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# Cloud Computing for Improving Traditional E-learning System in Rwanda's Education

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**ABSTRACT:** This research study aimed to find out whether Learning institutions in Rwanda would need Cloud computing to support conventional or traditional e-learning systems for improving academic performance where the learning materials could be accessed anywhere and anytime for students and teachers. Traditional E-learning is currently introduced in many private and public learning institutions but when Covid-19 pandemic forced schools to be closed, the conventional e-learning was incapable to help students continue courses teaching at home. We described how e-learning system-based cloud computing is capable and feasible to provide learning materials for students and teachers from anywhere and anytime and how it is valuable during pandemic moment and lockdown. In this research study, we describe the benefits available when cloud computing is used to support traditional e-learning system and the study identify the challenges that traditional e-learning systems are currently facing out of using cloud computing in education. We further evaluate the impact of covid-19 for Rwanda's education system and economy. Based on the research findings, we advise that it is wisely that learning institutions in Rwanda move to e-learning cloud-based system for increasing availability of learning materials for users while increasing learning performance for students and teachers from anywhere and anytime. Based on the findings, we conclude that e-learning based cloud computing is an economically solution for helping learning institutions with minimal resources.

**KEYWORDS:** Cloud Computing, Traditional E-learning, benefits, Challenges, Covid-19, Cloud models, cloud Readiness, Cloud Planning, E-learning Framework, IaaS, PaaS, SaaS

## I. INTRODUCTION

Cloud computing is a new paradigm that could help the learning environment to boost the quality of education for lower cost and it allows the learning society to create new opportunities in learning system. Mostly an e-learning needs different technologies to provide learning services for learners such internet (even though it is not always that an e-learning requires internet), the e-learning requires also virtual class rooms or smart class rooms which covered the big screen TV, as well as computers to help students learn accordingly at school [1]. The important of cloud computing for e-learning is that there is an opportunity of access to the learning materials wherever you are at any time. Cloud computing play a vital role in many fields including education sector where it increases the accessibility to the learning materials for affordable cost and it is a dynamically scalable system that provide facilities in e-learning as services [1]. According to [2] Cloud computing defines a model that illustrates the higher level of the delivery of the shared of computing resources such as hardware, software and data as service that you can access on demand via internet connection. This shows where cloud computing can support online learning where it would help students and teachers to share learning materials which are updated and latest and they can access these learning materials anywhere and anytime [3]. In some ways, the concept of teaching and learning always go together with the means and methodologies and they are important to the country's education which needs to expand the learning teaching environment [1]. Bizimana et al. [4] illustrated that the concept of e-learning born to remove the barriers currently happened to the many scholars who are unable to attend class due to different circumstances and e-learning have to resolve those challenges. Currently, Rwanda's education has long journey to realize the needs of the Rwanda's population in education where the numbers of students who are attending class have been increased and Government

requires to construct new class rooms to resolve the big number of students in the one class and building additional class rooms in a whole country will require additional budget[5]. According to [5] the additional new class rooms of to the 22505 will be used for academic year that will start by September 2020. This happened due to the Covid-19 pandemic Corona Virus that pushed the schools to be closed from March 2020 and Ministry of Education proposed to reopen on September 2020. Covid-19 have been affected the whole education sector in Rwanda and helping students from learning at home might become difficult management for parents that not everyone has real kit to access online materials and due to literacy among many parents, students will have no support from their parents during covid-19 lockdown [6]. To help resolving the Covid-19 issue, Ministry of Education used different ways to help minimize the consequences of Covid-19 for Rwanda's education and created how students can have access to the online learning through televisions, Radio stations and website of Ministry of Education and Rwanda Education Board [7]. What are challenging the students are the fact that not all families have necessary tools to help students learn from home which is the big challenge caused by covid-19 for education [6].

This paper also covered four important specific objectives which are following:

- i. To examine the benefits of Cloud computing in supporting traditional e-learning systems.
- ii. To identify the challenges that traditional e-learning systems are currently facing without using cloud computing in education.
- iii. To evaluate the impact of covid-19 for Rwanda's education system and economy.
- iv. To advise whether it is necessary to use cloud computing for e-learning system in Rwanda's learning institutions.

