived difficulty of use of cloud computing system as listed below:

- **Perceived Usefulness (PU)**

  The user's expectation to work more effectively and faster when using a specified system which plays a big role in a student's intention to use.

- **Perceived Ease Of Use (PEOU)**

  This important for many users new to a technology. It's the degree to which a student expects the system to be clear and fairly understandable to use.

- **Perceived Ease Of Access (PEOA)**

  The level to which the student expects a system to be ubiquitous. This is really important for the student's convenience.

- **Perceived Cost Of Usage (PCOU)**

  This is usually in terms of internet required and accessories which can also influence greatly how much a student accepts the technology.

- **Perceived Security Concerns (PSC)**

Also influence technology acceptance since there is a lot of sensitive data to deal with. Students' concerns regarding their security while using technology.

3.4 Reliability and Validity of the Questionnaire

As the instrument was further customized, it was important to carry out another validity and reliability test to ensure that the tool used involves items that are essential and reliable and eliminates any unnecessary. First face validity was carried out with the supervisor and 3 experts in the related field and the different items in the instrument were categorized as favorable or unfavorable. In order to determine the face validity, the data was analyzed using Kohens Kappa index and a Kappa value of 0.82 was obtained (Taherdoost, 2016).

Additionally, to ensure content validity, the research instrument was sent to 8 panelists in the same field for evaluation. This content validity test was to determine the degree to which items reflect the content universe to which the instrument will be generalized. Items were judged on a three-point scale i.e., not necessary, useful but not essential and essential. Items that are undesirable are eliminated and only remain with essentials. 7 of the 8 panelist judges essential and the corresponding Content Validity Ratio (CVR) was using Lawshe's method and a valid CVR value of 0.75 was obtained as shown in Equation: 2.

$$CVR = \frac{ne - (\frac{N}{2})}{\frac{N}{2}}$$

Equation: 2

Where CVR is content validity ratio, *ne* is the number of panelists indicating essential and *N* is the total number of panels. In the equation, the value, 7 panelists voted essential and the CVR was 0.75 which is the minimum acceptable value for the given number of panelists at p = 0.5.

To ensure reliability, Cronbach Alpha coefficient is one of the most appropriate measures of reliability when using the Likert scales in a research instrument (Taherdoost, 2016). A pilot study was carried out with a few participants from the population and IBM Statistical Package for the Social Sciences (SPSS) version 23 was used to analyze the collected data an internal consistency of $\alpha = 0.638$ was obtained shown in table 1.

Table 1 Cronbach Alpha Coefficient for pilot study

Reliability Statistics

Cronbach's Alpha	N of Items
.638	20

Taherdoost (2016) also mentions in his study that most rules agree on a minimum internal consistency of $\alpha \geq 0.7$ as shown in the table 2 however for a pilot study like this, the reliability coefficient can be equal or above 0.6.

Table 2 Cronbach's Alpha table

Cronbach's alpha	Internal consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

3.5 Ethical Consideration

This study adhered to ethical research standards before data gathering commenced to ensure credibility of the results. The researcher initially sent a letter to participating institutions (gateway institutions) seeking for their permission to carry out this study. Once permission was obtained, an informed consent form was sent to prospective participants via email or social media. Informed consent form comprised of: a detailed information about the study, why the study was being carried out, how the data was be used, a provision to voluntarily accept or decline from participating, and signature or checkbox to consent. At any point, before or during the data gathering, a participant was able to be granted the privilege to withdraw from the study. Participants were reassured of their privacy and confidentiality of their opinion. Their respective opinion was coded to ensure anonymity of participation.

The essence of anonymity is that the information provided by participants was not to reveal their identity. To maintain anonymity and to ensure honest response, information that could specially identify the student was not asked.

In light of the Covid19 pandemic regulations, this study adopted online questionnaire to ensure that the participants respect and follow social distancing policies. All consent forms were digitally sent to corresponding institutions and participants via their email.

