Usage of Cloud Computing in Education

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ABSTRACT

Cloud computing is expanding in rapid pace and is being used in all business activities. Cloud adoption has always been beneficial irrespective of the business sector in which it is used. This is due to the subscription based payment and demand based provisioning. Optimal advantages of cloud adoption can be leveraged when the software requirement usage is not perennial. Education is one sector which has also benefitted due to cloud adoption. Education is a field in which the use of software is the combination of both regular and periodic usage. The periodic usage will be session or semester based. The specialized software will be used for a period of three to four months in a year. In this scenario, rather than purchasing perpetual licensed software, colleges can opt for cloud based usage software or platform. Even though cloud inclusion is beneficial, it also has few demerits due to the inherent Internet based working. This paper discusses about the prospects of cloud usage in education along with its barriers and possible solutions.

Keywords: *ICT, Cloud in education, benefits of cloud, challenges of cloud adoption*

INTRODUCTION

Information and Communication Technology (ICT) has an inevitable part in educational institute to establish effective and efficient implementation of its day-to-day, monitoring and controlling activities. Technology inclusion in educational institutes is essential for enhancing interaction quality between students and faculty, providing centralized view of academic records, improving transparency and standards (Naik et. al., 2013).Digital Interactive White Boards (IWBs) also known as Smart Boards, which is an enhancement of ICT utilization in education are slowly gaining foothold in primary and secondary schools. The concepts of just-in-time, community and found learning are picking up which have the intrinsic features of collaboration, peer exchange learning and social participation that needs to be achieved through effective IT infrastructure. The perception of considering infrastructure as an asset is changing to consume them as service overcoming hosting and maintenance worries (Plummer et. al., 2008). The new approach of personalized or individualized learning is gaining popularity, where flexibility prevails in learning and teaching process with the help of internet.New collaborative teaching paradigm removes the physical classroom constraint and learning hour restrictions. Digitization of education also assists institutes to gather information regarding progress of students, attendance, performance etc. Predictive analysis when applied on this information will help to reveal the dropout risks and the prospective areas of improvement in each student thusinitiating proactive measures to avoid failures (IBM, 2012).

Cloud computing is the extension of grid and utility computing along with the IT technology features extracted from Service Oriented Architecture (SOA), virtualization and Web2.0 (Jeong, et. al. 2013).

Virtual Desktop Infrastructure (VDI) implementation and other traditional server based IT implementation are migrating towards rental based cloud implementation for higher availability, scalability, cost reduction and resilience (Koch et. al., 2010). VDI provides desktop based learning and resource sharing with reduced IT overhead and enhanced security (Dell, 2011).Average availability of 99.5% aimed by the institutions for the delivery of its learning modules is escalated to 99.9% on adoption of cloud Google application suite for education (Sclater, 2010). Well established educational institutes have to opt for “brownfield development” while adopting cloud as the cloud implementation need to interoperate with existing IT systems (Hopkins & Jenkins, 2008). IT requirements of educational institutes have fewer fluctuationsunlike organizations as the requirements can be predicted for a year or at least for a term of three months. Deferring or circumventing cloud adoption will deprive the institutes from achieving flexibility, mobility and the opportunity to utilize the availability of abundant resources across the globe (IBM, 2012).

Pay-per-use or subscription based usageof cloud resources, dynamic self-provisioning to meet the requirement demands are some of the beneficial features of cloud, but at the same time lack of proper planning before cloud adoption and monitoring after cloud implementation might result in dwindling effect on cost reduction benefits. Extensive analysis of IT requirements of the institutes and marking the processes to be migrated to cloud is essential as not all processes are beneficial when implemented through cloud. This must be followed by detailed cost benefit analysis and budgeting of cloud adoption.

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ICT IN EDUCATION

Information and Communication Technology (ICT) includes computers, the Internet, and electronic delivery systems such astelevisionsand projectors and is widely used in today's education field.In the new pedagogical paradigms, the learner is a central figure who actively participates in the learning process. ICT enable the implementation of such contemporary forms by interacting and collaborating with all participants. Implementing ICT in education leads to training consistent with the needs and characteristics of the new generation of learners.