## II. LITERATURE REVIEW

### 2.1. Cloud Computing for learning institutions with Minimal Resources

According to Foster et al. [8] defined that cloud computing as "A large-scale of distributed computing paradigm that is driven by economies of scale, in which a pool of abstracted virtualized, dynamically-scalable, managed computing power, storage, platforms, and services are delivered on demand to external customers over the Internet". This shows that as long as cloud computing is used for e-learning that it will help learning materials accessed over internet anytime and anywhere for low cost and helping of utilizing the resources with mobility and flexibility. According to [9,3] Cloud Computing can be simply defined as a pool of computing resources that are delivered through the web which means each individual has the chance for accessing the resources through the web anywhere and anytime. Cloud computing provide several benefits for education's institutions and they provide many learning services with the use of electronics devices such as laptops, tablets, smartphones[9]. According to [10] the number of internet active users in Rwanda grew up to 20% and many of them are from learning institutions which means that the use of cloud computing in education is possible. Bizimana et al.[4] pointed out that many internet users are the students of universities and some Secondary schools that have access to computers and smart phones and tablets which are the necessary tools to support e-learning. In education sector where [9] pointed out that cloud computing is very important in some learning institutions where resources are minimal and this helps to derive a positive experience from its utilization in education especially for e-learning where sharing learning materials virtually would be easier and economically.

### 2.2. Benefits of Cloud Computing for Learning Institution

The use of cloud computing permits on-demand scalability and mobility of using minimal resources where the learning institution will deliver required instructions and teaching through online and those instructions would be accessible anywhere and anytime as long as the learning content is hosted on the cloud [22]. Majid et al. [11] pointed out that mostly it is normal that e-learning system necessitates additional software and hardware resources to perform better services for users especially for those institutions which have minimal resources and budget. The cloud computing platform when it uses for e-learning, it has ability to provide several resources services accessible online to learners including students, teachers and other stakeholders in the learning environmental for affordable cost or free of charge and possibility of pay per use is applicable in cloud-based e-learning services [3,11]. For the learning institution once migrate to cloud computing, this should be allowed the institution not using high budget that goes for IT infrastructures. There is an important reduction on the use of cloud services than using the traditional e-learning situation where it needs of buying IT infrastructures for learning institutions [2]. In Rwanda, cloud computing is too new for academic institutions and there are few Cloud services providers which locally like Africa Olleh Services (AoS) which is hosting different cloud services including colocation [2]. The way the number of students augmented in the learning institution, it will require additional budget for institution to buy new IT infrastructures and building new class rooms but if courses contents are hosted on the cloud, students and teachers

will have access on virtual content and there will be no need to delay graduation deadline because of any pandemic issue like covid-19 that caused the learning institutions to be closed from March 2020 in Rwanda[7,11]. Cloud computing is useful information technology platform that permits teachers and students to have access on the knowledge by sharing distributed e-learning resources in different ways either public, hybrid, community and it can also be used for private cloud systems [1].The private cloud is suitable for single learning institution as it provides scope for advanced privacy and security concern and also provides high availability and better data management [1,3]. Virtualization of cloud computing allows rapid replacement of learning resources which means that virtualization improves flexibility and utilization of IT resources and facilitates centralized data storage where this removes the worrying of data loss when a certain crash occurs [13-14].

### 2.3. Cloud Computing Readiness for Education

According to [1] designing a collaboration-based cloud computing for online education with best virtualization system where the learning institution has to choose the best partners cloud computing service providers to work with and set up an e-learning approach and clear indicating the institution goals. The learning institution would have clear view of comprehensive architecture approach and security concerns with virtual private server establishment[15]. The learning institution will have to measure the whole benefits available in cloud services and what goes for current environmental teaching and learning system. According to Gartner [16] it is noticeable to look on workloads to the creation of cloud technology optimization. For this way the limitations and opportunities must be guaranteed better so that the fully exploitation of the potentials which are available on Cloud computing reaching for delivering global class applications [16].In [15] the most consideration in Cloud computing readiness such as security requirements, service characteristics, network infrastructure, application and data readiness, Technology lifecycle and also institution readiness. It is clear for learning institution to consider whether it is reasonably ready to migrate their service to the cloud. In this way, the prioritizing is very important to choose what is need first by learning institution [15,17].Robert Green illustrated that the official idea with cloud computing is that you can gain value and cost reduction by matching the peaks of your load to how much infrastructure you are using [18].For some kind of application to migrate on an infrastructure as service platform with smaller scale up or down or perhaps no alteration or change, they may consume more storage and computer resources than they actually need [18].Therefore, it is better to review above assessments so that the disadvantages of cloud may not weigh than its advantages according to the learning institution objectives and available resources and budget.

