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Conceptual Framework to Adopt Cloud Based M-Learning for Higher Education Institutions: Ethiopian Perspective

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ABSTRACT:The prevalence of wireless technologies in education leads to increasing research interest in M-learning that blends wireless technology and mobile computing to educate the world. On the other hand, Cloud computing is the latest effort in delivering computing resources as a service. Using an integrated approach based on Cloud Computing may be a solution to obtain the agility and quick access to technologies, with the achievement of savings at an institution level.This study proposed a conceptual framework that specifies a number of steps for HEIsas well as organizations to adopt cloud computing. The framework is designed by taking into account a range of strategic issues and technological factors from a broad cross section of areas of expertise in order to ensure a successful cloud computing adoption. The framework helps HEIs in adopting cloud based M-learning successfully. Based upon this conceptual framework, this paperproposed Architecture for delivering M-learning services through Cloud for HEIs Ethiopian perspective. The paper finally recommends further research directions.

KEYWORDS:Cloud Computing, Mobile Learning, Adoption, Higher Education Institutions (HEIs), Conceptual Framework.

I. INTRODUCTION

Globalization, financial crisis, requirements of the students from the 21st century and other factors are leading to pressure on educational institutes in terms of ensuring appropriate IT (Information Technology) supports necessary for educational and research/development activities. The institutions of higher education must address the students' requests with respect to IT and the access to institutional networks of wherever and whenever. Consequently, educational institutes recognize the need of adopting new technologies; new methods, instruments and learning techniques in order to satisfy the demand of the age [1]. New technologies have revolutionized education, yielding new learning delivery methods. E-learning extended the reach and support of education but relied on tethered computers, and hence was bound by location and time. Mobile learning (M-learning) extends E-learning by breaking these tethers, allowing learning to occur anytime and anywhere.

One definition of mobile learning is: Any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning that happens when the learner takes advantage of the learning opportunities offered by mobile technologies. In other words mobile learning decreases limitation of learning location with the mobility of general portable devices.

Mobile learning includes portable devices and related technologies such as handheld computers, notebooks, net-books, ultra-books, tablets and mobile phones. Recently there is a new trend in mobile learning which adds mobility of the instructor and includes creation of learning materials "on-the-spot" using mainly smart-phones with special software. Using mobile tools for creating learning aides and materials becomes an important part of informal learning. Mobile learning is convenient since it is accessible virtually anywhere. It has high collaboration and provides for an instantaneous sharing among everyone using the same content, which leads to the reception of instant feedback and tips, as well as for a strong portability by replacing traditional textbooks [2]. However, the existing learning infrastructure is

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still not complete. Currently, the majority of M-learning systems have difficulty in interfacing and sharing data with other systems. To resolve this problem, it is recommended to use cloud computing to support resource management.
Cloud computing is not a new concept, though is still evolving across the information technology industry and academia. Several definitions have evolved so far, the National Institute of Standards and Technology, defines cloud computing as "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction [3].

The author in [4] defines cloud computing as a model for enabling network users' on-demand access to a shared pool of configurable computing resources that can be rapidly provisioned and release to the client without direct service provider interaction. Again, cloud computing is the result of evolution and adoption of existing technologies and paradigms (autonomic computing, Client–server model, Grid computing, Mainframe computer, Utility computing, Peer-to-peer, and Virtualization). The goal is to allow users to take maximum benefits from all of above mentioned technologies, without the need for deep knowledge about or expertise with each one of them. Thus, cloud computing provides the opportunity of flexibility and adaptability to attract the market on demand.
In recent days, many research institutes are struggling to adapt Cloud Computing for solving problems that are continuously increasing computing and storage. There are three main factors that interests in Cloud Computing: rapid decrease in hardware cost and increase in computing power and storage capacity, and the advent of multi-core architecture and modern supercomputers consisting of hundreds of thousands of cores; the exponentially growing data size in scientific instrumentation/simulation and Internet publishing and archiving; and the wide-spread adoption of Services Computing and Web 2.0 applications. The Cloud Computing trend of replacing software traditionally installed on campus computers (and the computers themselves) with applications delivered via the Internet is driven by aims of reducing HEIs IT complexity and cost. Cloud Computing could be a technological innovation that both reduces IT costs for the HEIsand eliminates many of the time-related constraints for students, making learning tools accessible for a larger number of students [5].

