

Application of Cloud Computing in an Education Sector through Education and Learning as a Service and its Cost Benefit Analysis

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Abstract— An education sector across the globe is facing numerous challenges. It is being one of the most badly affected sectors due to Covid-19. This paper presents a perspective on applying Cloud Computing technologies in the field of education at several abstraction levels. In addition, it proposes Education and Learning as a Service model and Decision-Making Matrix for an Organization.

Keywords—Cloud Computing, Cloud Service Provider, ELaaS, Cost Benefit Analysis, CAGR

I. INTRODUCTION

Cloud computing can be defined as the on-demand delivery of a shared pool of IT resources like servers, storage, databases, networking and software over the internet on a pay-as-you-go basis. Cloud computing offers anywhere and anytime access to services so that many businesses across the globe tackled the challenge of Covid-19 to a certain extent. Along with providing efficiency in the business environment, cloud computing offers data security. Cost-benefit is a major concern for all small, medium and large-scale organizations to shift toward cloud computing (Subramanian and Jeyaraj, 2018). It has great potential to get implemented in a variety of economic sectors.

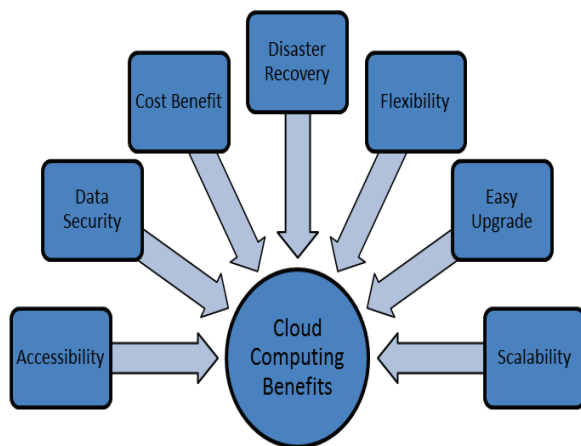


Fig. 1 Benefits of Cloud Computing

A scenario in the education sector is changing with the use of handheld computing devices like smartphones, tablets and laptops. Virtual classrooms can prove advantageous to students, teachers and administrators to have interaction in a time and cost-saving environment. By commissioning cloud computing in the field of the education, we can make value addition like anywhere and anytime access to the teaching

and learning resources. Along with the collaboration among the different stakeholders of the education system, cloud computing can offer a cost-saving approach to build educational organizations. By adopting the technological transformation in the field of the education, we can migrate to an efficient, secured, economical, scalable and accountable education system. This paper contributes an innovative proposed approach in terms of Education and Learning as a Service in order to achieve learning outcomes through cloud computing application. It further introduces decision making matrix to help educational organizations to adopt cloud computing.

II. CHALLENGES IN THE EDUCATION SECTOR

An education is a basic human right which acts as the driver of the development of the nation and it can be used as a tool to solve social problems like poverty, inequality, health unawareness and economic instability (www.worldbank.org). It offers an equal opportunity to individuals for self-development and spurs the economic growth of the country. When it comes to developing countries, they have to make enormous efforts to bring children into classrooms because of the socio-economic and demographic diversities. The problem gets intensified with the extreme poverty level present in the developing and poor countries. Covid-19 has worsened these problems by affecting every stakeholder in the education sector. 1.6 billion of the students i.e., 94 % across the globe were away from the classrooms in April 2020(www.worldbank.org). We are in the middle of a global learning crisis since most students across the globe had missed school due to the Covid-19 pandemic in the last two academic years. The students are not able to cope with fundamental learning skills like reading such that 53% of the students below the age of 10 from middle-income countries are unable to read (blogs.worldbank.org). If we don't not pay special attention to the crisis, the problem can get worsen and increase the drop-out rate. It will distress the poor population hardly because poor children will miss the mid-day meals eventually will affect their health. We could not guarantee the learning of the students in such a global crisis.

The covid-19 pandemic divided the world between the most advantaged and least advantaged households. The digital divide among the households in the different countries, states, cities and villages creates barriers of inequality in opportunities for learning (Ahmed et al., 2021). Expenditure on the education sector in middle and low-income countries is less than 3% of their GDP as compared

to developed countries. It poses a serious threat to the education sector that the governments are not willing to solve the problems in the sector. The lack of required infrastructure to achieve the global right to education and Quality of Service are massive challenges in this sector. Electricity, connectivity, availability of computing devices, and learner's adaptability to transformed educational systems are the crucial parameters to efficiently implementing remote learning systems (Ngwacho, 2020). So, this is the time that we should adopt the transformation in education and learning by engaging suitable technological models to connect every child with the school to overcome future challenges in this sector.

