Evaluation of Potential Impact of Implementing Cloud Computing in E-learning Environment: A Review

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Structured Abstract:

Purpose: The paper examined the influence of cloud data storage, particularly the potential effect of cloud computing and security threats in e-learning environment. The reviewed provides a concise and all-round analysis on data security and privacy protection issues associated with cloud computing across all stages of data life cycle

Method: Review of relevant Literature

Findings: The paper revealed that cloud computing provides successful learning flexibility, virtualization, level of security tolerance, cost effectiveness, monitoring, controlling, high computing capability, future focus, information sharing and collaboration in teaching and learning activities. Similarly, the reviewed found that there are number of security issues and threats on cloud storage such as lack of proper policy to govern cloud storage, inadequate access to client information, breach of trustworthiness, technological bottlenecks, lack ICT infrastructure, managerial problems, absence of qualified personal to manage ICT facilities/equipment, lack of data confidentiality and integrity.

Originality / Value: Application of cloud computing in e-learning environment has significantly improved teaching and learning process effectively globally. However, security issues are the subject of concerns in cloud computing platform which need to be addressed to make cloud environment safe and trustworthy. The paper recommended among other things that the security of cloud computing cloud be enhanced through adopting three level user's authentication.

Keywords: Cloud Computing, E-learning, Service, Evaluation, and Security.

Paper Type: Review Paper.

Introduction

The acceptability of cloud computing application in e-learning environment is gaining fast recognition due it significance. Recent researches revealed a lot of impacts of cloud computing in e-learning atmosphere (Masud *et al.*, 2012, Pocatilu *et al.*, 2009, 2010a, 2010b, Greenhow *et al.*, 2009, Ramgovind *et al.*, 2010, Leavitt, 2009 & Dong *et al.*, 2009,). Cloud computing is an informal expression used to describe different types of computing concepts

that involve a large number of computers connected through a real-time communication network such as the Internet (Carrol *et al.,* 2012 and Leavitt, 2009). This means that Cloud computing is a type of computing that relies on sharing computing resources rather than having local services on personal devices to handle applications. Additionally, cloud computing can be seen as a computing model based on networks especially the Internet, whose task is to ensure that users can simply use the computing resources on demand and pay money according to their usage by a metering pattern like water and electricity consumption (Masud *et al.*, 2012*).* Thus, Cloud Computing means storing and accessing data and programs over the internet instead of computer's hard drive. To store and access data effectively, there are several cloud computing service providers that support education system for good knowledge delivery. Among them are Google, Microsoft, Amazon and Yahoo (Pocatilu *et al*, 2009).

An e-learning is an internet based-learning procedure that uses web technology to design, implement, select manage, control, support and spread learning outcome, which will not replace traditional education methods, but have significantly improves the effectiveness of education system (Masud *et al.*, 2012). This indicates that cloud computing uses internet as a life-wear could play significant role in decentralizing e-learning activities. This paper will focus on categories of cloud computing, tools for delivering cloud computing, impact of cloud computing and security issues and threats on cloud storage.

Aims & Objectives

This article aims to review the current impact of cloud application in e-learning atmosphere. The objectives are as follows:

   i. To review the potential impact of implementing cloud computing in e-learning system.

  ii. To review security issues and challenges affecting cloud implementation in e-learning system.

 iii. To proffer viable and dependable solution to any identify problem.

Service Layers of Cloud Computing

Cloud computing operate under three basic service layers which comprised the of Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS) (Ramya,

2015; Matthew, 2015; Masud *et al.*, 2012; Pocatilu *et al*, 2009; Kulkarni *et al*, 2012; Pocatilu *et al.*, 2010a; Ramgovind *et al.*, 2010 and Al Noor *et al.*, 2010). Each of these categories achieves a specific goal and support different outputs for organizations and individuals throughout the universe.

Software as a Service (SaaS)

Kulkarni *et al.*, (2012) reported that, SaaS is run by cloud service providers through internet and mostly used by organization. This assertion was supported by (Matthew, 2015; Goel *et al.,* 2011; Ramgovind *et al.,* 2010 and Low *et al.,* 2011). The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email) or a program interface (Matthew, 2015; Goel *et al.,* 2011). Similarly, SaaS is a process by which different software applications are provided by the application service provider as a rental over the internet, leveraging cloud infrastructure and services released by Salesforce.com (Low *et al.,* 2011).