### 2.4. Cloud computing Planning for learning institution

The learning institution when wants to deploy applications to the cloud, it is strictly necessarily to consider data security and privacy requirements, the type of cloud such as public, community, private or hybrid and consider how training will be and the budget and Client access requirements would be fulfilled. The other consideration can be based on the data export and data backup requirements and dashboard and reporting requirements([1,3,19]).

### 2.5. E-learning Framework for cloud computing

The use of new technology always is needing additional guidance to help building strong implementation. The learning institution when it comes for utilization of e-learning with support of cloud computing, it has to follow these guidance's. The e-learning framework for cloud computing let learning institution think about setting up good planning and designing e-learning materials such as Learning Management System and Content LMS and comprehensive authoring systems where e-learning courses and programs are well planned and setting up by organizing resources for e-learning environment and designing distributed learning systems[14]. In [14] it is good to design and evaluate the blended learning environments. He pointed out that it is very important to think and analysis the available resources for institution while deciding to integrate to new system[14].

### 2.6. Traditional E-learning Currently facing challenges in Education

When traditional e-learning system is used to support learning environment, it could be encountering or interacting with different challenges and providing learning facilities to students and teachers become unstable. Fernandez et al. [13]pointed out that the e-learning system when it is using to provide learning materials without supports of cloud computing, the optimizing large-scale resources management and provisioning become the big challenge for traditional e-learning system's owners or institution's owner. Because of that the big numbers of users who are trying to access online contents as well the services learning materials at the same time, the system could be busy and system may be stopped due to the huge number of users for the system which is not capable to support big numbers of users at the same time. For different reasons, e-

learning system resources could be missing or unavailable for users for example, if the source of learning material is damaged, imagine the local server where all data for examinations and other modules is burning or just simple interrupted or data crash and if this crash happens, it will become the nightmare for learning institution and for that moment students and teachers would not have capability to share learning materials.

The e-learning system without the support of cloud computing could require the maintenance cost to repair if there are any IT materials crashing or damaged and it happens that important data would be lost forever. With cloud computing supporting e-learning system, owner has no burden of IT infrastructure crashing or worrying of maintenance cost or loss of data permanently due to system crashing.

### 2.7. Cloud computing Services Models

Cloud computing support e-learning in the way of services and there is no doubt that we should say that there is an e-learning as a service in cloud computing services. Because what mostly the stakeholders are benefiting from cloud are the services [14]. There are common and popular terms in cloud computing services models which are Infrastructure as-a-service (IaaS), Software as-a-Service (SaaS) and also Platform as-a-service (PaaS) [22]. Besides that, every service from cloud can be a service in cloud for example, Storage as-a-service, network as-a-service, etc. In this paper we focus on the SaaS, PaaS and IaaS. The clear view of Cloud services models which shows what is managed is on Figure 1 [14].

