

# Using Cloud Computing to Mitigate Rural E-Learning Sustainability and Challenges

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**Abstract**— The Internet Technology is at forefront of transforming education and opportunities around the globe by allowing different kind of interaction and innovation among various educational institutes and students alike, all participating in the global online innovations. In particular, educators have realized that technology enhanced learning, offers flexible and powerful way of accomplishing wide range of opportunities that have been important and resourceful in schools, such as gaining access to universal information resources that relieve academic staff of their work load leaving time for professional development and time to improve on their studies and research output which have been so elusive for sometime now. Extending this novelty and gain to the rural settings raises lot of concerns and challenges that threaten its sustainability to its core implementation. Cloud computing brings wide ranges of computing power, innovations and shifts in paradigms of Information Technology. This paper will probe whether the promise of cloud computing could be employ to enhance or mitigate the challenges poised to e-learning implementation and sustainability in the rural setting using descriptive research approach. The paper will inform stakeholders of any gains or prospect of using cloud computing to downgrade the e-learning sustainability problems that have plagued the implementation of e-learning in the rural setting as unviable future instructional offering.

**Index Terms**—e-learning, e-learning implementation, e-learning sustainability, cloud computing, Instructional offering.

## I. INTRODUCTION

The recent cutting-edge in technology such as World Wide Web and online conferencing systems has enabled the universities and other tertiary institutions to implement distance education to reach a diverse population and to provide open learning environments 24 hours a day, 7 days a week, 365 days a year. More importantly, to provide rapid access to human resources, study materials and information. We argue that the internet-supported distance education courses do more than bringing new students into online classrooms but in addition, form “a critical pressure point

for challenging the dominant assumptions and characteristics of the existing traditionally organized universities in the 21<sup>st</sup> century.” Evidently from the ever-growing number distance courses, substantial discussions about distance education in higher education are dominated by enthusiastic studies and accounts [24-25], [27], [29], [33].

Although there are evidences that web based application technology and e-learning technology can provide higher education with effective medium to distribute learning material and course information on the internet, it provides such an excellent platform for developing, organizing and spreading varieties of resources including class notes and outlines, long textual resources that resemble traditional textbooks, interactive non-linear tutorials, student questions and comments and even simulations of individual class sessions any time, any where [9]-[10], [17]-[18]. Research and studies have equally shown that there are challenges and issues that threaten the implementation and sustainability of e-learning especially in our rural communities. While most institutions of higher learning in the cities and surrounding town enjoy the privilege and opportunity to rake in e-learning large economy of scale advantages, the same cannot be said of their counterparts located in the deep rural communities. They are beleaguered with sustainability problem and challenges that undermine their existence [1]-[3], [6], [12], [18]-[19], [23], [26], [29]-[32], [41]-[48].

The cloud computing Model on the other hand offer the complementary, provision and delivery of computing resources, products and services as a utility over a network to supplement or provide adequately computing power wherever is lacking or not adequate at a reasonable costs. The cloud concepts is overwhelming and on the increase daily with lot of patronage from Information Technology based organization. Their continuous refinement by cloud provider increases its chance as an option in future investment consideration. The objective of cloud is to provide same or improved computing service and performance to the client as if the technology and applications were localized at the client premises. The rudimentary and the underlying processes are not known or visible to the end-user. Equally, the cloud provide profound opportunity for faster and un-equal processing power, unprecedented low cost of maintenance, less computing downtime, bigger storage, more manageability, quality and sophisticated IT infrastructures to meet the client unstable and unpredictable infrastructure that will meet their business demand and increase their competitiveness [37], [39]-[40].

The cost of implementing cloud computing is very low because the client, a customer in this case does not have to purchase or own the equipments. The cloud Service

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provider are been paid to render these services and resources. It provides improved agility by allowing users the opportunity to re-provision their technological Infrastructure resources. The interaction and accessibility with the cloud is provided using the principle of facilitating interaction between human and computer by Application Programming Interface (API). The virtualization technology provision of cloud allows maximization of utilization, sharing of storage, infrastructures and other resources to commensurate the Return on Investment (ROI). The cloud is device and location independence. The participants or clients access the cloud using a web browser regardless of their location or device. Hence there is a lot of responsibility on the part of the provider to ensure high reliability, uninterrupted performance, scalability and improved security at a lower cost [37], [39]-[40]. All these are pertinent and are guaranteed by the provider to ensure their customer base retention and profitability.