CHAPTER 4: DATA ANALYSIS AND RESULTS

4.1 Demographic

Part A of the collection instrument was dedicated to three (3) demographic questions which covered institution, level of education, and gender of the participant and are represented in the tables 3, 4 and 5. There were students from 6 different universities that responded to the questionnaire and the frequencies in table 3 show that majority of the respondents were from Islamic University of technology (IUT) with 47.9% followed by Islamic University in Uganda (IUIU) with 23.5%. The rest had lower responses compared to the first two with some universities contributing less than 20 participants.

Table 3 Frequency distribution by institution

Frequency based on name of institution.

	Frequency	Percent	Valid Percent	Cumulative Percent
Brac University (BU)	40	11.2	11.2	11.2
Kampala International University (KIU)	34	9.5	9.5	20.7
Islamic University In Uganda (IUIU)	84	23.5	23.5	44.3
Islamic University of Technology (IUT)	171	47.9	47.9	92.2
Metropolitan International University (MIU)	13	3.6	3.6	95.8
North South University (NSU)	15	4.2	4.2	100.0
Total	357	100.0	100.0	

There were more responses from the male participants which were 69.7% of the total responses compared to the female participants who contributed 30.3% (table 4). As shown in table 5, the participants stretched across all levels of higher education from 1st year undergraduate students (10.6%) to post graduate students (20.2%) and also diploma (5.9%). 3rd year students were the majority group to respond with 26.6% and closely followed by 2nd year with 24.9% and finally 4th year participants were 11.8%. This could be because many institutions prioritized the finalists during the Covid19 lock-down period for example in Uganda where only final year students studied for several months while the rest had not yet started.

Table 4 Frequency distribution by gender

Frequency based on gender

	Frequency	Percent	Valid Percent	Cumulative Percent

Female	108	30.3	30.3	30.3
Male	249	69.7	69.7	100.0
Total	357	100.0	100.0	

Table 5 Frequency distribution by academic level

Frequency based on year of study.

	Frequency	Percent	Valid Percent	Cumulative Percent
1st year Undergrad	38	10.6	10.6	10.6
2nd year Undergrad	89	24.9	24.9	35.6
3rd year Undergrad	95	26.6	26.6	62.2
4th year Undergrad	42	11.8	11.8	73.9
Diploma	21	5.9	5.9	79.8
Post graduate	72	20.2	20.2	100.0
Total	357	100.0	100.0	

4.2 Data Analysis

Data analysis process was mostly carried out using IBM Statistical Package for the Social Sciences (SPSS) to determine the validity and reliability tests as well as testing the hypothesis. Since the measurement model was modified from literature, the study carried out the corresponding tests to ensure validity and reliability.

Firstly, compound variables i.e., Perceived Usefulness (PU), Perceived Ease Of Use (PEOU), Perceived Ease Of Access (PEOA), Perceived Cost Of Usage (PCOU), Perceived Security Concerns (PSC) were created as a result of calculating the means of the sub-items from the measurement model and hence the distribution of the data was to be tested i.e., test of normality by dividing the skewness/kurtosis statistic value by the standard error. Table 6 shows the significance based on Shapiro-Wilk measurement (K. Singh, 2007).

Table 6 Shapiro Wilk normality test results

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
PU	.261	357	.000	.888	357	.000
PEOU	.236	357	.000	.839	357	.000
PEOA	.259	357	.000	.889	357	.000

PCOU	.324	357	.000	.829	357	.000
PSC	.222	357	.000	.877	357	.000

a. Lilliefors Significance Correction

An item is considered normally distributed if it has a significance value (Sig.) greater than or equal to 0.05 and from the result table 6, the significance values of all the test items are less than 0.05 which means the data is not normally distributed.

4.2.1 Validity and Reliability Test

After confirming that the data is not normally distributed, the measurement of fit was carried out. The Goodness-of-Fit test yielded the results as shown in the table 7. A model is said to be fit for the data if the goodness-of-fit has a significant value i.e., Sig. < 0.05 and therefore result table shows that our model is a good fit.

Table 7 Goodness fit test results

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	547.599			
Final	533.267	14.332	2	.001

Link function: Logit.