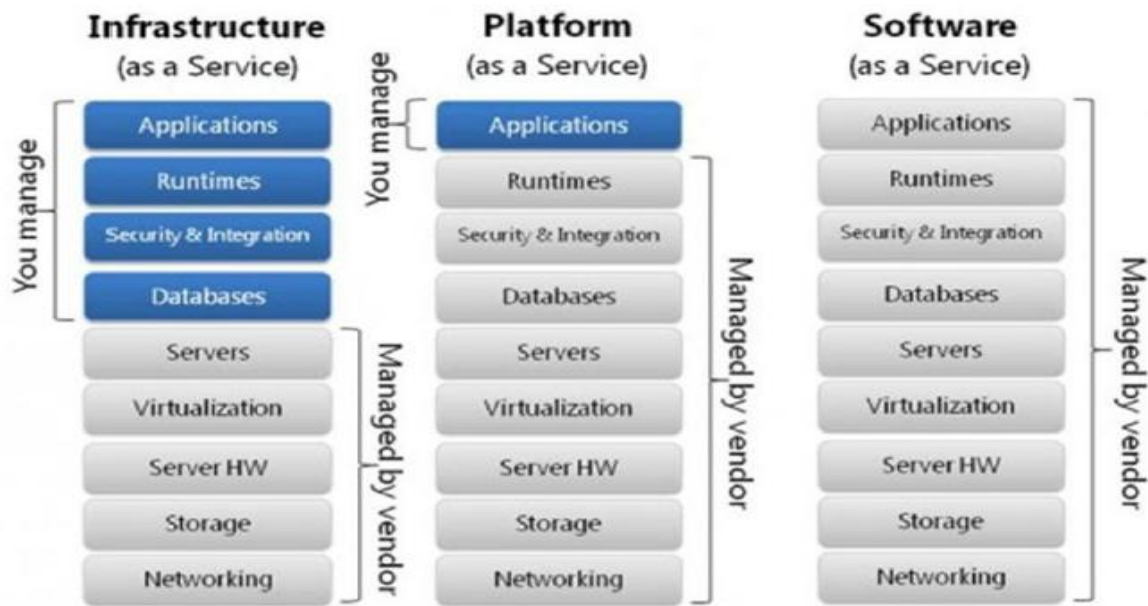


Figure 1: Illustration of cloud computing services models [14].

- **Infrastructure as-a-Service:** Here, the cloud services providers allow users to install software applications and be responsible to manage these applications and data. IaaS provides capability for users to create a dynamic scaling and desktop virtualization which allow creations of virtual machines [3,14].
- **Platform as-a-service (PaaS):** The Platform as-a-service offers an Application Programming Interface (API) and development tools to the developers and helping the end user to access business and learning applications servers and libraries services and so forth [3,19]. In this type of services, consumer has capability to create or acquire applications created using programming languages and tools supported by the provider.
- **Software as-a-Service (SaaS):** This model allows users to access different applications virtually which means there is no need to install these applications in the electronics devices like computers, smartphone, etc [19]. SaaS is the most suitable for education sector while it is increasing learning performance of students and teachers as it provides the learning facilities anywhere and anytime [14,19]. For example, Google and Microsoft provide free emails services for education which is allowing teachers and students to share easily learning materials [19]. Drop box, Google Drive, OneDrive, eBooks, YouTube are other learning materials which are easier to access anytime and anywhere and they are very useful for teachers and students and if it is needed to pay, in cloud services, it is paying per use which is economically manner [20, 21-22].



**2.8. Impact of covid-19 for Rwanda’s Education System and economy sector**

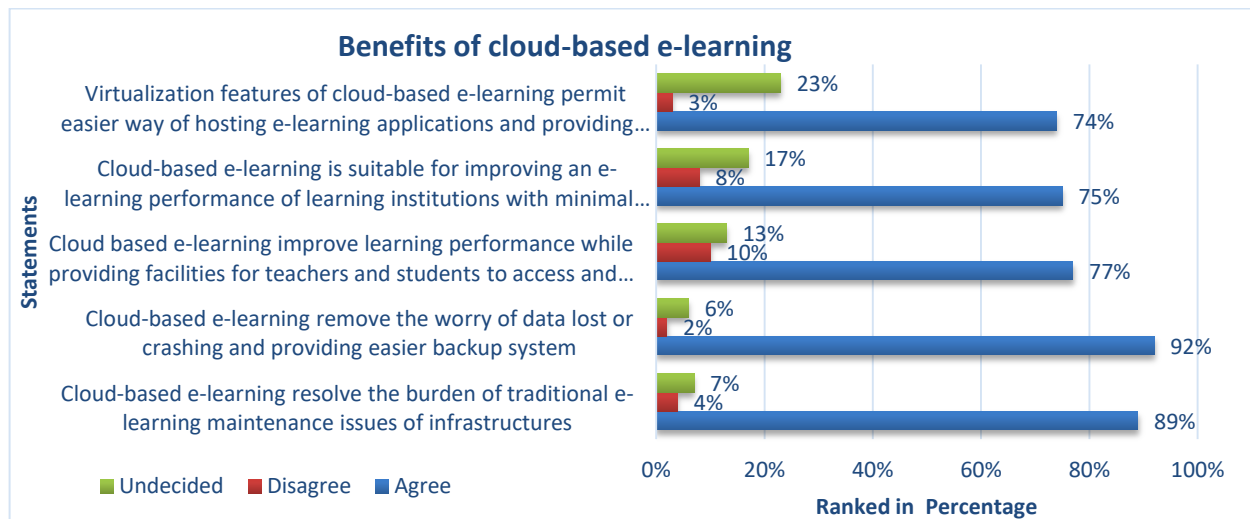
Since 14 March 2020 when Government of Rwanda announced the outbreak of covid-19 in Rwanda, Ministry of Education also have announced that all schools to close from 16 March 2020 until September 2020 if there will be no change [7].The proposed solutions are based on the way students should continue to learn from home and assisted by their parents but many parents lack of literacy and it is clear that not everyone that has real kit to access online materials and due to literacy among many parents, students will have no supports from their parents during covid-19 lockdown [6].This covid-19 not only have negative impact for education sector in Rwanda but also for economy of country as well as a whole society. Because many families never planned that students would return home before end of the first trimester, so their economy have been affected and this also affected learning institutions in their economic planning [12]. Many learning institutions have postponed their contracts between institutions and their employees due to lacking of budget due to Covid-19 lockdown which happened that teachers have not received monthly salary as it was before covid-19 pandemic and this have greatly affected the country’s economy. The one of scientific solution for learning institutions to let students and teachers continue their courses teaching from home during lockdown is to build a strong and robust e-learning system which is strong enough with the capability of letting students and teachers continuing virtual class learning and sharing learning materials easier anytime and anywhere where students and teachers have access to update books, learning software tools, and also good collaborations with their teachers. It is in this way cloud computing have the potential for supporting traditional e-learning system and help in providing learning resources with higher availability and flexibility of learning material for teachers and students anywhere and anytime [13].