An appropriate use of ICT can raise educational quality and connect learning to real-life situations (Lowther, et al. 2008; Weert and Tatnall 2005). As Weert and Tatnall (2005) have pointed out, learning is an ongoing lifelong activity where learners change their expectations by seeking knowledge, which departs from traditional approaches. ICT tends to expand access to education by ensuring learning to occur anytime and anywhere. Online course materials, for example, can be accessible 24X7 facilitating learner driven approach.Teleconferencing classrooms allow both learner and teacher to interact simultaneously with ease and convenience. Based on ICT, learning and teaching no longer depend exclusively on printed materials.

Multiple resources are abundant on the Internet, and knowledge can be acquired through video clips, audio sounds, visual presentation and so on. ICT assists in transforming a teaching environment into a learner-centered one (Castro Sánchez and Alemán 2011). Since learners are actively involved in the learning processes in ICT classrooms, they are empowered by the teacher to make decisions, plans, and so forth (Lu, Hou and Huang 2010). ICT therefore provides both learners and instructors with more educational affordances and possibilities.

CHALLENGES IN TRADITIONAL ICT IMPLEMENTATION

The implementation of traditional ICT has many problems in the area of hardware, software and Students (Nayar and Kumar,2018). As far as the hardware problems are concerned, the hardware may bevery expensive for an Educational institute. Maintenance and updation of hardware may be time consuming keeping in mind the decreasing life span of the hardware.There are a number of systems in one particular lab of universities and institutes which requirelicensed software for every system that attracts the challenges pertaining to purchase of costly licensed software, purchase of newer versionsand purchase of antivirus.

The problems faced by the students comprise of a limited time period and non- availability of the resources, portability, geographical space, compatibility, computing power and delay in procurement process of software and hardware.So traditional forms of e-learning require significant investments – building appropriate IT infrastructure, expenses for its maintenance, need for highly qualified IT staff to operate and manage it. The increased costs and reduced financial resources urge educational institutions to seek solutions to overcome existing constraints and to provide conditions for effective learning process, consistent with the new educational trends and paradigms.

CLOUD SCENARIO IN EDUCATION

Innovation is essential to keep pace with ever changing requirements in all sectors. Cloud adoption is one such innovative measure which helps users to leverage the advantage of latest technology at reduced cost and efforts. It is a distributed computing technique that offers pool of shared resources on demand in pay-per-use or subscription model (IBM, 2012). The minimum requirement for cloud adoption is a thin client with Internet connection(Mathew, 2012). Cloud computing model emphasizes primarily on availability with five essential characteristics such as broad network access, on-demand self-service, resource pooling, measured services, rapid elasticity along with three models Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS) (Mell & Grance, 2009). IaaS is lowest level service model where storage, network and compute resources are utilized from cloud provider to run in-house operating system or applications. Example, Amazon Elastic Compute Cloud provides servers for the institutes which can be scaled up or down on demand. PaaS service model allows the users to rent the software platform for the development of in-house applications. Example, Google apps and Microsoft Azure used to develop and install applications. SaaS is the top levelservice model which is often utilized by educational institutes. Example, Microsoft Live@Edu for communication and cloud based ERP Suites (Johnson et. al. 2009). Private cloud, public cloud, hybrid cloud and community cloud are the four deployment models, which is chosen based on requirements and criticality of data security (Naik et. al., 2013).

Educational institutes strive to inculcate optimal management of IT infrastructure for maintaining satisfaction of students, quality of service and delivery of up-to-date education materials (Sultan, 2010).Escalating demand for IT infrastructure and software for a short time span with restricted IT budget is often faced by academic institutes (Pardeshi, 2014). Innovation speed of IT, mobility and versatility requirement in teaching and learning space, consumerization of IT, learning at the user pace, collaborative learning through forums and urge of the younger generation to view everything through various digital tools such as smart phones, internet, chats, blogs, social network etc., are also the instigating reason for the revamp in IT utilization across educational institutes (IBM, 2012). Cloud adoption for the delivery of educational services is an easy and cost effective solution

for the educational institutes to keep pace with the technology changes and the all-time access requirements of students and academicians. Google Drive, Dropbox, SkyDrive are some of the free cloud storage services that can be leveraged by student for easy sharing and any-time access of