The promises of cloud computing are huge, fascinating and cost effective that ensure the deliverable of stable, high performance, Return On Investment (ROI), less commercial and operational risk computing application and implementation as against on-site alternative. Whereas, the implementation of e-learning technology raises lot of sustainability concerns and challenges that threaten this innovative technology to its core. It almost renders it usable, unsuitable and less effective in our rural communities. This in turn led us to our research question:

***How can we employ the promises and gains of cloud computing model to improve sustainability level of e-learning implementation in the rural settings?***

The answer to this question may give an insight towards alleviating some major rural settings e-learning sustainability challenges that have render the implementation of this state of the heart technology to the backdrop. The efforts may also provide direction for selection of future e-learning implementation strategy in the rural settings and create awareness for its return to stardom and enhance its competitiveness. Furthermore and towards answering our research question, the following section II will highlight and present the details of cloud computing and the benefits thereof, the advantages and disadvantages of e-learning and the future cloud computing as a strategies for implementing rural e-learning. Section III will discuss e-learning sustainability challenges vis-à-vis the provision of services and resources offered by cloud computing in resolving some of these challenges in a best possible ways. We will equally shed more light on how cloud computing could provide a turn around strategies on the Return on Investment of rural e-learning implementation and sustainability dilemmas to level of been competitive and viable. Finally, section IV will conclude the study. This section will make informed conclusion and recommendations about the future of rural e-learning implementation and the adoption of cloud computing and the benefits thereof.

## II. LITERATURE REVIEW

The use of Information Communication Technology as a competitive weapon has become a popular niche, yet there is still lack of understanding of the issues that determine the influence of Information Technology on a particular organization and the process that will allow smooth coordination of the technology and the corporate strategy. We are informed of the three opportunities arising from deploying Information Technology as a form of organizational strategies ranging from internal strategy which is concern with the development of efficient and effective organization structures and process for achieving goals and objectives. The business portfolio strategy is concern with the choices of which industries to compete with and how to position organization in those industries. Lastly, competitive strategy focuses on the competitive move and maneuver within the industries in which the organization does its business [4], [34]-[35].

The prospect of gaining competitive advantages have prompted the implementation of e-learning as a formal mode of instruction in our higher institution of learning in order to rake in all the benefits of e-learning with its profound accolade. Without doubts, the implementations of e-learning in higher education institutions will yield a brilliant success to the extent of threaten traditional mode of delivery to its value and basic [5], [7], [9]-[11]. Whereas, the same successes cannot be claim in our institution of learning in the rural setting. Instead, it raised an unpalatable sustainability challenges and issues that make it unsuitable choice in the rural setting [1]-[3], [6], [12], [18]-[19], [23], [26], [29]-[32], [41]-[48]. The quest for cost effective platform to deploy most ICT infrastructure and strategies while maximizing profits and remaining competitive drove the rigorous search for alternative and new paradigm for deploying services, resources and products at a minimal cost. All leads point toward the adaptation and advancement of cloud computing, hence we decided to conduct this study.

The cloud computing model is an abstraction and extension of the power of internet, Information Communication and Technology using virtual shared server to deploy services, products, resources, software, infrastructure, devices, platform and database hosting to customers on a pre-define contractual basic. The company in cloud model does not own the infrastructure or expend huge capital expenditure on IT hardware infrastructure and software maintenance. The third party in return provides access to these services on the cloud computing model and manages the cloud. These arrangements have much to desired by allowing the customers in cloud model to have full concentration on their core business while the cloud service provider bother with the instinct cases, rigor and management of providing for their customer ICT infrastructures and services over the cloud, undauntedly at a reduced cost. In most cases, the risk and uncertainty associated with procurement of infrastructure, under-utilization of computers and equipment, Return on Investment (ROI) is minimal or not applicable to the customer. Other benefits include access are not bounded by time and location, increased competitive advantages, advantages of internet large economy of scales, increased security at lower cost, market flexibility and agility, good return on investment, increased performance, broad network access, high resources pooling [37], [39]-[40].