**III. METHODOLOGY**

For the purpose of this research study, the researchers collected quantitative data as well as qualitative data. Researchers use online interviews and questionnaire used to reach to the objective of this research study. The population chosen to participate in this research were teachers from higher learning institutions, teachers from secondary schools in ICT field and other ICT employees who are working in education sector. Due to the goals of this research study, the judgmental sampling used and 95 people were selected. The 79 questionnaires received which indicates the good response rate of 83,158. The non-probability sampling technique used because researchers only chose the responders based on the skills and knowledge they have to the cloud and e-learning and it is for this purpose that the purposive or judgmental sampling technique used [23,24]. The judgmental sampling is low-cost and convenient and it is good for time saving and it does not permit generalization and subjective [24].

**IV. RESEARCH FINDINGS BASED ON THE OBJECTIVES OF THIS STUDY**

- *To examine the benefits of Cloud computing in supporting traditional e-learning systems.* To reach to the solution of this statement, the five statements have set up for responders and the findings shown in Figure 2. The responders had to answer the statement with Agree, Disagree and undecided.



**Figure 2:** How cloud computing is supporting traditional e-learning

The findings show that the statement “Cloud-based e-learning resolve the burden of traditional e-learning maintenance issues of infrastructures” ranked at 89% whereas 4% ranked disagreed and 7% undecided. Cloud-based e-learning reduces the construction and maintenance cost of the learning resources. The statement “Cloud-based e-learning remove the worry of data lost or crashing and providing easier backup system” ranked at 92% whereas 2% ranked disagreed and 6% undecided to the statement. The findings showed that the statement “Cloud based e-learning improve learning performance while providing facilities for teachers and students to access and share learning materials (latest books, lab facilities, latest software) with higher availability anywhere and anytime” ranked at 77% whereas 10% ranked disagreed and 13% ranked undecided. The statement “Cloud-based e-learning is suitable for improving an e-learning performance of learning institutions with minimal resources and budget while increasing system availability and robustness” ranked at 75% whereas 8% disagreed and 17% undecided to the statement. The findings showed that the statement “Virtualization features of cloud-based e-learning permit easier way of hosting e-learning applications and providing for user capability of managing these hosted e-learning applications” ranked at 74% by responders whereas 3% disagreed and 23% undecided to the statement. The findings showed that cloud computing is very important to boost traditional e-learning system and the findings showed that it is the solution to traditional e-learning system currently available in some learning institutions.

- *To identify the challenges that traditional e-learning systems are currently facing out of using cloud computing in education.* To find the solution, we used four statements which are covering the most challenges that traditional e-learning systems is facing today and the findings shown in Figure 3.