Dynamic provisioning of resources and applications on demand through remote accessing at reasonable cost, reduced investment, greater flexibility, guaranteed Service Level Agreement (SLA)and cost transparency are the attractive essential features of cloud adoption that are required to support academic and research activities in educational institutes (Educase, 2011; Truong et. al., 2012).As per UNESCO report 2010, economies of scale and various other features of cloud computing are expected to provide a radical shift from institutional server based hosting techniques (Sclater, 2010). The pay-as-you-go model of cloud services charge the educational institutes for the compute and storage resources, specialized software and software development platform utilization. The overhead of hardware costs and software provisioning lies with cloud service provider (Buyya et. al., 2009; Ambrust et. al. 2010). Cloud adoption in education eliminates the cumbersome and complex process of infrastructure investment and upgrade planning which enable the institutes to concentrate on education and research activities (TechDecisions, 2014). Email, online collaboration, conferences, online learning, file sharing and web hosting are the top priority functions of the educational institutes for which cloud based services are utilized (Klug, 2015). Institutional Learning Management System (LMS), which are often implemented using Moodle or Blackboard application,arealso hosted from cloud that shifts the cost and maintenance overhead from the institute to providers (Sclater, 2010). Smart education system delivered through cloud assistance leverage convenience of easy sharing and delivery of e-learning educational contents such as text, images, videos, 3D objects modeling with Virtual Reality (VR) and Augmented Reality (AR) (Jeong et. al., 2013). Different stakeholders of academic institutes such as students, staffs, faculty, research scholars, developers and management are to be benefitted by cloud adoption in various ways.Cloud based servicedeployments promote extensive dynamic exchange and participation among academicians.The demand of the stakeholders to access IT infrastructure and applications of the institute through various devices such as smart phones, tablets, kindle, e-readers etc. are met by cloud adoption which allows access from any device at any time (IBM, 2012).

Shortage of skilled staffs, over-crowded classrooms, less number of teachers and restricted budgets are some of the major issues faced by K-12 education segments across the globe (Dell 2011). The Cloud computing adoption will enable IT staff of this segment with an innovative way to balance minimum budgets and maximum utilization of the existing IT infrastructure. Cloudcomputing is being adopted at lower pace in the K-12 arena, where schools and classrooms are slowly migrating to digitalization. The availability of enormous study material and resources, pedagogical and technological trend changes are driving institutes to opt for Bring Your Own Device (BYOD) implementation allowing mobile devices and tablets in the classrooms (TechDecision, 2014). SaaS solutions are used in larger numbers in K-12 institutes.

Cloud plays a major role in dissemination of continuing educations which is an educational enhancement of employees that bridges the skill gaps and is also essential for career development (Vmware 2016).Adult learners are the major users of continuing education which mainly focuses on digital and computer skills. It has the characteristics of after-hours learning along with full time employment, varied study requirements based on expertise levels and personalized curriculum. Remote access to study material is considered as the best option in cases where the living place or the work place of the learner is far from the educational institute (Lennon, 2012).

Larger institutes often benefit from cloud adoption as even the cloud service providers concentrate on requirements of large institutes whilst the smaller institutes are provided with simple cloud adoption like emails or conferencing tools (Klug, 2015). Cloud adoption is increasing

i. Benefits of cloud adoption in education

The inherent benefits of using virtualization and cloud adoption include cost reduction, scalability, availability, self-provisioning, reduced IT investments, remote access etc. Cloud adoption also reduces the energy consumption of the institutes which inevitably reduces carbon footprint contribution of the institute and its environmental impact (Kumar & Vidhyalakshmi, 2013). Cloud adoption facilitates IT standardization and transparency among costs, funding and IT demands foster (Katz et. al., 2010).Educational resources such as study material or contents hosted on cloud platform as virtual lecture theaters enable academicians to create collaboration forums that can be used to interact with teaching fraternity of all disciplines (IBM, 2012). A shift in the role of cloud as major influential factor in education is expected in the next five years. Cloud computing which is considered as a moderate factor in education is expected to be have a shift as a major factor as depicted in figure 1 (vmware, 2016).