This paper proposed a framework specifies the virtualization technology to be used to build a cloud based M-learning above the existing hybrid cloud infrastructure in order to use the resources more effectively and also to support the QoS (Quality of Service) objectives such as high availability, performance, reliability, scalability, load balancing and security in the service models of the cloud. Based on the roadmap for the successful adoption of cloud based M-learning, the researcher proposed Conceptual Framework for Cloud based M-learning system. Based upon this conceptual framework, this studyproposed a Cloud-based architecture for cloud based M-learning System for HEIs in Cloud Computing Environment, by using technologies enriched with mobile and wireless devices, addressing the challenges and overcoming the existing limitations of m-learning. The proposed architecture supports educational institutes with diverse learning styles in different learning contexts in order to facilitate lifelong learning and information/knowledge sharing accumulated through cloud based systems. As mentioned above, cloud-based education not only requires technology support but also requires a need to distil it into a practical, consistent, accessible architecture.

Advantages of cloud based M-learning for Higher Educational Institute
Cloud based M-learning have many advantages to higher educational institutions. Following are the some of important merits with mobile computing. As it is highlighted by [20],

- Cost: Cheap for cloud computing vendors to build complex mobile cloud applications.
- Availability: Sharing information and applications
- Performance: Enhanced features and functionalities of mobile devices through new cloud applications.
- Increased Reach of Learning Programs
- Wide Network Access
- Rapid Elasticity
- Ease of Implementation etc…

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II. Background Review

A. Cloud Computing

According to USA NIST's definition, 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. This cloud model is composed of five essential characteristics (On-demand self-service, Broad network access, Resource pooling, Rapid elasticity and Measured service), three service models (IaaS, PaaS, and SaaS), four deployment models (Private, Public, Community and Hybrid), and four**a**rchitecture layers (Hardware Layer, Infrastructure Layer, Platform Layer and Application Layer) [6].

B. Cloud-based M- Learning for Higher Education Institutions

The cloud-based mobile learning catalyses the appearance of diversified virtual learning communities and virtual teams, which are dismissed the restraint of location, nation, and culture background of learners and expanded the influence scopes.

The kind of informal learning through the use of mobile devices makes it an even more potent tool of educational communication than the customary forms and modes of traditional education. These revolutionary changes developed out of the unforeseen significance of human social life generally more "mobile", creative and opportunistic, than the formal modes of traditional education [7]. The proliferation of smart mobile devices and higher bandwidth of internet connections have had a significant impact in Higher Education. Virtual Learning Environments (have been deployed by HEIsto provide access to learning materials and tools for students for over a decade [8].HEIsspending huge investment towards shifting of resources shared initiatives for cloud computing, programme possibly supports universities and colleges on centralized and shared functions to support learning, teaching, and research activities and reduces IT complexity and cost.

III. Cloud Based M-Learning Adoption for Ethiopia Higher Education Institutions

The proposed roadmap provides a prescriptive series of steps end users should take to ensure successful adoption of existing applications to cloud computing as shown in Figure 1 has seven stages: Planning, Choosing the right deployment model, Choosing the suitable service models, Vendor selection, Negotiating the SLA, Migration, and Integration [9].

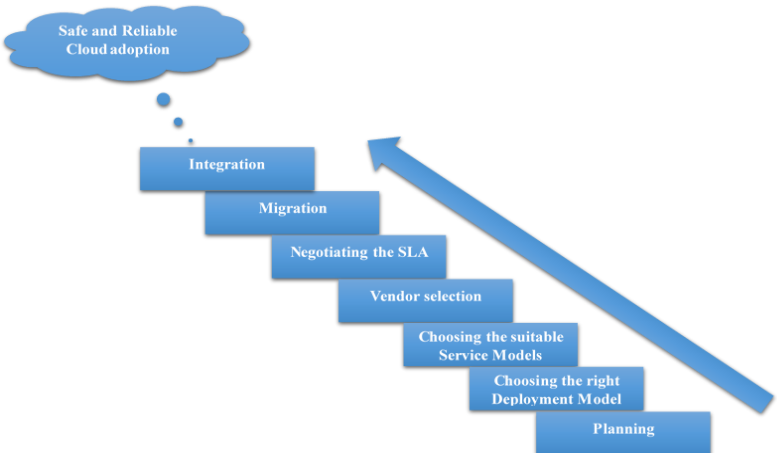

Figure 1: Roadmap for successful adoption of Cloud Computing.