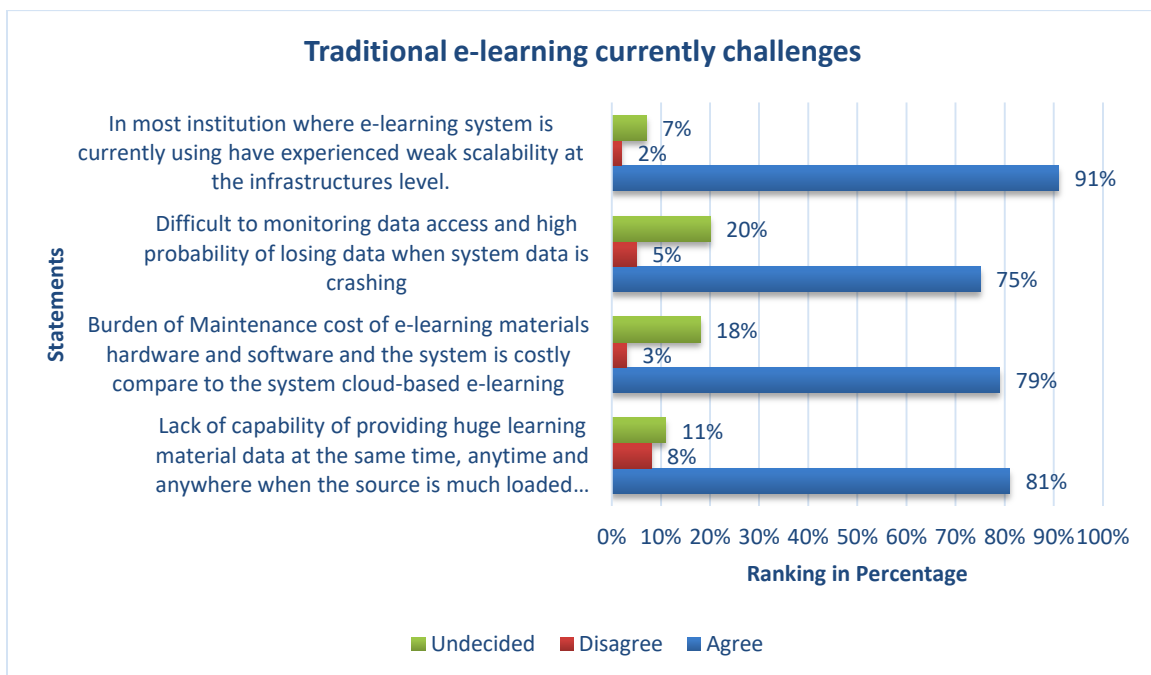


Figure 3: Traditional e-learning currently challenges

Based on the research findings in Figure 3, the statement “Lack of capability of providing huge learning material data at the same time, anytime and anywhere when the source is much loaded because of many users who are logging on or doing different staffs on the e-learning system” ranked at 81% by responders whereas 8% disagreed and 11% undecided to the statement. The statement “Burden of Maintenance cost of e-learning materials hardware and software and the system is costly compare to the system cloud-based e-learning” ranked at 79% whereas 3% disagreed and 18% undecided to this statement. The statement “Difficult to monitoring data access and high probability of losing data when system data is crashing” ranked at 75% whereas 5% disagreed and 20% undecided. The findings show that the statement “In most institution where e-learning system is currently using have experienced weak scalability at the infrastructures level” ranked at 91% whereas 2% disagreed and 7% undecided to the statement. The findings showed that Traditional e-learning still experienced different challenges and it is obvious to think about new technology that could boost e-learning performance academically as well economically.

- *To evaluate the impact of covid-19 for Rwanda's education system and economy*

For this statement, we have set five statements which explained the impact of covid-19 Corona virus how it affected Rwanda's education as well as country's economy. The findings shown in Figure 4.