For construct reliability, the factor loading (alpha>=0.5), composite reliability (CR>=0.7), average variance extracted (AVE>=0.5) and Cronbach alpha (alpha>=0.7) were calculated and that indicated that the measurement model is highly reliable. Items of PU2 And PEOA2 were removed in the test as their factor loadings (0.350) were way below the threshold and can affect other tests (K. Singh, 2007).

Table 8 Factor loading, Composite reliability, Average variance extracted and Cronbach's alpha results

Factor	Item	Factor Loading	CR	AVE	Cronbach's alpha
PU	PU1	0.868	0.839667	0.775437	0.748
	PU3	0.893			
PEOU	PEOU1	0.861	0.631404	0.594689	
	PEOU2	0.63			

	PEOU3	0.76		
	PEOU4	0.82		
	PEOU5	0.765		
PEOA	PEOA1	0.893	0.843037	0.780663
	PEOA3	0.874		
	PCOU1	0.838		
PCOU	PCOU2	0.589	0.62731	0.548609
	PCOU3	0.738		
	PCOU4	0.775		
	PSC1	0.89		
	PSC2	0.879		
PSC	PSC3	0.579	0.659349	0.636418
	PSC4	0.715		
	PSC5	0.878		

From table 8, the first column values of factor loadings range from 0.589 – 0.918 which are all higher than 0.5 and the next column of composite reliability two are more than 0.7 but not all above threshold but close. The average variance extracted is above threshold ranging from 0.548-0.781 and lastly the Cronbach alpha value is 0.748 which is above the minimum acceptable alpha value. These results ensure that not only is the data reliable but also valid and will not yield any invalid correlation computations in the next step of the analysis.

4.2.2 Correlation between Constructs

The researcher went ahead to determine the correlation coefficient value between the constructs that were measured. Correlation between constructs is regarded strongly positive if the correlation coefficient value is 8.0 and above whereas 0.6 – 0.8 is moderately strong and below that it is either fair or poor as it was explained in other research (Ibrahim et al., 2018).

Based on the measurement model, the correlations that were determined were between PU with PEOA, PEOU with PSC and lastly PEOU and PCOU. The table 9 shows a strong positive correlation between PU and PEOA with a correlation coefficient value of 0.99 and the other two correlations are poor or insignificant.

Table 9 Correlation between PU and PEOA results

Correlations (PU → PEOA)

			PU	PEOA
Spearman's rho	PU	Correlation Coefficient	1.000	
		Sig. (2-tailed)	.	
		N	357	
	PEOA	Correlation Coefficient	.999**	1.000
		Sig. (2-tailed)	.000	.
		N	357	357

**. Correlation is significant at the 0.01 level (2-tailed).

Table 10 Correlation between PEOA and both PSC and PCOU results

Correlations (PEOA → PSC and PEOA → PCOU)

			PEOU	PSC	PCOU
Spearman's rho	PEOU	Correlation Coefficient	1.000		
		Sig. (2-tailed)	.		
		N	357		
	PSC	Correlation Coefficient	.208**	1.000	
		Sig. (2-tailed)	.000	.	
		N	357	357	
	PCOU	Correlation Coefficient	.002	.123*	1.000
		Sig. (2-tailed)	.965	.020	.
		N	357	357	357

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

4.2.3 Model Coefficients and Hypothesis Testing

After testing for normality to determine the distribution of the data and computing the corresponding validity and reliability together with the correlation between the constructs, the researcher went ahead to estimate the relationship between the variables which were measured from the model and this next step ensured the validity of our hypotheses.

Path analysis technique was applied to measure path coefficients and determine the relationship between the dependent and independent variables. This relationship between the two constructs is considered

significant if the value of the t-test statistic is higher than 1.96 and the p-value is less than 0.05 at a confidence level of 95%.

In the first case, we have two independent variables i.e., PSC and PCOU which should have an effect on the dependent variable (PEOU) and the second part of the measurement model has one independent variable and one dependent variable which are PEOA and PU respectively. The tables 10 and 11 show in detail the results of the path coefficient computed for each relationship in our model.