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Stage 1: Planning
In this stage, a high-level analysis exploring the business objectives and how adopting a cloud can fit with the business strategy is executed.

- Awareness of Cloud adoption
- ICT Infrastructure
- Cloud Considerations

Stage 2: Choosing the right deployment model
Choosing the right deployment model is key to having a successful cloud platform, each of the four models of cloud computing have their strengths and weaknesses. This paper proposes that the hybrid cloud to be implemented should be the combination of public and private clouds.

Stage 3: Choosing the most suitable service models
It is good for organizations to carefully considering their IT portfolios and developing roadmap for deployment and migration. These roadmaps prioritize services that have high expected value and high readiness to maximize benefits received and minimizes delivery risk.
The choice of the delivery model is dependent on need. For a typical Institutions setting, based of the three models will be useful as they all have their unique features relevant to the needs of the HEIs.

Stage 4: Vendor selection
As it is the case of storing Institutions related data it is the key component to choose the right cloud vendor from so many other vendors for ensuring a successful and long-term relationship between HEIs and vendor. As cloud vendors are the service providers who are going to support HEIs in maintaining the data privacy and security within the Cloud.

Stage 5: Negotiating the SLA
The SLA is a very important document; it is a binding contract between the HEIs and the cloud service provider. The terms of the SLA should be negotiated and agreed upon by the HEIs and chosen vendors before the deal is signed.

Stage 6: Migration
At this stage, the chosen deployment model and processes to be hosted on the service delivery models are mapped out. After HEIs had selected cloud provider and identified which application they want to migrate first into cloud.

Stage 7: Integration
A successful integration is the key to realizing the full potential of the entire cloud investment. Lack of proper integration of the cloud with existing on-premise applications has been identified as one of the key reasons why cloud projects fail in the survey conducted; therefore, to avoid this from happening, a proper integration is needed to harmonize processes across the hybrid model.

IV. CONCEPTUAL FRAMEWORK OF CLOUD BASED M-LEARNING SYSTEM FOR ETHIOPIA HIGHER EDUCATION INSTITUTIONS

Cloud computing solution saves us from having to purchase, maintain and train IT staff on expensive hardware and proprietary software code. With One Network's technology solutions in the cloud, we no longer have to purchase, maintain, update and replace expensive equipment. The cloud solution also enables us to provide industry-leading time-to-value, with implementation times averaging less than half the time of traditional supply chain solutions. In addition, real-time data across all of your value chain participants means increased revenue opportunities.
This framework specifies the virtualization technology to be used to build a cloud based M-learning above the existing hybrid cloud infrastructure in order to use the resources more effectively and also to support the QoS (Quality of Service) objectives such as high availability, performance, reliability, scalability, load balancing and security in the

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service models (IaaS, PaaS, SaaS) of the cloud.Based on the roadmap for the successful adoption of cloud based M-learning, the researcher proposed Conceptual Framework for Cloud based M-learning system. Figure 3.1 show the Cloud based M-learning framework for Ethiopia HEIs. The Proposedconceptual framework consists primarily of four horizontal (User Interface, SaaS, PaaS, and IaaS) and two vertical layers (Service Management and Integration and System Security Layers). Figure 2 show the Cloud based M-learning conceptual framework.