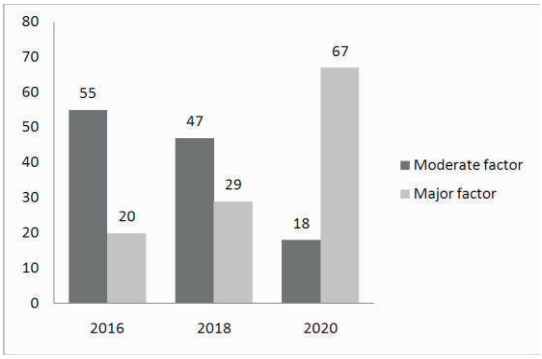

Figure 1: Cloud adoption as influence factor in education

Benefits of cloud adoption with respect to education are: (Sclater, 2010; Educase, 2011; IBM, 2012; Cross 2013; Bhatia 2014; vmware, 2016)

i. Updated learning material

Non-availability or affordability of extensive and expensive study material is a perennial issue in K-12 segment (Bhatia, 2014). Cloud adoption solves this issue as a single copy of the material is maintained in the cloud servers and is accessed by everyone using subscription model. The more the subscriptions count the lesser will be the price and hence this increases the chances for the students of less affluent rural based educational institutes to leverage study material in tune with their urban counterparts. Centralized maintenance and systematic consistent modification using cloud setup enable institutes to access documents, assignments, projects, syllabuses and study material without complexity and this also ensure updated material availability to all users (IBM, 2012).

ii. Enhanced research collaboration

Cloud adoption enables institutes to concentrate on core activities like providing education and performing research (Sclater, 2010). It also enhances collaborative learning through its remote and anytime access facility. This also eliminates the geographical and time barriersin education progression. Researchers from one part of the globe can get advice and consultation from experts of their field from any part of the globe through chats, blogs, forums, social and professional community sites (IBM, 2012). The research papers, study materials, data analytics processes and other valuable research materials that are maintained in the cloud data centers can be shared and updated by the members of the research group. Data duplication processes undertaken as a routine of backup process ensures the integrity of the research resources even at the times of disaster.

iii. Reduction in IT investment

The cost reduction is attained through sharing of IT infrastructure and implementation of virtualization. Cloud adoption drastically reduces the number and complexity of the machines, application software installations and maintenance thus reducing costs (IBM 2012). The elimination of the under provisioned or over provisioned IT resources also adds on to cost reduction. Students utilizing cloud solutions can also leverage the free storage offerings by major providers like Google (Bhatia 2014). Expensive licensed software can be replaced by Microsoft Office 365 for education, freely available Google Docs or monthly subscription based SaaS applications.

iv. Access to state-of-art technology

Innovation in technology takes place at a rapid pace and institutes often struggle to keep pace with the ever changing technologies mainly due to budget and skill restrictions. Software products become shelfware due to end of the product life cycle or technology developments. Adoption of cloud will enable institutes to leverage state-of-art technologies at the same cost as the providers always maintain latest technology to gain competitive advantage (Bhatia, 2014). Elasticity and dynamic provisioning enable institutes to start with small set of services and expand their cloud usage based on the demand of the curriculum, peak admission periods and examination periods (Sclater, 2010).Futuristic planning and investment which is the barrier for progression in adopting new technology is removed with the help of virtualization in cloud adoption (IBM, 2012).

v. Multiple device access

E-learning which was introduced as desktop based has evolved to be used by multiple devices as these devices are integral part of our lives and switching between them is a commonly followed practice (Lahri, 2015). Cloud adoption is inevitable in e-learning as it supports multiple device access at the time of need. This also gave forth to responsive design of sites and its contents. Responsive LMS modules are easy to develop and maintain when compared to maintenance of different versions of the same applications to ensure multiple device compatibility.