The cloud computing model provides for three (3) fundamental services models and four (4) deployment models. The Software as a Service (SaaS) model provides opportunity for users to run the provider application running on a cloud infrastructure. The Platform as a Service (PaaS) model is the capability that allow the users to deploy their specific application or package software on the cloud using the languages, libraries, function, services and tools supported by the provider. Whereas, Infrastructure as a Service (IaaS) provides the users with the much needed computing power like processing, network, storage, memory e.t.c. We need to emphasize that the principles and management of the cloud is the sole responsibilities of the provider. These services can be deployed on Private, Community, Public or Hybrid cloud [39]-[40].

Cloud computing as emerging and evolving technology has been penetrating the global market with noticeable effect despite its criticism in the area of security, ownership, legal issues, interoperability and portability [37]. Its dominion have been significantly felt in online backup service, social network services, personal data service, online application, redundant servers, mirrored websites, e.t.c. It is these considerable feats that motivated this study of evaluating whether the implementation of e-learning in rural setting using cloud computing model and provision thereof would ease the sustainability challenges raised by formal implementation using our dedicated system and make e-learning technology a competitive ventures in the rural settings.

### III. CLOUD COMPUTING MODEL VERSUS E-LEARNING SUSTAINABILITY

The market growth and shares of cloud computing is on the increase. The relative growth of the service models in various industries is spelling a boom and propelling cloud computing model as a viable option of deploying ICT business strategies. Forrester predict a steady global market growth for cloud computing from USD40.7billions in 2011 to more than USD 241 billion in 2020. The total size of public cloud is expected to flourish from USD25.5 billion in 2011 to USD159.3 billion in 2020. In a separate study, Deloitte predicts that cloud computing based application will replace 2.34% of enterprise IT spending in 2014 with an expected increase of 14.49% in 2020. Equally, Cisco predicted that global cloud IP traffic will increase in twelvefold over the next 5 years. This represent a more than one third (34%) of total traffics by 2015. The Forbes put their figure at USD12.1 billion growth in cloud computing service in 2011 with estimated growth in value USD35.6 billion by 2015 [49]-[51]. A relatively and fascinating figures with wide range of opportunities, visions, accomplishments and possibilities that could be adapted to enhance business initiatives for competitive advantage and improve ICT alignment strategy crusade. Undoubtedly, we could tap into this progression to enhance the sustainability challenges poised by implementing e-learning in the rural settings.

The promise of e-learning has recorded a slow growth in the rural area. Its implementation is plagued by severe sustainability challenges that undermine its successful implementation. These setbacks could spell a doom in our

efforts to make e-learning a viable instructional option and gains competitive advantages in the rural setting. The sustainability challenges include Financial support sustainability, Stakeholders sustainability, Social and Political sustainability, Technological sustainability, Security sustainability, Energy sustainability, Internet connection sustainability, Content development and management sustainability, Training sustainability and Best practice sustainability [3], [6], [12], [18]-[19], [23], [26], [29]-[32], [41]-[48]. Judging from the promise of cloud computing, our instinct effort will now be directed towards evaluating and resolving our research question by descriptively inquire whether or not the services of cloud computing could be use to facilitates or enable some (if not all) of these challenges. While we acknowledge that cloud computing may not provide answers to all of our enumerated sustainability challenges. We will appreciate its effort in mitigating or polarizing some of these circumstances. The progress made will no doubt give a new lease of life in our efforts to adopt e-learning as an instructional offering option in the rural setting.