Platform as a Service (PaaS)

In this category, a client is provided with the ability to install onto the cloud infrastructure, consumer-created or acquired applications created using programming languages, libraries, services, and tools supported by the provider. The client does not manage or control the underlying cloud infrastructure (network, servers, operating systems, or storage), but has control over the installed applications and perhaps configuration settings for the application-hosting environment (Matthew, 2015). In contrast to this Kulkarni *et al.*, (2012) reported that PaaS is a tool (windows, LINUX) used by developers for developing Websites without installing any software on the system, and can be executed without any administration expertise.

Infrastructure as a Service (IaaS)

In IaaS, a client is provided with processing, storage, networks and other fundamental computing resources where the customer can deploy and run arbitrary software, which can include operating systems and applications. The customer does not manage or control the underlying cloud infrastructure (network, servers, operating systems, or storage), but has control over operating systems, storage and deployed applications; and maybe restricted control of select networking components (Matthew, 2015). In support of this statement, Low

et al. (2011) and Kulkarni *et al.* (2012) reported that IaaS is operated, maintained and controlled by cloud service providers that support various operations like storage, hardware, servers and networking. Low *et al.,* added that service provider sown the equipment and is responsible for housing it. Stability and reliability of the IaaS is guarantee through hardware and software virtualization technologies (Dong *et al.,* 2009)

Cloud Computing Application Tools

Cloud computing application is delivered in several ways in teaching and learning processes. In an article written by Thomas (2011) on potential of cloud computing application in scholarship of teaching and learning found that Google docs and Microsoft SkyDrive are among the vital tools for effective delivery of knowledge. However, the limitation of the study is lack of an indication as which methodology was used. An investigation carried by Cachin *et al.* (2009) on trusting the cloud confirmed the findings of Thomas (2011) and further revealed that Amazon S3, Amazone EC2, Google Apps, NirvanixCloudNAS and Apple MobileMe are application tools for cloud computing. MobileMe allows users to synchronous common applications that run multiples devices. Generally, these tools allow easy collaboration with colleagues. However, the authors argued that risk was involved over releasing control of client data and the availability of online service is the major concern due to downtime as reported recently with Google Mail, Hotmail, Amazon S3 and MobileMe. The key drawback on this research, the proposed solution to security issue raised on cloud storage is yet to be implemented. In support of both Thomas (2011) and Cachin *et al*. (2009), a similar research carried out by Ramya (2015) found several cloud computing application tools such as Dropbox, Apple iCloud, Google drive, Microsoft OneDrive, Amazon Cloud drive, and Box. These cloud application tools support cloud storage, file synchronization and collaboration. Dropbox is a modern workspace designed to reduce busywork for one to focus on the things that matter.

A research conducted by Husain *et al*. (2010) reported MapReduce is currently an evolving tool for cloud computing in handling large amount of data. The authors further outlined that Scholars and enterprises have applied MapReduce technology for web indexing search, data mining and semantic web. According to the researchers Semantic Web technologies are being developed to present data in a more effective way which can be retrieved and understood by both users and machine. In another research conducted by Calheiros *et al*. (2011) developed a CloudSim toolkit for modeling and simulating extensible Clouds. It is a suitable research tool

that can manage the difficulties arising from simulated environments. Therefore, it refers as a platform for modeling and simulation of cloud computing infrastructures and services. The study suggested future work, which will incorporate new pricing and provisioning policies to CloudSim, to offer a built-in support to simulate the currently available Public clouds. In support of this finding Nurmi *et al.* (2009) built a EUCALYPTUS system which allow administrators and researchers to deploy an Infrastructure as a Service (IaaS) for user-controlled virtual machine creation and control upon existing resources.

Impact of Cloud Computing in E-Learning System

Cloud computing plays a substantial role in advancing e-learning processes. The numerous significance of cloud computing in e-learning platform are discussed below:

Flexibility of Learning: E-learning offers flexible teaching and learning process through online test, exams, feedbacks, home works, projects, train the trainers, dealing with content management general, assessments, learning collaboration and teacher / student forum (Pocatilu *et al.*, 2009). Similar findings were obtained by (Thomas, 2011). A research conducted by Masud *et al.* (2012, 2009, 2010a and 2010b) outlined that devices with minimal hardware requirements (mobile phones, for example) could be successfully used as cloud clients for accessing E-learning information. Similarly, Dong *et al.* (2009) revealed that one of the most important feature ideas behind Cloud computing is scalability, and the key technology which makes it possible is virtualization. In support of the above findings Berl *et al.* (2009) augured that cloud computing acknowledges substantial attention as a best approach for ICT delivery service by enhancing utilization of data center resources.