vi. End-user satisfaction

Enhanced availability feature of cloud adoption allows students, research scholars and faculty to access study materials, research papers and assignments during and even after hours of college or university. Anti-obsolescence is guaranteed due to periodic automatic updates and enables institutes to provide the latest technology sessions to the students which will also help to bridge the industry-academic gaps (IBM, 2012). Elimination of physical classroom restriction in the student teacher interaction due to cloud adoption enables students to carry out assignments and projects at their convenient schedules.

vii. Augmented learning process

Cloud computing and Augmented Reality (AR)are the key innovations in the e-learning market. AR which works on the principle of layering interactive image on the physical reality image when implemented in education will help educators to provide 4D learning experience (Murray, 2016). Integration of augmented reality in lectures increases the understanding levels of the students as it allows them to participate and helps to capture the attention of the students using 3D models, prototypes and detailed illustrations (Lindsay, 2015). A single scan of the image using Augment App will enable students to link to the corresponding sites for detailed information at the touch of the screen which helps in long term knowledge retention.

viii. Reduction in technically skilled labor

Replacement of heavy servers with thin clients removes the need for highly skilled database and

system administrators, thus reducing human resource cost (IBM, 2012). Thin clients have lower maintenance cost as most of the movable parts of the PCs are not present and the software do not need regular patchesorupdationsas they are maintained centrally and handled by providers at the data centers (Dell, 2011). IT staffs must be trained for the cloud setup and its usage. Training must be provided for requirement based scaling and monitoring processes which are essential to leverage the cost benefits of cloud adoption.

ix. Faster solution deployment

New cloud services, software for the newly introduced course or additional resource capacity required by the institute are provisioned by the cloud provider on demand. This eliminates the planning time and investment of new servers and software installation (Educase, 2011). The requirements of the resources and applications are normally short termed, procurements of these resources results in piling up of idle resources in the institutes. Cloud adoption provides resources on demand and adoption of multi-tenancy by the providers enhances the optimal utilization of the resources.

x. Protection against natural disasters

Efficient Disaster Recovery (DR) management in educational institutes is crucial as any loss or damage to its repository consisting of examination results, fee details, various circulars and documents will have serious repercussions. Fast recovery is very important after disaster to ensure continuity of operations in the educational institutes (Nayyar & Kumar, 2015). Huge investment on data servers in traditional DR method is eliminated on cloud adoption which has in-built DR facility. Additional DR requirements are also provided as service (DRaaS) from cloud with flexibility and monitoring of the metrics of DR management such as Recovery Time Objective (RTO) and Recovery Point Objective (RPO). Various backup sites such as hot, warm and cold can be chosen depending on the criticality of the document being migrated to cloud storage.

Cloud adoption is education will eliminate the binding of learning process with physical classrooms and facilitate the learners to choose their comfortable timing for learning. Student oriented curriculum configuration is add on benefit of cloud adoption in education which enable shift of traditional institute oriented education models to student needs based educational models (vmware, 2016). The rate of cloud adoption by educational institutes and universities is increasing in the US and UK for the enhancement of efficiency and convenience of educational services along with cost reduction benefits (Sultan, 2010).

ii. Barriers for cloud adoption in education

Non affordability ofInternet connection by 60% of the global population is a major hurdle in expanding cloud adoption (vmware, 2016). Loss of control on data and applications that are hosted from cloud is an initial barrier for cloud adoption in institutes, which might get diminished by increasing transparency of the provider operations (Klug, 2015). Security is a major road block for cloud adoption as hosting application and data outside the institute instill security fears and hence cautious analysis of critical and non-critical data along with hybrid cloud adoption will reduce the security issues. The providers are more equipped with latest security measures than the institute's security in the current scenario of growing IT complexity and its related security threats (Educase, 2011).Vendor lock-in and service unavailability due to downtime are other barriers for cloud adoption. Utilization of cloud services offered by a single cloud service provider includes vendor lock-in as wide usage of applications involves migration costs in spite of the interoperability claims by the providers (Sclater, 2010). A simple solution for vendor lock-in is to adoptservices from multiple providers. A survey on the future of cloud computing across different industries conducted by vmware has revealed that cloud adoption in education is slow in comparison with the cloud adoption rates of banking, manufacturing and retail sector. Non-competitiveness of the sector is cited as the reason for this slow cloud penetration into the sector (vmware, 2016).