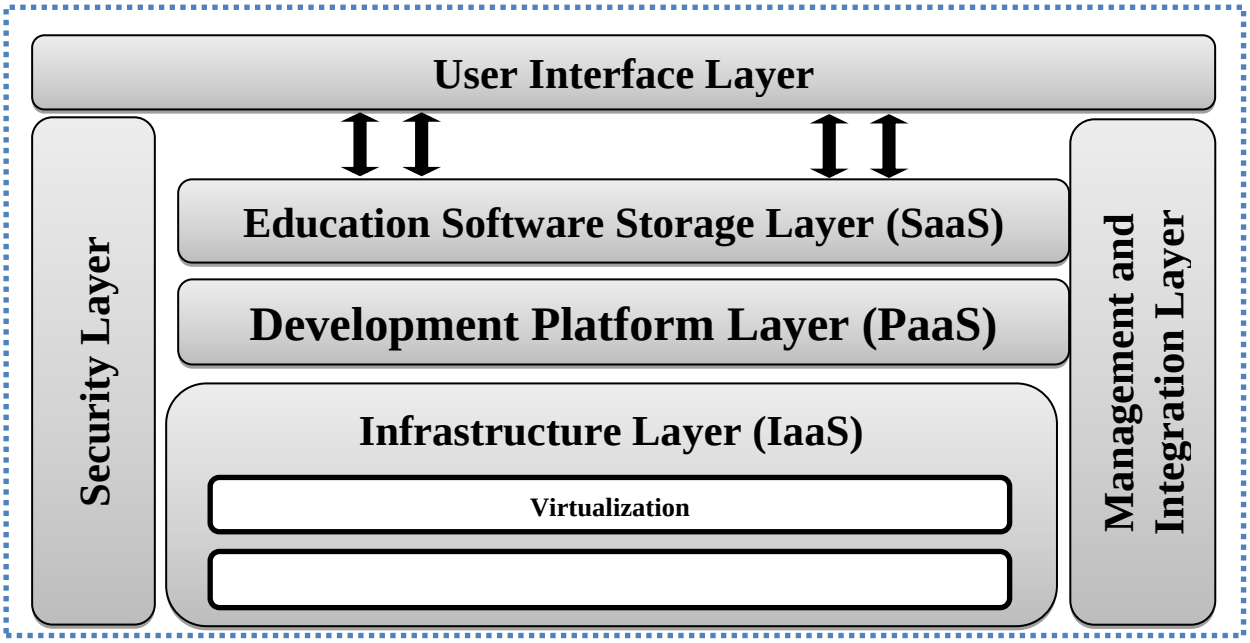

Figure 2: Conceptual Framework for Cloud Based M-Learning

i. User Interface Layer

The user/learner interface is simple and intuitive, without much graphics and drawings. It will reduce the amount of memory required by the application and reduces the time of development. The original version would be designed with interactive and user-friendly icons and menus. The end-users communicate with the cloud based M-learning using the browser enabled devices by means of the protocols.

ii. Software as a Service Options for Education Layer

Education Software as a service for students to manage interactions with Cloud Services in HEIs. Cloud application layer deliver software as a service over the Internet, eliminating the need to install and run the application on the customer's own computers and simplifying maintenance and support. This layer provides the SaaS to the end-users of the university. The M-Learning software using web2.0 tools or above and other licensed third-party software are installed in the HEIs cloud and these are provided to the students as a service. Apart from this, it provides various customization options to the end-users using the protocols such as REST, SOAP etc…

iii. Platform as a Service Options for Education Layer

Cloud platform services deliver a computing platform and/or solution stack as a service, often consuming cloud infrastructure and sustaining cloud applications. It facilitates deployment of applications without the cost and complexity of buying and managing the underlying hardware and software layers. The Platform Layer adds on a collection of specialized tools, middleware and services on top of the unified resources to provide a development and/or deployment platform. Platform as a Service (PaaS) offers a high-level integrated environment to build, test, and deploy custom applications.

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iv. Infrastructure as a Service Options for Education Layer

Infrastructure as a Service (IaaS) provisions hardware, software, and equipment's to deliver software application environments with a resource usage-based pricing model.

- Physical Sub-layer: It mainly supports the basic environment, including computers, storage, network interconnect devices, and database resources.
- Virtual Resources Sub-layer: Using virtualization technology, IT resources are combined into resource pools: the computing, data, network, storage resource pool. Thus a large number of the same type of IT resource is configured into graph isomorphism or near graph isomorphism, providing high performance services.

v. Service Management and Integration Layer

The Management and Integration layer is used to automate the flow of filtered data and information between the horizontal layers. It ensures that processed outputs from one layer to another are contextually related and syntactically correct. It also a management layer that leverages automation and functions across physical, virtual, and application resources is another required layer for higher IT maturity.