Virtualization: Virtualization allows multiple operating systems and applications to run on the same server at the same time and it serve as the fundamental element of cloud computing application. It put the underlying hardware, including servers, storage and networking equipment and comprehensive virtualization, to build a resource pool of sharing and distribution on-demand (Masud *et al.*, 2012) this assertion was also put forward by Berl *et al.* (2009). Likewise, it makes possible the rapid replacement of a compromised cloud located server without major costs or damages and it is very easy to create a clone of a virtual machine so the cloud downtime is expected to be reduced

substantially (Pocatilu, *et al*, 2009, 2010a and 2010b).This has been sustained by Dong *et al.* (2009).

Level of Security: Storing data in cloud will guarantee considerable level of security threats. This is in accordance with (Masud *et al.*, 2012) who stated that Relying on one or more data center, the managers manage the unified data, allocate the resources, balance load, deploy the software, control security, and do the reliable real-time monitoring, thus guarantee the users' data security to the greatest possible degree. These assertions agree with Goel *et al. (*2011), who outlined that there is security standard, integration and no additional risk in case of emergency or natural disaster in cloud computing. Accordingly, Dong *et al.* (2009), developed a cloud architecture that can provide an effective way of balancing resources with the current economical state by utilization of unused resources and removal of third party involvement and this will provide strong secure atmosphere that allows the client to configure his own security policy.

Cost Effectiveness: Using Cloud data storage allows individuals and organization saving a lot of funds which can be channel to other importance things. Goel *et al.* (2011) and Ramya (2015) revealed that cloud computing benefits in many ways such as service provisioning, reducing costs and best resource utilization. This is supported by Berl *et al.* (2009), using plugs-in and energy-control center for networked large-scale will reduce cost of software and hardware, reduce load imbalance and it reduces energy consumption due communication. In the other hand cloud uses highly costly software and processors for running cloud application which is very difficult to own by individual (Masud *et al.*, 2012). Managing cloud application require large amount of money. Pocatilu *et al.* (2010a) suggested that it is cost effective if the E-learning services are used for relative brief time (such as several weeks, a quarter, or a semester). It also promises tangible cost saving and speed to costumers. (Wycliff *et al.*, 2016). IaaS is a single tenant cloud layer where the Cloud computing seller's dedicated resources are only shared with contracted clients at a pay-per-use fee. This significantly reduces the need for huge initial investment in computing hardware such as servers, networking devices and processing power (Ramgovind *et al.,* 2010).

Monitoring and Control: Monitoring and control of data storage is one of the important feature that attract clients to in patronizing cloud services. Cloud computing system can automatically detect the node failure and exclude it, do not affect the normal operation of

the system. (Masud *et al.*, 2012). Equally, monitoring of data access becomes easier in view of the fact that only a centralized server should be supervised. (Pocatilu *et al*, 2009, 2010a and 2010b). Also, any security changes can be easily tested, verified and implemented since the cloud represents a unique, entry point for all the clients. Likewise, it consists of massive resources, and provides some mechanisms to provide, reimage, workload rebalance, de-provide, and monitor those resources. (Dong *et al.*, 2009).

High Computing Capability: Cloud service has high power of computing and storage capacity. It locates substantial number of distributed system among ocean of clouds to provide powerful computing and large storage space (Masud *et al.*, 2012). It offers access to many sophisticated supercomputer and their resultant processing power, connected as numerous locations around the world, thus offering speed in the tens of trillions of computations per second. (Wycliff *et al.*, 2016).

Solution to E-learning Problems: Cloud computing offer vital solution to E-learning constraint. Pocatilu *et al*. (2010a) reported that students benefit from online course, exams, feedback, homework and projects. The authors further added that trainers also benefit through content management, prepare tests, assess teste, homework and projects. These could be achieved via email, Instagram, skype, video conference and forums. A similar study by Thomas, (2011) agreed with the above findings. The study outlined that feedback from peers based on teaching observation and peer review from all stake holders could be evaluated.

Information Sharing: Cloud computing has the capability of sharing information which are very expensive to possess and maintain. It provides availability of a huge array of software applications, seemingly unlimited storage, has given access to lightning processing power and the ability to easily share information across the globe. (Wycliff *et al.*, 2016). The authors further reveal that Cloud computing allows consumers and corporate structure to use all the applications offered by the cloud without extra effort of instillation and offers access to their personal file from any computer anywhere at any time with internet access. It offers futuristic needs, customization and group organization (*Goel et al.,* 2011).