#### A. Financial Support Sustainability

Embarking on project of the magnitude as implementing e-learning in rural setting is capital intensive and always cause some strain on the budget with huge consequential effects. There is need to purchase the ICT equipments, networks infrastructure, Application packages, servers, e.t.c. We also need running, contingency and maintenance costs. All of these come at a very high cost. A very expensive and exorbitant e-learning implementation will beckon and lean the whole process towards sustainability crisis. With cloud computing model, the customer doesn't have to purchase or own these equipments. The users are provided with access to use any of the services on cloud. This will in turn alleviate the cost constraint in this regard. Money saved for these efforts could be used to fund training or other sustainability needs.

#### B. Stakeholders Sustainability

The stakeholders in institutional e-learning play a major role in decision making of facilitating the implementation of e-learning in rural settings. We expect all on sundry to play leadership role in their various undertaken. Although cloud computing may not have any bearing on this factor but taken decision on whether to embark on cloud computing model would be an acid test or proof commitment to relieve sustainability problems as associated with this factor.

#### C. Social and Political Sustainability

Culture, social or political affiliation is a big role player decision making. An ugly power play among stakeholders is detriment and set back to our decision making mechanism and this can only widen e-learning sustainability gap. A dynamic and constructive debates backed with due process conflict resolution is ideal and important for any organization [22]. This will in turns filter down when the decision on cloud computing is tabled. An organization where issues are debated based on their merits will have a

great influence on cloud computing and e-learning sustainability decisions.

#### *D. Technological Sustainability*

Thanks to cloud computing, the era of spending huge budget provision on procurement of the state of the art Information, Communication, Technology applications and infrastructures are over. The cloud service models and providers ensure that we have access to these high level state of the art technologies to undertake our core business and activities [37], [38]. It implies that the technology sustainability issues and challenges will be a thing of the past. We argue that cloud computing technological provision will come as a huge cost saving model.

#### *E. Security Sustainability*

The risk and threat to system and any computer installations is real and imminent. In order to sustain e-learning implementation, efforts should be made to protect the data against any form of mis-use, intention/unintentional loss of data, sabotage, destruction, the effect of natural disaster, theft, fraud, electronic infection – viruses, unauthorized access and modification of data. The security threats are still alive and valid in cloud computing model [28], [34], [41]-[44], [45]-[46]. Although the bulk of the infrastructures are on the cloud provider premises, we expect that adequate security will be provided while we cater for the limited technology and equipment security on our site. Because of the seriousness of this threat, we will advise that irrespective of the paradigm or platform, the issue of security should not be down played especially in cloud computing where third party or cloud provider is the sole owner of the technology and infrastructure. We are not sure of any cost saving measure in this regard but categorically, it will be minimal on the customer end and the same cannot be said of cloud provider.

#### *F. Energy Sustainability*

Most cloud service providers are located in the cities where there is high supply of energy and pooled of resources. Notwithstanding, there is persistent and intermittent supply of energy in the rural area. The heighten service delivery protest is waged on the erratic energy supply in our township. The energy provider even promise more black out in the nearest future citing over loading and energy shedding and urbanization as an excuse. This will remain an e-learning sustainability issue for as long there is no complementary energy supplied to the rural area. Alternative source of energy will come at a high price for the budget taking cognizance of the cost of maintenance, fuelling, etc [47]-[48].

#### *G. Internet Connection Sustainability*

Like energy supply, internet connectivity are intermittently supplied and connect may be lost any point in time. This is a critical success factor for e-learning implementation. Noting the only way we could access or participate in the cloud provision is through internet

connectivity and access. Low connectivity rate as synonymous with rural setting could spell a doom for e-learning implementation or cloud computing model and adoption. The provision of complementary stable, high speed connectivity using efficient and effective communication technologies at an affordable cost and low maintenance cost should be our priority. We may however get the opinion of cloud provider as to which technology would provide highly rated hand shake to their equipments and technologies?

#### *H. Content Development and Management Sustainability*

E-learning as a new frontier in education is redefining teaching and learning beyond its scope, time, and boundaries. Online education delivery must be supported with learning and curriculum development as a pre-requisite for effective e-learning implementation [13]-[16], [8], [20]. The Learning Management System may be provided by the cloud computing model as Software as a Service (SaaS) or Platform as a Service (PaaS). Whichever model that is adopted, we argue that this must be complemented by availability of a qualified curriculum practitioner on site to train and assist lecturers in developing and managing their subject contents in line with e-learning standards.