i. Absence of strategic IT vision
ii. Security
iii. Loss of data control
iv. Vendor lock-in

CLOUD IN EDUCATION - CASE STUDY

Major cloud players like Google, Amazon, Microsoft, IBM, Cisco, HP and Salesforce.com have taken numerous initiatives by offering various tools, application and IT infrastructure for utilization by students and educational institutes. Google and Microsoft have announced unlimited storage facility for educational institutes(TechDecision, 2014). Various learning management systems such as Moodle, Blackboard etc. delivers cloud implemented educational services (Jeong et. al. 2013). Most of the educational institutes in the US have opted either Gmail or Microsoft's Live@Edu for e-mail application and have found increase in performance, reliability and decrease in cost overheads. Cloud based e-mail also includes other tools such as instant messaging, calender application, contact management and the ease of access advantage where mails can be accessed from any smartphones, PCs, tablets or laptops (Sclater, 2010; Educase, 2011).

Cloud infrastructure to pool IT resources such as server, storage system and software of several sites in the form of Virtual Computing Lab (VCL) has been implemented in North Carolina State University. Resources are availed from the pool by placing the requirement request at the start of a session which is then released back to the

resource pool at the end of the session. 75% saving of software license cost, 150% increase in the ratio of the number of students per software license, optimal utilization of server, reduced investment due to the use of thin clients are the benefits leveraged due to cloud adoption by the university. The VCL enabled primary, secondary schools and different university campuses to access centrally developed, up-to-date technical and learning material thus achieving education equality (IBM, 2012).

Baadal designed by IIT Delhi is a cloud service tailored for academic and research requirements that provides solution to match the institute requirements with the private cloud setup.

CLOUD ADOPTION STRATEGIES

Optimal high speed network connection with some process and IT infrastructure changes are essential for successful cloud adoption in any institute (IBM, 2012). A single cloud model does not fit all educational institutes. It is up to the institute to identify the correct mix of cloud resources and in-house resources to be utilized depending on the usage requirement. The baseline is that occasionally used resources are opted from cloud and incessantly used or time critical processes are maintained as in-house processes (Educase, 2011). IaaS service model is also opted next to SaaS adoption for storing and uploading audio and video lectures which have low data security concerns (Sclater, 2010). Different resource allocation methods based on usage for reducing IT cost and enhancing Quality of Service were explained by Koch et. al. (2010). Three techniques discussed are 1) resource pre-allocation method mentioned as proactive method, where the resource demands are predicted with the help of usage history; 2) dynamic resource allocation method which is identified as reactive method, allocate resources on demand with delay in allocation and releasing of resources; 3) workload aware resource allocation method which is both reactive and proactive method, includes time interval and nature of resource requirement of the institute and allocates resources prior to the usage depending on their demand inference from timetable (Koch et. al., 2010). Complexity, technical readiness and institutional sizes with respect to employee and student enrollment count are the major factors that are to be considered before planning cloud migration (Klug, 2015).Cloud adoption of the institutes is unavoidable if issues prevail in the level of sophistication of the available resources and its expertise to manage deals with technical readiness(Low et. al., 2011).

Steps for cloud adoption in education (Sclater, 2010; Educase 2011; Klug, 2015)

1. Size of the institute.
2. Analyze and prepare the list of functionality for cloud adoption.
3. Determine the complexity in cloud adoption.
4. Identify the suitable cloud deployment model (private / public / hybrid).
5. Calculate the costs and risk involved.
6. Assess the readiness of the institute in terms of technology and staff skills
7. Detailed study and understanding of the SLA terms
8. Determine the post cloud monitoring processes.
9. Peer-review or auditing the quality of contents disseminated to cloud storage.

Monitoring and controlling the cloud services is an essential and inevitable activity which enable the institutes to leverage the cost benefits. For example, the cost breakdown of IaaS usage will delve down to the usage cost of the components such as Virtual Machine (VM), data transfer and storage out of which switching off the VM when not in use will reduce the cost to a greater extent (Khajeh-Hosseini et. al. 2011).