The cloud integration is the ability to deliver a complete integration stack from the cloud, including interfacing with applications, semantic mediation, flow control, integration design, etc. In essence, includes most of the features and functions found within traditional EAI technology, but delivered as a service.

vi. System Security Layer

The Security layer ensures the necessary authentication, authorization and auditing for the use of data and services by legitimate users. Further, it ensures secure personalization of end users services based on pre-defined preferences for processing and retrieval of contextual information from a Cloud environment. Each service layer has different levels of security requirement in the cloud based M-learning environment.

V. ARCHITECTURE FOR DELIVERING M-LEARNING SERVICES THROUGH FRAMEWORK

This architecture for delivering M-learning services through Cloud based M-learning to implement in HEIs.The proposed architecture for M-Learning is given in Figure 3. The four layers architecture distributing the service platforms.

i. User Layer

In the M-learning ecosystem, three user's roles can be notice: student, teacher and educational institutions staff. When implementing cloud based M-learning services it is important to clear define scope of each user role in terms of access right and set of available features. This user layer mainly responsible for checking the track of the authorizations users and its access mode which is selected in the User Interface layer checked them via this module. Users' information is stored in the Users Logs module.

ii. Devices layer

The end-users communicate with the cloud based M-learning using the browser enabled devices such as (handheld computers, notebooks, net-books, ultra-books, tablets and mobile phones) by means of the protocolssuch as RDP, SSH, Http/Https and LDAP. In addition, context-aware and U-learning introduce using sophisticated devices, such as difference types of sensors, RFID tags, GPS receivers, NFC devices, smart devices, etc.

iii. Connection Layer

In order to use cloud computing services, a device has to ensure secure and reliable network connection. Considering availability, GSM network are the most often used network connection technology (GPRS, HSDPA, 3G and 4G). In terms of reliability, Network bandwidth and latency for Mobile device connection to Internet, best way is using WiFi or WiMax connection. In mobile learning environments, group of RFID tags are connected to appropriate reader or other

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device that connects to cloud be used as well. Mobile device connects to a trusted, resource-rich computer or cluster of computers that is well-connected to the internet (for instance group of computers in the classroom or within campus).

iv. Cloud services Layer

Cloud that hosts M-learning services can be implemented in hybrid cloud infrastructure in order to use the resources more effectively and also to support the QoS (Quality of Service) objectives such as high availability, performance, reliability, scalability, load balancing and security in the service models. Considering service models (SaaS, PaaS and IaaS) of cloud computing, SaaS is the most appropriate. M-learning applications are provided to the users of M-learning system on demand as a service.