Security Issues and Threats on Cloud Data Storage

Despite the benefits of cloud computing in E-learning system, the cloud is not completely safe or trustworthy since it could be compromised or illegally accessed by an unauthorized third party. One of the biggest concern is security issues of the data because both data and the software are placed on isolated servers that is not guarantee from smash or vanish without any cautions (Pocatilu *et al*, 2010a). This finding was supported by Wycliff *et al.*, (2016) who revealed that data security has always remained a major issue in cloud application since data are scattered at various places all over the globe. Similarly, Al Zain *et al.* (2012), reported that in everyday computing, security is one of the most acute aspects to be considered and it is no less important for cloud computing due to the sensitivity and significance of data stored in the cloud.

In cloud computing environment, security issues could be divided into four types: safety problems caused by virtual technology; root authority of the data center; data security and consistency; and problems prompted by modern technology (Han & Zhang, 2012). A similar study by *Goel et al.,* (2011) supported the above findings.

Mathew (2015) examined the trends, benefits and challenges being encountered for adopting cloud computing in Nigerian Universities. An empirical research via questionnaire was used to generate data for the study. The study found challenges of cloud computing adoption in Nigerian University as shown in the table below:

S/N	Challenges of using Cloud Computing in Nigeria Universities	% of Respondents
1	Data insecurity	89.3
2	Unsolicited Advertising	64.6
3	Lock-in	77.6
4	Reluctance to eliminate staff positions	64.6
5	Privacy Concerns	68.9
6	Reliability challenge	64.2
7	Regulatory compliance concerns / User control	80.0
8	Institutional culture / resistance to change in technology	59.2

Table 1: Challenges of using Cloud Computing Adoption in Nigerian Universities (Mathew, 2015).

In support of these findings, similar studies by Cachinet *et al.* (2009), Minqui Zhou *et al.* (2010) and kresimirpopovic *et al.* (2010), disclosed that there are various threats concerning cloud storage security which include: lack of total access to owner information, absence of proper control, inadequate compliance to the law governing cloud storage, lack of data integrity, lack of audit, privacy breach, and poor confidentiality. A study by Ramgovind *et al.* (2010) on the management of security in cloud computing adoption confirmed the above findings and added that data segregation, recovery, investigative support, long-term viability and data availability are among the challenges of adopting cloud computing application. In support of both Mathew (2015), Minqui Zhou *et al.* (2010), kresimirpopovic *et al.* (2010) and Ramgovind *et al.* (2010) a study by Rewagad & Pawar (2013) revealed that privacy, confidentiality and integrity are among the forefront of security issues in cloud and it demands a trustworthy computing atmosphere so that data confidentiality can be maintained. In contrast to above findings, a study by carried out by *Goel et al.* (2011) on the impact of cloud computing on ERP implementations in higher education, discovered challenges of implementing cloud computing for ERP in higher technical education such as elasticity complexity, superstructure emergence, technological bottlenecks, serializability and consistency, programming model; monitoring, analysis and building trust, mobility and provisioning.

Conclusion

From the reviewed literature, both previous and recent researches revealed potential impact of cloud computing application and security challenges associated with cloud storage for e-learning platform. The likely benefits include learning flexibility, virtualization, level of security tolerance, cost effectiveness, monitoring, controlling, high computing capability, future focus, information sharing and collaboration in teaching and learning activities. In the other hand the reviewed found that there are number of security issues and threats on cloud storage such as lack of proper policy to govern cloud storage, inadequate access to client information, breach of trustworthiness, technological bottlenecks, lack ICT infrastructure, managerial problems, absence of qualified personal to manage ICT facilities / equipment, lack of data confidentiality and integrity.

Recommendation

From the reviewed literatures, numerous impact and challenges of cloud computing application in e-learning were identified and therefore, techniques / algorithm were suggested to provide secure atmosphere for data storage on cloud:

- Three levels password should be adopted. The system could able to generate alternative corresponding number of the password each time of login for proper authentication.
- Adequate laws for handling issues of data storage breach should be enacted at all level of operation.
- The use of thump print, face, voice and image recognition should be adopted for user authentication.
- To ascertain the confidentiality of encrypted data the clients should own and manage the data encrypted keys.
- The clients should have contingency plans in place in the event their cloud provider fails or goes bankrupt.

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