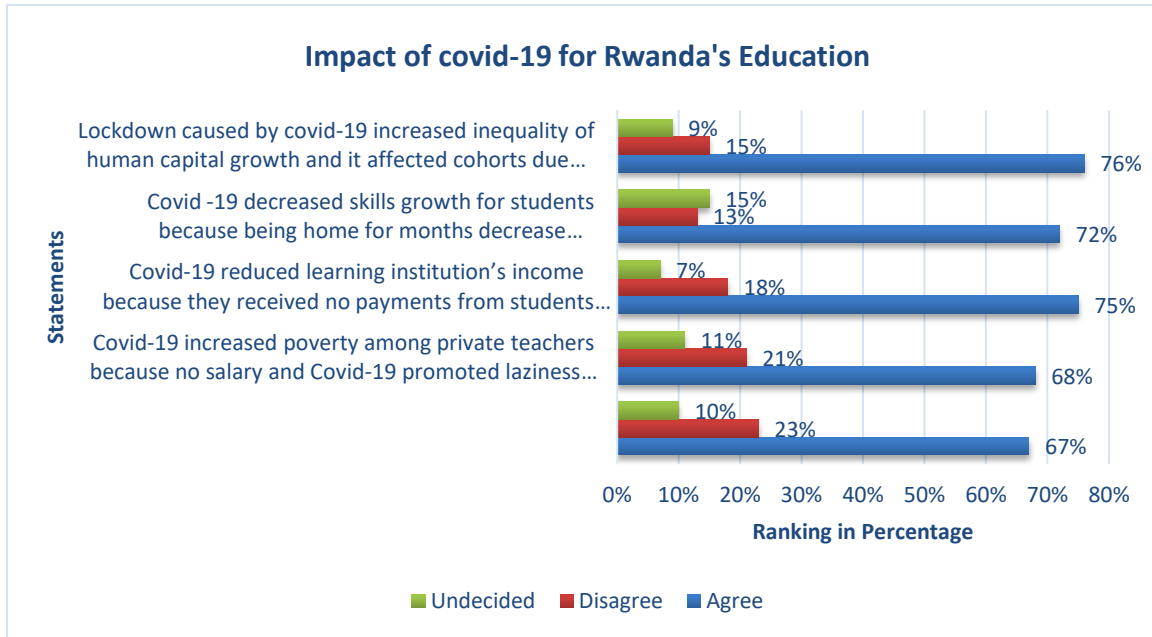


Figure 4: Impact of Covid-19 for Rwanda's Education and economy

The findings in Figure 4 show that the statement “Lockdown caused by covid-19 increased inequality of human capital growth and it affected cohorts due to some parents who are incapable of providing addition support during home learning for their students (due to lack of literacy or lacking of electronics devices like TV, Radio, smart phones, etc)” ranked at 76% whereas 15% disagreed and 9% undecided to the statement. The findings showed that the statement “Covid -19 decreased skills growth for students because being home for months decrease knowledge and skills as fundamental way of learning is to go to use schools especially those of primary and nurse schools” ranked by responders at 72% whereas 13% disagreed and 15% undecided to the statement. The statement “Covid-19 reduced learning institution's income because they received no payments from students during lockdown, there is no suitable solution to let students learn from home like cloud-based e-learning system” ranked by responders at 75% whereas 18% disagreed and 7% undecided to the statement. The findings showed that the statement “Covid-19 increased poverty among private teachers because no salary and Covid-19 promoted laziness for students while they are at home” ranked at 68% by responders whereas 21% disagreed and 11% undecided to the statement. The findings also showed that the statement “Covid-19 have the negative impact to Rwanda's education as the whole academic year will be repeated” ranked at 67% by responders whereas 23 voted disagreed and 10% undecided. The findings showed that Covid-19 had the great effect to the Rwanda's education and as well Country's economy. The education sector will reopen on September if Covid-19 decreases the speed of spreading in whole country and what should be if covid-19 continue to expand and schools remained closed after September? Let this question be addressed to the policy makers.

## V. CONCLUSION AND RECOMMENDATIONS

This study examined the benefits of Cloud computing in supporting traditional e-learning system and this study showed that cloud computing is very important to boost traditional e-learning system where this traditional e-learning was unable to help learning activities during covid-19 pandemic especially for university's students. The findings illustrated that Cloud based e-learning is suitable solution for those learning institutions with minimal resources and budget. The findings showed that not all students have access to the local traditional e-learning system due to the family's affairs (lack of literacy by parents, lack of e-learning tools, etc) where Covid-19 have affected both private universities and public universities and it is for



these reasons from research findings that it is wisely to choose new alternative solution that could support the traditional e-learning system and let students continue their courses teaching from home, anywhere and anytime. There is no doubt that covid-19 pandemic would not have big negative impact for Rwanda's education if the universities and high schools already have planned powerful e-learning system supported by cloud computing. The use of cloud computing for e-learning bring the stability of learning environment and learning resources availability which would allow students to attend virtually class rooms from anywhere and anytime. We recommend and advise to the policy makers to provide facilities for universities and secondary schools so that cloud-based e-learning implementations could be easier. We recommend also to learning institutions to think about how they can start the use of cloud computing for supporting their traditional e-learning projects because the findings showed that cloud-based e-learning is the best choice to resolve and remove potential challenges available in traditional e-learning system.

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