Table 11 *Path coefficient results for PEOU as dependent variable*

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	3.166	.245		12.946	.000	2.685	3.647
	PCOU	-.003	.049	-.003	-.053	.958	-.100	.094
	PSC	.189	.045	.219	4.195	.000	.101	.278

a. Dependent Variable: PEOU

Table 12 *Path coefficient results for PU as dependent variable*

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	.083	.020		4.076	.000	.043	.123
	PEOA	.978	.005	.995	179.373	.000	.968	.989

a. Dependent Variable: PU

From the results of path coefficients shown in the tables 11 and 12, only two hypotheses, H1 and H3 are supported and H2 is not supported. This means that according to the results, PSC of cloud computing have a small but significant effect on PEOU of the system with a t-statistic value of 4.195 and a corresponding path coefficient value of 0.219. Similarly, the effect of PEOA on Perceived Usefulness of cloud computing (PU) is seen to be strongly positive with a t-statistic value of 179.373 and a path coefficient of 0.995.

H2 was computed to have t-statistic value of -0.053 which is less than 1.96 and the value of significance being greater than 0.05 clearly indicates that PCOU does not have an effect on PEOU as previously stated by the hypothesis. Since the participants of the study were students, they might not have incurred direct cost of using cloud computing tools and applications and thereby not experiencing any cost implication to their ease of use.

The figure 4 shows the measurement model with the standardized path coefficients for the paths in the hypotheses.