III. APPLICATION OF CLOUD COMPUTING IN HIGHER EDUCATION

The demand for E-learning has risen in recent years as we are facing once in lifetime pandemic situation across the globe. Cloud-based applications can help to meet the requirements of the different stakeholders in the education field. Education and learning systems for higher as well as mid and primary-level can be upgraded without incurring large infrastructural investments by engaging cloud computing (Almajalid, 2017). Its high computing capabilities are beneficial for university researchers and can offer several software and platforms on a pay-as-you-go basis. More than 70% of North American universities are moving to cloud-based services to increase the collaboration among learners, professors and administration to enhance the learning experience (cloud.netapp.com). Since youth across the world is a highly connected population to the internet, it is easy to meet the requirement of implementing cloud-based services in higher education. Universities are also seeking cost-effective technological up-gradation in education and learning to overcome infrastructural investments. Being data-driven entities, universities require secure database management by keeping privacy, which can be achieved by cloud deployment models (Hiran and Henten, 2020). Cloud computing has facilitated the world's best universities Harvard, Stanford, Columbia and others to offer Massive Open Online Courses (MOOC) to remain competitive and attractive in the markets.

If we succeed to implement cloud-based education and learning, organizations can relish the following benefits along with the cost-benefit.

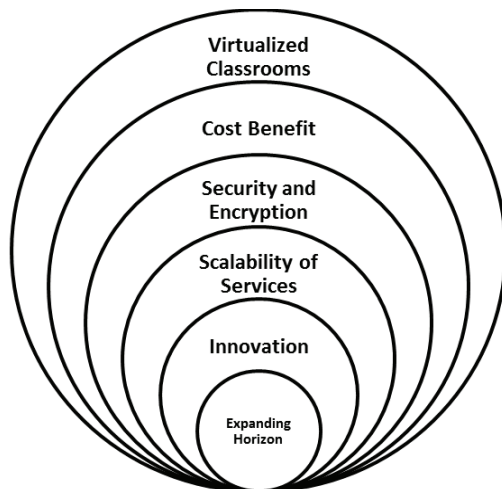


Fig. 2 Cloud Computing Benefits in Higher Education

A. Virtualized Classrooms

The organization can reduce the implementation cost of the infrastructure and can hire remote skilled trainers to deliver the courses. The students can access resources anytime and anywhere which can save their time and expenses.

B. Cost Benefit

The different stakeholders will get the cost-benefit as learners need not buy books since all the learning resources will be available online on the cloud. Organizations can be saved from management expenditure.

C. Security and Encryption

Educational institutions deal with a tremendous amount of data and its security is a major concern. Cloud can provide a secure and encrypted environment so that data integrity is maintained. Even privacy of the stakeholders is also taken into consideration by cloud service providers.

D. Scalability of Services

Scalability is the most useful characteristic of cloud computing. Educational institutions can scale up the learning applications depending on the increasing number of users. Peak time service delivery can be ensured as well services can be scaled down when there is no need or no users are present so that wastage of resources can be avoided.

E. Innovation:

The educational institutes can innovate applications, tools and features to meet their requirements by engaging the cloud. It can enhance the learning experience for the students.

F. Expanding Horizon:

The learners can opt for more remote courses and even can pursue overseas education without incurring the overseas living cost. It creates the opportunity for working professionals to upgrade them by connecting to universities.

The schools, colleges and universities can enhance their teaching and learning processes and improve the quality of service they provide by engaging cloud computing on their campus.

IV. EDUCATION AND LEARNING AS A SERVICE

Education cannot be delivered on either offline or online platforms solely rather it has to be a combination of both to achieve the learning outcomes. When we elucidate the term Education and Learning as a Service it means that cloud services are provided to educational institutions on a subscription basis (Alabbadi, 2011). The cloud service provider manages all the infrastructure, software, database, networking and security so that the institutions can focus only on the solitary goal of teaching and learning. The cloud service provider provides the following services to the institutions:

- 24 Hour support to students and faculties through remote access to desktop applications and data sharing
- On-demand scale-up of IT resources on a pay-as-you-go basis
- Enhanced learning through powerful computing tools

- Data security with disaster recovery
- Video conferencing, emails and chat boxes