#### *I. Training Sustainability*

E-learning implementation offers new pedagogy. A vital point towards ensuring e-learning sustainability it to invest in teacher's capacity building that will provide them with valuable technological skills, knowledge and understanding on how to integrate technology with the new pedagogical approach. Continuous training and professional development will create and foster community of practice and excellent engagement that can guarantee e-learning sustainability [2]. The cloud provider may also be called upon from time to time to conduct informative training and workshops for effective utilization of the cloud model.

#### *J. Best Practices Sustainability*

The choice of e-learning implementation using cloud computing model does not come easily amidst issues like security, interoperability, legal, portability, sustainability, abuse and deceit [28], [34], [41]-[44], [45]-[46]. We argue that e-learning offering in the rural settings must be competitive with the urban area by providing all kind of interaction and excitement of a new vista and pedagogy [5], [21], [7]. It is advisable that the choice of the cloud provider should be view with all seriousness as demand. The cloud provider should be benchmark with others in the industries and there must be constant review of the service contract with expected industry requirements and standards. The cloud provider should ensure that equipments, technology and services are of high standards and comparable with international standard of community of practices. Also, it should foster cooperation and collaboration to remain competitiveness and sustainable [2], [47]-[48].

#### IV. CONCLUSION

It is understandable that the main aim of elevating e-learning sustainability awareness is to raise the challenges faced by e-learning as the fastest growing teaching and learning alternative and viable instructional offering model in the rural setting and possibly finding means of mitigating the factors to a bearable minimal. Also, we want to ensure that the progress made by new reforms and activities of the nature, complexities and dynamics like e-learning and not easily derailed and goes well into the future. We emphasize the capabilities of equitably meeting the need of present e-learning challenges without compromising the needs of the future. E-learning sustainability efforts explore those possible ways of enduring the gains of e-learning implementation over time in the face of numerous challenges it presents to our teaching and learning especially in the rural setting. These efforts have prompted us to look outwardly on the gains and possibilities offer by cloud computing model and provision as a possible alternative ways of deploying and implementing e-learning technology. The cloud model offers means of creating strong collaboration and enduring partnership in reducing e-learning implementation costs, increased competitive advantages, increased security at lower costs, market flexibility and agility, good return on investment, increased performance, provide broad network access and high resources pooling.

The cloud computing is an extension of Internet growth and technological innovation. It offers a huge cost saving model of collaborating and enabling ease access to network, servers, storage, applications, infrastructure, computing resources, products and services at a reasonable and affordable costs over the internet. In most organization, the costs of deploying and adopting technology come with a lot of strain on the budget provision. In most cases, it raises some sustainability challenges and low Return on Investment. Whereas, in cloud model, users or participants doest not own equipment or buy any technology or infrastructure, the cloud provider make provision for the customer to access and fulfill their core business activities over the cloud. There are wide ranges of opportunities to be derived from this model that could possibly empower the e-learning implementation in the rural setting and consequently, alleviate the sustainability saga affecting e-learning as viable options in the rural setting.

We have no doubt that cloud computing model will be better option at deploying e-learning implementation especially in the rural setting. We have descriptively evaluate the power of cloud computing in mitigating the listed sustainability challenges and found it worthy of its efforts and costs effective means of ICT provision and deployment while remaining competitive and at the same time fulfilling our corporate goals. There are more gains and benefits from cloud computing model in terms of provisioning of technologies, infrastructures, resources, agility, computing power, storage, communication and networking tool, e.t.c. Arguably, they equally gives contention in form of security challenges, interoperability and other inadequacy. In our opinion we are optimistic that

cloud provider can lift up to the expected standards especially in the area of security and deliver. We are expecting a high level professional service from the provider because their business existent will be at stake if ever cloud services are violated. Hence we conclude that cloud computing model could be used to mitigate the effects of e-learning sustainability in the rural setting. Adopting cloud computing is a right stepping in the right direction, its known challenges notwithstanding.

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