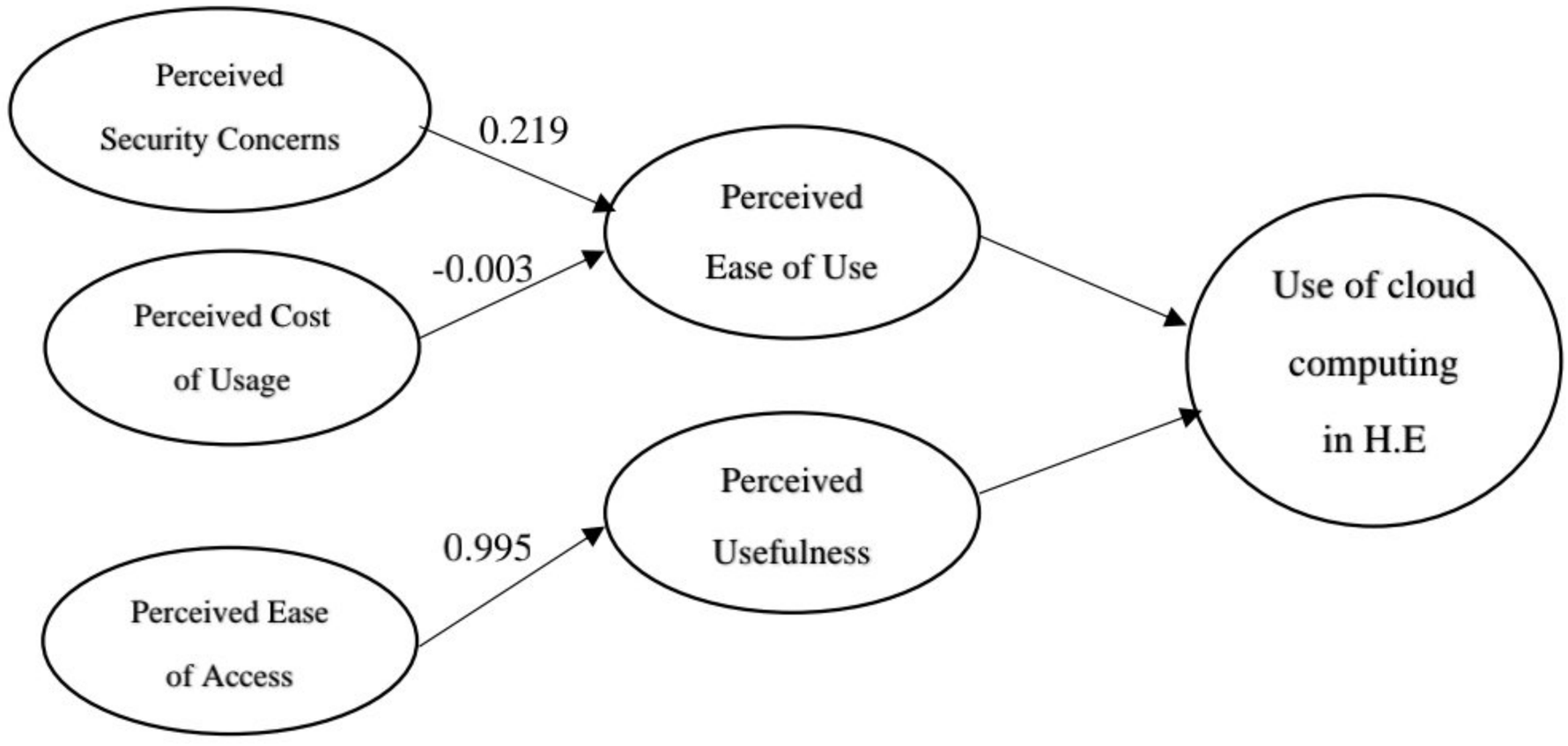

Figure 4 Measurement Model with Standardized Coefficients

CHAPTER 5: DISCUSSION AND CONCLUSION

The major aim of this study was to investigate the challenges that influence students use of cloud computing in higher educational institutes. The Covid19 pandemic provided a different context from the existing literature and students' opinion was important to asses these challenges.

The results of this study indicate that the ease students have to access the various cloud computing applications has a very strong effect on how useful they perceive them. Similarly, the presence of security concerns amongst these students affects how easily they use the cloud computing systems without any hesitation. On the other hand, the results suggest that cost of usage does not have any impact on the PEOU as had been hypothesized.

5.1 Interpretation

We can draw conclusions from the data based on the observed patterns and relationships. Some students like, third year and second years, appear to use the system more than the diplomas and the first-year students. The most significant result from the analysis was how much of an effect PEOA has on the PU according to the students. This means that poor accessibility to cloud computing, whether in educational institutes or in the comfort of their homes, is seen as a major challenge that affects student's perception. This is a major challenge as students will deem a system irrelevant or not useful on the fact that they have trouble accessing it, which is in line with previous studies (Almaiah & Al-Khasawneh, 2020; Juma & Tjahyanto, 2019).

Additionally, in line with the third hypothesis (*H3*), the data indicated that among the challenges that influence student's use of cloud computing are security concerns. If the students do not feel safe using the system or are suspicious of any threats from using the system, it will affect how easily they get to use cloud computing applications (Nayar & Kumar, 2018; Olaloye et al., 2019). There was no significance effect identified between cost of using cloud computing applications and the ease with which students use said systems as previously hypothesized (*H2*). As the study was carried out on students in higher education, they might not have incurred a direct cost of using cloud computing tools and applications and thereby not experiencing any cost implication. The global pandemic which forced many students to study at home (Chick et al., 2020), which meant that some of the previous expenditures like hostel accommodation and transportation were not expected as classes were conducted remotely. This meant that using cloud computing did not in any way affect them financially.

These results of the study also helped to address the previously stated research question about some of the challenges that could be encountered by students while using cloud computing system. Clearly, the major

issues include security concerns and accessibility in addition to other challenges that they may have encountered.

5.2 Implications

Results build on existing evidence of challenges influencing the use of cloud computing in higher education and provide a different context of the Covid19 pandemic. It is important to note that the outcome of this study helps to understand students' opinion on what they consider challenging when using cloud computing applications during unprecedented moment like pandemics.

Students are part of the primary users of educational cloud applications which makes their input important (Zdraveski, D., Janeska, M., Sotiroski, K. and Manceski, 2020). Students' opinion and feedback about the cloud technologies in education significantly contributes a clearer understanding of their preferences and can help educational institutes in selecting cloud resources to fit student's need to feel secure while using them.