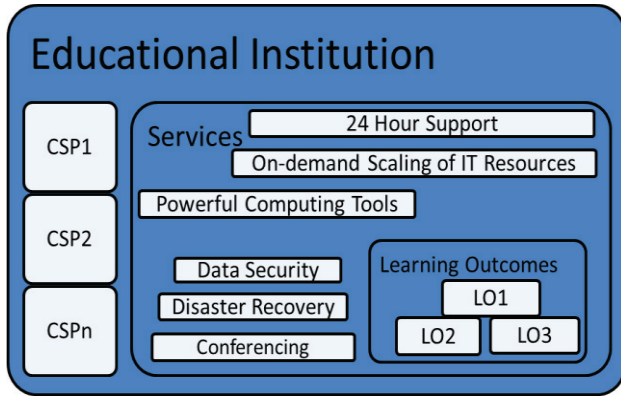


Fig 3 Education and Learning as a Service Model

There is tremendous diversity in the services provided by numerous cloud service providers. In the proposed model of ELaaS shown in figure 3, the educational institutions are expected to go for diverse CSPs to meet their need of achieving learning outcomes considering the economic aspects of the services. The following table enlists a few of the cloud service providers and ensured services:

TABLE I. CLOUD SERVICES FOR ELAAS

Cloud Service Provider	Services
Google	Gmail, Hangouts, Google calendar, Google drive, Google docs, Google sheets, Google Classroom, Google meets, Google App Engine, Compute Engine, Cloud SQL, Digital Analytics, Search Engine
Microsoft	Office 365, Microsoft Teams, SQL Database, Virtual Machines, Application Service
Amazon Web Services	Elastic Compute Cloud (EC2), Simple Storage Service (S3), Relational Database Service, Load Balancers, Deployment of Web Applications Service
Rackspace Manage Cloud	Scalable websites and Applications
Digital Ocean	Virtual Machines, Servers, Databases, Load Balancers
Oracle Cloud Platform	Building and deployment of Web Applications Service, Integration
HubSpot	Content Management and Web Analytics
Slack	Internal messaging and Conferencing
Dropbox	Solutions for documents and data
NetSuite	ERP Platform

V. CASE STUDIES

Transitioning to cloud computing can be a great milestone for educational institutes. But some of the institutes are already ahead in this competition. Here are some cases across the world where organizations have achieved deep success on this swing:

A. Glossika

It is an educational technology firm headquartered in Taiwan that proposed an application to train people in 148 countries to understand and speak more than 60 languages. Glossika uses Amazon RDS, ElastiCache and CloudFront from AWS to build a language learning platform. It can store more than 3,50,000 sentences and their translations in audio-textual format. In addition, it has scaled its infrastructure to

house more than 25 million users and has acquired cost savings with automation (aws.amazon.com). It has succeeded in maintaining high uptime due to global incoming traffic.

B. ShikshaLokam

It is a nongovernmental organization which is working in the field of India's education system to fill the resource gaps. ShikshaLokam works for developing leadership skills among the stakeholders of the education system through programs and solutions by providing open digital infrastructure. It works with 10 NGOs and 8 states in India to provide context-based self-learning. It uses Open-source Sunbird datacenter infrastructure management along with Amazon's Elastic Compute Cloud (EC2) and Elastic Container Service (ECS) for hosting its infrastructure. Resource utilization cost is reduced to 20 % by engaging AWS Cost Explorer and Amazon CloudWatch (aws.amazon.com). Starting with 100 users, ShikshaLokam has reached a milestone of more than 1,50,000 users today.

C. CoreAzure

It is a leading certified partner of Microsoft and was founded in 2014 and headquartered in the United Kingdom. CoreAzure intends to provide the maximum output from Microsoft technologies to its customers. Along with the cloud migration projects for UK government agencies, it is helping UK universities to move to the cloud to overcome the ageing infrastructure difficulties. A new horizon of digital opportunities has opened to learners as well economic rewards are appreciated by universities. Sheffield Hallam University and the University of Plymouth have migrated to the cloud by using the IaaS lift and shift approach and adding next-generation firewalls, Sentinel and Azure Security Center (partner.microsoft.com). CoreAzure is constantly growing in the higher education area by implementing Microsoft's Azure platform in universities to provide accessibility and convenience in cloud-based services.

D. Monash University

Monash is one of the largest Australian universities in existence on four continents educating more than 80,000 learners across the globe. It falls under the top 1 % of the universities aiming to inspire and equip its students to be agents of change in the world. In addition, it has implemented the multi-cloud model based on AWS and Azure to ensure the cloud-only strategy. Monash relied on ONTAP's data replication features and Cloud Manager to obtain single-click full-stack provisioning (cloud.netapp.com). Benefitted by a 25% reduction in storage space, Monash has enhanced performance in its academic chores.