Cloud computing setup between among institutes enables sharing of infrastructure, teaching content, skills and software, which provide educational equality and solution for digital divide. It also eliminates idle time and duplication of resources which enhances quality of education with reduced IT usage costs (IBM, 2012).

The decision making process of educational institutes for cloud migration must adhere to the inclusion of all service models as the institutes might require IaaS for storage and computation requirements when the hybrid approach is used where cloud is used to complement the existing IT infrastructure, PaaS for practical implementation during lab sessions and SaaS for the implementation of e-learning modules, ERP suites, accounting application etc.

Few challenges also exists in cloud inclusion. Actual resource cost utilized depends on the load, the difference in cost of data transfer within and between cloud data centers, change in provider's price at short notice (Khajeh-Hosseini et. al. 2011).Based on the historic data, the elasticity patterns need to be generated to identify the need for additional resources. Intellectual rights of the contents stored in the cloud data center must be with users who have uploaded the material and these insist for ownership to be maintained with the customer.

CONCLUSION

Implementing ICT in education has many benefits and difficulties. Each educational institute has its own barriers depending on its contextual factors. Not only the educational institutionsrelieved from the burden of handling the complex IT infrastructure management as well as maintenance activities though application of cloud computing, but also leads to huge cost savings. Along with many industry sectors, education sector is largely benefited by adopting cloud services which promises to deliver affordable, reliable and flexible computing solutions to the education sector and enable it to compete more effectively with bigger organisations.

Cloud Computing transforms the role of ICT in training, supports and accelerates the processes of creating and providing an interactive learning environment where all participants have continuous access to diverse, high-quality educational resources and activities and work collaboratively.

REFERENCES

- Armbrust, M., Fox, A., Gri_th, R., Joseph, A.D., Katz, R.H., Konwinski, A., Lee, G., Patterson, D.A., Rabkin, A., Stoica, I., Zaharia, M. (2010). A View of Cloud Computing. Communications of the ACM 53(4), pp. 50-58
- Bhatia S (2014). Cloud Computing in Education. Article retrieved http: //cloudtweaks.com /2014/12/ cloud-computing-education-growth/ on May 15, 2016.
- Buyya, R., Yeo, C.S., Venugopal, S., Broberg, J., Brandic, I.: Cloud computingand emerging it platforms: Vision, hype, and reality for delivering computing asthe 5th utility. Future Generation Computer System 25(6), 599{616 (2009)
- Castro Sánchez, J. J. and Alemán, E. C., 2011.Teachers' opinion survey on the use of ICT tools to support attendance-based teaching.Journal Computers and Education, vol. 56, pp.911-915.
- Cross A (2013). Cloud Computing in Education: How moving to the cloud can help schools.Retrieved from http://www.computerweekly.com/tip/Cloud-computing-in-education-How-moving-to-the-cloud-can-help-schools on June 20, 2016.
- Dell (2011), Improving Student access to Technology in the Classroom – in a Declining Budget Environment, Dell Wyse White paper retrieved from www.wyse.com
- Educase, (2011), What Campus Need to Know About Cloud Computing, an Educase briefing retrieved from educase.edu on May 10, 2016.
- Hopkins, R & Jenkins, K, (2008).Eating the IT Elephant: Moving from Greenfield Development to Brownfield, IBM Press. 2008.
- IBM (2012).Applying the Cloud in Education: An Innovative approach to IT, IBM Global Technology solutions white paper retrieved from www.ibm.comon May 10, 2016.
- Jeong, J. S., Kim, M. &Yoo, K. H. (2013). A Content Oriented Smart Education System based on Cloud Computing. International Journal of Multimedia and Ubiquitous Engineering, Vol. 8, No. 6 (2013), pp. 313-328.
- Johnson, L, Levine, A & Smith, R. (2009), The 2009 Horizon Report. Austin, Texas: The New Media Consortium
- Katz, R, Goldstein, P., Yanosky, R., &Rushlo, B., (2010). Cloud Computing in Higher Education, online article from EDUCASE retrieved from http://net. educause. edu/section_params/conf/CCW (Vol. 10). On May 2016.
- Khajeh-Hosseini, A., Sommerville, I., Bogaerts, J., &Teregowda, P. (2011). Decision support Tools for Cloud Migration in the Enterprise, In IEEE International Conference onCloud Computing (CLOUD), 2011 (pp. 541-548).
- Klug, W., &Bai, X. (2015).FACTORS AFFECTING CLOUD COMPUTING ADOPTION AMONG UNIVERSITIES AND COLLEGES IN THE UNITED STATES AND CANADA. Issues in Information Systems, 16(3).
- Koch, F., Assunção, M. D. and Netto, M. A. S. (2010). Cost analysis of Cloud Computing for Education, IBM Research
- Kumar, V., &Vidhyalakshmi, P. (2012).Cloud computing for business sustainability. Asia-Pacific Journal of Management Research and Innovation,8(4), pp. 461-474.
- Lahri, P. (2015). Top 13 eLearning trends in 2015.Blog article posted on March 2015. Accessed on July 5, 2016 from https://www.upsidelearning.com/blog/index.php/2015/03/11/top-13-elearning-trends-for-2015/
- Lindsay (2015).5 reasons to use Augmented Reality in Education. Blog post posted on March 2015 retrieved from http://www.augment.com/blog/5-reasons-use-augmented-reality-education/ on May 10, 2016
- Low, C., Chen, Y., & Wu, M. (2011).Understanding the determinants of cloud computing adoption. Industrial management & data systems, 111(7), pp. 1006-1023.
- Lowther, D. L., Inan, F. A., Strahl, J. D. and Ross, S. M., 2008. Does technology integration work when key barriers are removed?. Educational Media International, vol. 45, pp.195-213.
- Lu, Z., Hou, L and Huang, X., 2010.A research on a student-centered teaching model in an ICTbased English audio-video speaking class.International Journal of Education and Development using Information and Communication Technology, vol. 6, pp.101-123.
- Mathew, S. (2012). Implementation of cloud computing in education-A Revolution. *International Journal of Computer Theory and Engineering, 4*(3), 473.
- Mell, P., &Grance, T. (2009).Effectively and securely using the cloud computing paradigm. NIST, *Information Technology Laboratory*, 304-311.