Lastly, these results should be taken into account when considering how to develop future cloud computing tools as ease of access and security are key aspect. Developers can now focus more on creating systems that are secure at all levels and can be accessed without much underlying infrastructure.

5.3 Limitations

The generalizability of the results is limited by the adopted theoretical framework as a measurement model being limited to five items. This was done to try and fit the given time scope of the research for it could have been further modified to include other constructs like Intension to use and computer self-efficacy (Ibrahim et al., 2018). This can help generate more results in relation to challenges that influence students' use of cloud computing in higher education and also provide a different perspective on the correlation between the constructs.

Due to the lack of data on different cloud computing systems used by different institutions, the results cannot confirm whether there is a significant difference between the perceived challenges among the participating institutions. This information would have provided a different insight into how the educational institutions' preferences and approaches to the use of cloud computing systems.

Furthermore, the methodological choices were constrained by the fact that the study was mostly carried out during Covid19 pandemic lockdown and this greatly hindered the data collection process. It was difficult to access the required number of participants and this led to adoption of purposive sampling which is not the most ideal and the sample size was just minimal but without much variety.

5.4 Recommendations

Further research is needed to establish the effect of other items of the theoretical model on PU and PEOU in relation to those in the current study. Items like computer self-efficacy and intension to use can provide a different view on the challenges that influence the use of cloud computing in higher education.

Research with different approach on methodology like use of stratified sampling to group cloud computing technologies or a qualitative study can adopt from this study to try and investigate the research problem in a different context.

The study also focuses on quantitative research methodology and the use of survey questionnaire for data collection. A mixed method approach can also be used in future works.

Reference

Agrawal, S. (2021). A Survey on Recent Applications of Cloud Computing in Education: COVID-19 Perspective. *Journal of Physics: Conference Series*, *1828*(1). https://doi.org/10.1088/1742-6596/1828/1/012076

Al-Samarraie, H., & Saeed, N. (2018). A Systematic Review of Cloud Computing Tools for Collaborative Learning: Opportunities and Challenges to The Blended-Learning Environment. *Computers and Education*, *124*(May), 77–91. https://doi.org/10.1016/j.compedu.2018.05.016

Almaiah, M. A., & Al-Khasawneh, A. (2020). Investigating the Main Determinants of Mobile Cloud Computing Adoption in University Campus. *Education and Information Technologies*, *25*(4), 3087–3107. https://doi.org/10.1007/s10639-020-10120-8

Almarzooq, Z. I., Lopes, M., & Kochar, A. (2020). Virtual Learning During the COVID-19 Pandemic: A Disruptive Technology in Graduate Medical Education. *Journal of the American College of Cardiology*, *75*(20), 2635–2638. https://doi.org/10.1016/j.jacc.2020.04.015

Arpaci, I. (2019). A Hybrid Modeling Approach for Predicting the Educational Use of Mobile Cloud Computing Services in Higher Education. *Computers in Human Behavior*, *90*, 181–187. https://doi.org/10.1016/j.chb.2018.09.005

Ashtari, S., & Eydgahi, A. (2017). Student Perceptions of Cloud Applications Effectiveness in Higher Education. *Journal of Computational Science*, *23*, 173–180. https://doi.org/10.1016/j.jocs.2016.12.007

Attaran, M., Attaran, S., & Celik, B. G. (2017). Promises and Challenges of Cloud Computing in Higher Education: A Practical Guide for Implementation. *Journal of Higher Education Theory and Practice*, *17*(6), 20–38.