VI. COST BENEFIT ANALYSIS

Cost-benefit analysis (CBA) is a powerful tool for an organization to decide whether to shift to cloud computing or not. It provides a decision-making metric for decision-makers to choose from suitable options available (Nayar and Kumar, 2018). Since we have proposed the ELaaS model for an entire education sector, the educational organizations are expected to go through the following CBA model and then can go to a decision considering their need and financial resources. Fig. 4 depicts the decision-making matrix for the organization.

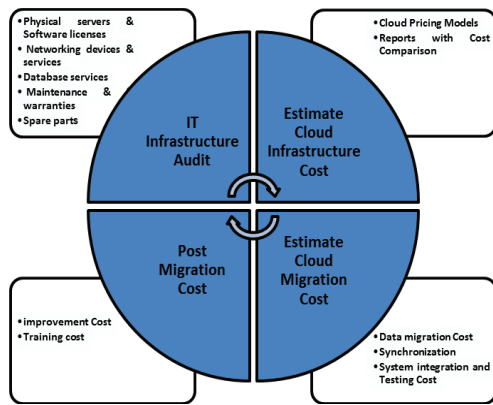


Fig 4 Decision-Making Matrix for an Organization

A. IT Infrastructure Audit

This is the metric where the organization determines implementation as well as maintenance cost of overall IT infrastructure. Physical servers, software licenses, networking devices, network services, database services, maintenance contracts and warranties, spare parts and any miscellaneous items must be taken into consideration. An annual balance sheet of the organization, purchase and payment records should be taken into account at this step (www.networkworld.com). The organization may also include operational costs such as labour costs for maintenance of the IT infrastructure. The administrative cost must be considered to maintain IT infrastructure.

B. Estimate Cloud Infrastructure Cost

Audit from step above gives a clear idea about the hardware, software, network, storage and database requirements of the organization. Cloud service providers offer cloud pricing models for their potential customers which are very simple to understand. From the list of CSPs, the organization can choose any pricing model depending upon the necessity. The organization need to enter its required on-premises infrastructure information. It includes all the information about servers and storage which can be obtained from the IT administrator. We can generate the report for the next three years along with the cost comparison.

C. Estimate Cloud Migration Cost

It is the actual cost of migration of existing IT infrastructure to the cloud platform. Data migration is the crucial stage and CSPs charge for the transfer of data to their cloud platform. Synchronization while transferring data is equally important since the organizations don't want to stop their operations in the process of migration. It is an essential factor that the organization should leverage the budget for the assessment of system integration and testing (www.networkworld.com). The organization may hire consultants to develop a strategic approach for cloud migration.

D. Post Migration Cost

The organization incurs the monthly cost calculated in step B along with improvement, integration, testing and training cost which reflects in the post-migration budget of the organization.

E. Intangible Benefits

The organization is also expected to look for the intangible benefits that the cloud may bring to stand in the ever-growing market competition (www.networkworld.com). It will enhance flexibility and agility to spur performance through high availability and load balancing.

Given all these metrics, if the net benefit is showing the positive value of shifting to the cloud, the educational organization is encouraged to go for migration on the cloud.

VII. FUTURE SCOPE

The cloud computing applications market is estimated at 140 billion U.S. dollars in 2021 globally within the Covid-19 crisis and is expected to grow by 168.6 U.S. dollars by 2025 (www.statista.com). The software as a Service model has the tremendous potential to grow at a CAGR of 4.8%. Amazon Web Services (AWS) being the key market player in cloud infrastructure held 34% of the market share in the second quarter of 2022(www.statista.com). It is followed by two giant competitors Microsoft Azure and Google Cloud.

The educational sector will be one of the most potential verticals of cloud-based applications. To remain attractive in the global competition and to develop the pool of smart learners; universities, colleges, schools, NGOs and related government agencies will get inclined toward cloud computing. By relishing tangible and intangible benefits of the cloud-based educational infrastructure, ELaaS can be near future at the global level. In our further studies, we aim to implement the proposed ELaaS model at institute level by applying decision making matrix parameters.

VIII. CONCLUSIONS

Cloud computing ensures on-demand delivery of IT services on a pay-as-you-go basis and offers secure, anytime and anywhere access to enhance the efficiency in the business environment. It can be used as a sophisticated tool to solve the key problems in the educational sector across the globe irrespective of the size of the economy. In addition, cloud-based education and learning provide many intangible benefits like innovation, scalability, and data security apart from tangible benefits like cost reduction. Educational institutions may adopt ELaaS on a subscription basis from different CSPs by undergoing a cost-benefit analysis. A Decision-making matrix will help an institution decide on cloud migration. Case studies reflect a successful scenario of cloud migration and reaching a milestone in the educational field. In conclusion, future of the cloud computing applications in the education sector is bright and by engaging cloud computing, institutions can stand out in the global competition.

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