- Murray, S. (2016). EDTECH: Augmented Reality and Cloud Computing are powering online learning, article posted on August, 12, 2016 retrievedon August 24, 2016from https://www.businessbecause.com/news/mba-distance-learning/4118/ar-cloud-computing-power-online-learning
- Naik, A. B., Ajay, A. K and Kolhatkar, S. S (2013).Applicability of Cloud Computing in Academia. Indian Journal of Computer Science and Engineering, Vol. 4, no. 1, pp. 11-15.
- Nayar, K. B., & Kumar, V. (2015).Benefits of cloud computing in education during disaster.In Proceedingsof the International Conference on Transformations in Engineering Education (pp. 191-201).Springer India.
- Nayar, K. B., & Kumar, V. (2018).Cost benefit analysis of cloud computing in education. International Journal of Business Information Systems, 27(2), 205-221.
- Pardeshi, V (2014). Architecture and Adoption Model for Cloud in Higher Education: Indian Perspective, Bonfring International Journal of Industrial Engineering and Management Science, Vol. 4, No. 2, May 2014.
- Plummer et. al. (2008). Gartner's Top Predictions for IT operations and Users, 2008 and Beyond, January 2008.
- Sclater, N.(2010), Cloud computing in education. Iite policy brief, UNESCO Institute forInformation Technologies in Education (September 2010)
- Sultan N, (2010). _____ Cloud Computing for Education: a New Dawn? International Journal of Information Management.
- TechDecision (2014).State of Cloud Computing in K-12
- Turong H. L. (2012), Cloud Computing for Education and Research in Developing Countries.IGI Global.
- Vmware (2016), Ascending Cloud: the role of Cloud Computing in Continuing Education, April, 2016, accessed from http://www.vmware.com/radius/ascending-cloud-role-cloud-computing-continuing-education on July 4, 2016.
- Weert, T. V. and Tatnall, A., 2005. Information and Communication Technologies and Real-Life Learning: New Education for the New Knowledge Society, Springer, New York.