Basavanthappa, B. (2007). Methods of Data Collection. In *Nursing Research* (pp. 278–278). https://doi.org/10.5005/jp/books/10557_13

Çakiroğlu, Ü., & Erdemir, T. (2019). Online Project Based Learning Via Cloud Computing: Exploring Roles of Instructor and Students. *Interactive Learning Environments*, *27*(4), 547–566. https://doi.org/10.1080/10494820.2018.1489855

Changchit, C., Texas, A., & Christi, M. U. (2014). Students' Perceptions of Cloud Computing. *Issues In Information Systems*, *15*(I), 312–322. https://doi.org/10.48009/1_iis_2014_312-322

Chick, R. C., Clifton, G. T., Peace, K. M., Propper, B. W., Hale, D. F., Alseidi, A. A., & Vreeland, T. J. (2020). Using Technology to Maintain the Education of Residents During the COVID-19 Pandemic. *Journal of Surgical Education*. https://doi.org/10.1016/j.jsurg.2020.03.018

Elkaseh, A. M., Wong, K. W., & Fung, C. C. (2016). Perceived Ease of Use and Perceived Usefulness of Social Media for e-Learning in Libyan Higher Education: A Structural Equation Modeling Analysis. *International Journal of Information and Education Technology*, *6*(3), 192–199. https://doi.org/10.7763/ijiet.2016.v6.683

Etikan, I., & Babatope, O. (2019). A Basic Approach in Sampling Methodology and Sample Size Calculation. *MedLife Clinics*, *1*, 1006.

Ibrahim, R., Leng, N. S., Yusoff, R. C. M., Samy, G. N., Masrom, S., & Rizman, Z. I. (2018). E-learning Acceptance Based on Technology Acceptance Model (TAM). *Journal of Fundamental and Applied Sciences*, *9*(4S), 871. https://doi.org/10.4314/jfas.v9i4s.50

Juma, M. K., & Tjahyanto, A. (2019). Challenges of Cloud Computing Adoption Model for Higher Challenges of Cloud Computing Adoption Model for Higher Education Level in Zanzibar (the Case Study of SUZA and ZU). *Procedia Computer Science*, *161*, 1046–1054. https://doi.org/10.1016/j.procs.2019.11.215

Khan Afridi, W. A., Hashim, H., & Kuppusamy, M. (2020). The Critical Success Factors of Professional Networking Sites' Adoption by University Students. *Test Engineering and Management*, *82*(1–2), 653–673.

Ma, Q., & Liu, L. (2011). The Technology Acceptance Model. *Advanced Topics in End User Computing, Volume 4*, *January*. https://doi.org/10.4018/9781591404743.ch006.ch000

Mell, P., & Grance, T. (2011). The NIST-National Institute of Standars and Technology- Definition of Cloud Computing. *NIST Special Publication 800-145*, 7.

Nayar, K. B., & Kumar, V. (2018). Cost Benefit Analysis of Cloud Computing in Education. *International Journal of Business Information Systems*, *27*(2), 205–221. https://doi.org/10.1504/IJBIS.2018.10009814

Olaloye, F. J., Adeyemo, A. D., Edikan, E., Lawal, C. O., & Ejemeyovwi, J. O. (2019). Cloud Computing in Education Sector: An Extensive Review. *International Journal of Civil Engineering and Technology (IJCIET)*, *10*(3), 3158–3171. http://www.iaeme.com/IJCIET/index.asp3158http://www.iaeme.com/ijmet/issues.asp?JType=IJCIE

T&VType=10&IType=3http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=10&IType=3

Singh, K. (2007). Quantitative Social Research Methods. *Sage Publications India Pvt Ltd*, *1*, 432.

Singh, U., & Baheti, P. K. (2017). Role and Service of Cloud Computing for Higher Education System. *International Research Journal of Engineering and Technology*, *4*(11), 708–711.

Taherdoost, H. (2016). Validity and Reliability of the Research Instrument; How to Test the Validation of a Questionnaire/Survey in a Research. *International Journal of Academic Research in Management*, *5*(3), 28–36.

Zdraveski, D., Janeska, M., Sotiroski, K. and Manceski, G. (2020). *Student's Perceptions on Benefits and Challenges of Using Google Cloud-Based Tools For E-Learning*. 260–271.

Appendix A

Letter of Consent

Dear Respondent,

REQUEST FOR COMPLETION OF QUESTIONAIRE.