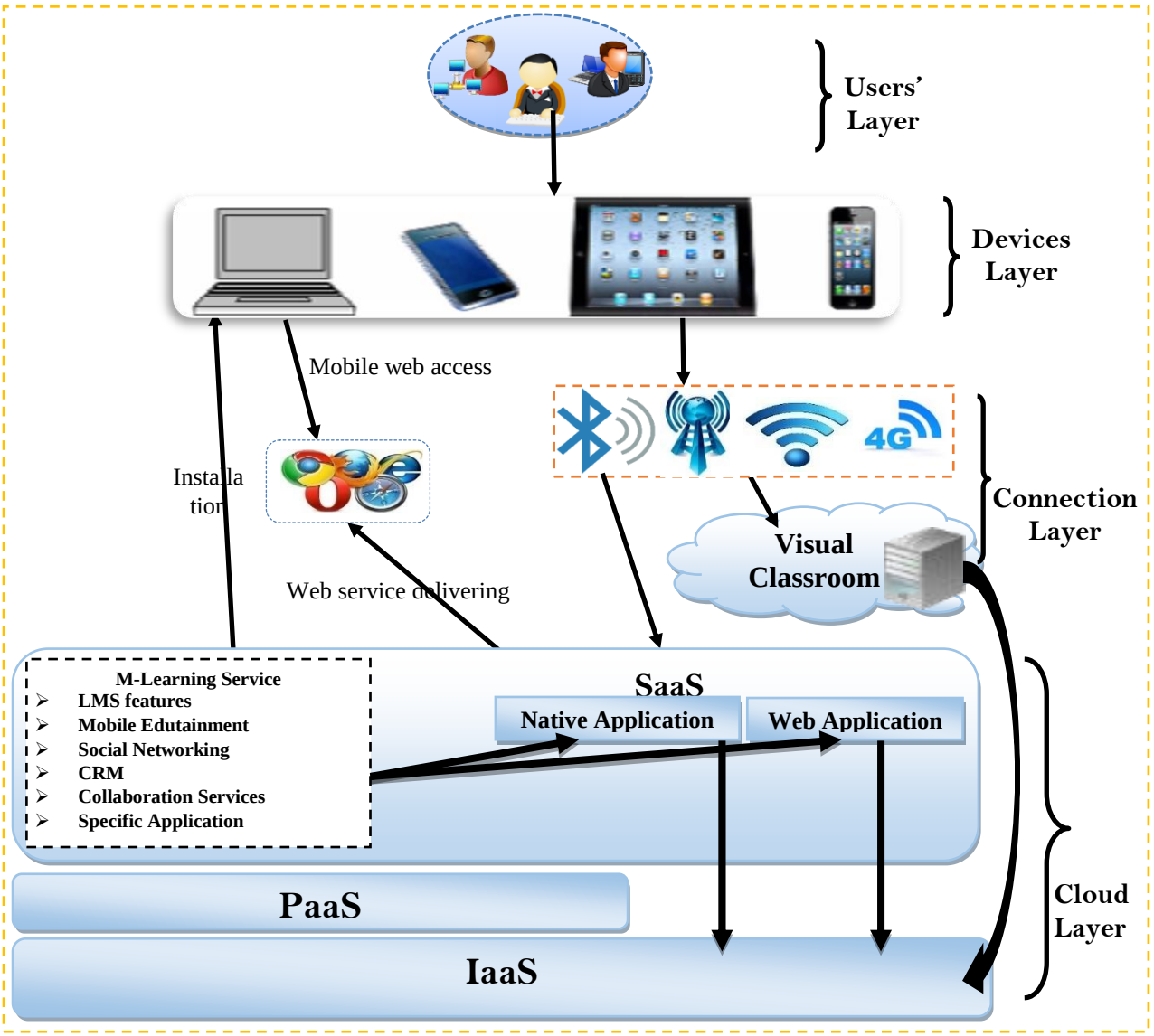

Figure 3: Architecture for delivering M-learning services through Cloud

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VI. CONCLUSION AND FUTURE WORK

Successful adoption of cloud computing is key for realization of benefits promised by cloud computing environment. As HEIs are faced with the need for high processing capabilities, large storage capabilities, IT resource scalability and high availability, at the lowest possible cost, cloud computing becomes an attractive alternative. However, the nature of cloud computing pose challenges to organization as they consider adopting it. Issues such as security, legal and regulatory compliance become more prevalent. The aim of the paper was to investigate the challenges facing cloud computing adoption and synthesize a framework which will HEIs with guidelines for successful cloud based M-learning adoption by addressing the challenges identified. The conceptual framework with the architecture delivery for M-learning system using cloud computing is designed to be implemented and managed by the collaboration of Ministry of Education and Ethiopia HEIs.

This paper will be the base for the development of an HEIs cloud based M-learning on the framework in a more effective way and it will be implemented on simulation environment/ cloud test beds using standard machinesAnother area for further paper is that of assessing the social-technical impacts of cloud computing in HEIs: the impact of migrating to cloud computing and its effects on the organizational culture, people and their relationships, work performance and system affordances.

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BIOGRAPHY

Mr. Atakilti Brhanu is a graduate student in Computing Science from Mekelle University, Ethiopia. AndHe has more than four year teaching experience and his research interests include Cloud Computing, Cloud based M-Learning and System Development and System Administration.