I am a student of Master of Science in Technical Education with specialization in Computer Science and Engineering of the Islamic University of Technology (IUT). As a partial requirement of my Degree, I should complete and submit a thesis on the topic titled

“An investigation of the challenges and issues influencing student's use of cloud computing applications in Higher Education: Student's perception”.

Cloud computing applications can be defined as systems for accessing shared resources which may include network devices, storage and operating systems that operate remotely and can be accessed at any time from any device with internet connection. Some of the cloud computing applications used today include google meet, zoom, google classroom, learning management systems (LMS), google drive and many more. Upon that, I need your information/data as mentioned in the attached questionnaire.

Your perception and response to the questionnaire will be highly appreciated and the information will be used for only research purpose and will remain confidential.

Thanks for your cooperation.

Appendix B

Questionnaire

Dear Respondent,

I am a student of Master of Science in Technical Education with specialization in Computer Science and Engineering of the Islamic University of Technology (IUT). As a partial requirement of my Degree, I should complete and submit a thesis on the topic titled

"An investigation of the challenges and issues influencing student's use of cloud computing applications in Higher Education: Student's perception".

I need your information/data as mentioned in the attached questionnaire. Your perception and response to the questionnaire will be highly appreciated.

Thank you.

Part A

Background information

It is under ethical requirement that all your personal information will be kept confidential.

Please choose the correct answer that applies to you from letters below.

Name of your institution.

- *Islamic University of Technology (IUT)*
- *Brac University (BU)*
- *North South University (NSU)*
- *Islamic University In Uganda (IUIU)*
- *Kampala International University (KIU)*
- *Metropolitan International University (MIU)*

Year of study.

- *Diploma*
- *1st Year*
- *2nd Year*
- *3rd Year*
- *4th Year*

- *Post graduate*

Gender

- *Male*
- *Female*

Part B (Likert scale questions)

Perceived usefulness.

The user's expectation to work more effectively and faster when using a specified system which plays a big role in a student's intention to use.

- **Using cloud computing applications is a more efficient way to attend classes**
- **Using cloud computing applications makes me better informed about class information**
- **Cloud computing applications make it difficult to study course content**
- **Is there any other perceived usefulness that is not mentioned above?**

Perceived ease of use

This important for many users new to a technology. It's the degree to which a student expects the system to be clear and fairly understandable to use.

- **The ability to use cloud computing applications in a variety of locations is important**
- **It is difficult to become skillful at using cloud computing applications**
- **Using cloud computing applications is easy and understandable**
- **Using cloud computing applications to learn is more flexible than traditional class**
- **Using cloud computing applications requires a lot of mental effort**
- **Is there any other perceived ease of use that is not mentioned above?**

Ease of access

The level to which the student expects a system to be ubiquitous. This is really important for the student's convenience.

- **I have difficulty accessing and using cloud computing applications in the university**
- **I am able to get assistance from a friend or family member to use cloud computing applications**
- **It is difficult to get help troubleshooting issues with cloud computing applications**

- **Is there any other perceived ease of access that is not mentioned above?**

Cost of usage

This is usually in terms of internet required and accessories which can also influence greatly how much a student accepts the technology.

- **Speed of cloud computing applications mostly depends on the speed of the Internet connection**
- **Cloud computing applications are more costly than buying software applications for a laptops/desktops**
- **Cloud computing storage is more expensive when you buy smaller amounts**
- **Cloud computing applications are cheaper to maintain than my own storage**
- **Is there any other perceived cost of usage that is not mentioned above?**

Perceived security concerns

Also influence technology acceptance since there is a lot of sensitive data to deal with. Students concerns regarding his/her security while using technology.

- **I am uncomfortable with my information being stored on the internet**
- **I am uncomfortable with my information data being shared with cloud service providers**
- **I believe the cloud computing providers will protect my data from theft**
- **I believe the cloud computing providers will prevent unauthorized access to my files**
- **I believe the cloud computing providers will have the means to prevent the loss of my data**
- **Is there any other perceived security concern that is not mentioned above?**