

Cloud Computing and Sustainable Development in Higher Education

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ABSTRACT

In higher education, sustainable development (SD) is a worldwide process that cuts across social, political, and economic divides. When bolstered by the required information technology (IT) infrastructures, the process of developmental change in higher education will result in long-lasting enhancements that will provide students with the most excellent chance to prosper in the global market. To produce graduates with the abilities necessary to succeed in the twenty-first century, this article discusses the role that cloud computing plays in facilitating and promoting sustainable growth in higher education. Additionally, we offer broad building blocks for a long-term shift in the direction of higher education, using cloud computing as a suitable substitute for existing assistance.

Keywords: *Cloud computing, Sustainable development, Information technology, higher education, virtualization.*

Introduction

Higher education has long been recognized as one of the cornerstones of a rising society hoping for revolutionary advancements in politics, technology, and the economy. There is evidence to support the idea that higher education has advantages for the public and commercial sectors. To change society and the global economy, researchers and students

must collaborate with government agencies, businesses, and higher education institutions to produce new ideas and acquire expertise. Stated differently, universities play a significant role in supplying the human resources needed to create knowledge that strengthens a community (Bulla et al., 2016). Technology and education working together have developed a solid foundation for the growth and improvement of society. Information technology (IT) forms the foundation of education, and education feeds IT. It is clear from this that information technology has significantly influenced the goals, practices, and perceived possibilities of education. When a society achieves sustainable socio-economic growth, it suggests that a sustainable development framework is required to provide education services that maximize benefits while minimizing costs (Kim et al., 2011).

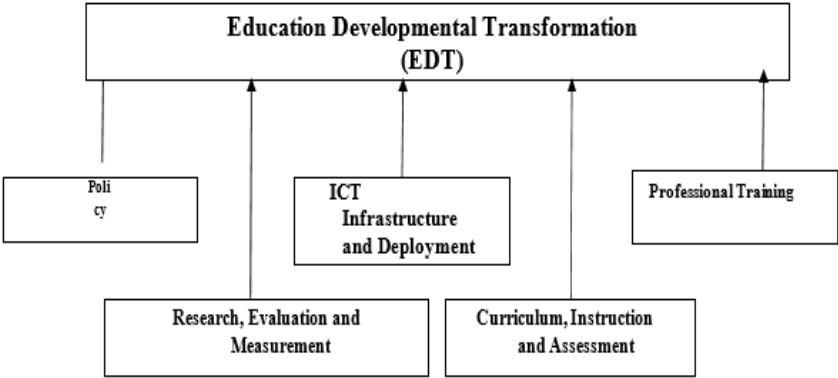


Fig 1: Basic support components of EDT

According to Horn, traditional higher education has been disrupted, as stated by [2], particularly in third-world nations, since development is linked to pricey or complex goods that are inappropriate for many consumers because of their cost, complexity of use, or irrelevance to modern demands(*Sensors | Free Full-Text | Smart Learning Services Based on Smart Cloud Computing, i.e.*).

Knowledge is the primary driver of economic growth and progress in today’s information-driven cultures. That information is primarily produced, disseminated, and

absorbed by any community through higher education [3]. Higher education thus merits a sustained developing process for the best outcome, given that it is essential to improving a country's people's ability to generate, assimilate, and use knowledge for sustainable development. A new computing paradigm called "cloud computing" is starting to take shape. It uses the tools and infrastructures already in place in information technology, like virtualization, grid computing, web services, and the Internet, to improve efficiency, save costs, and facilitate the delivery of services and higher education (Kobayashi et al., 2017).

Information Technology in the Development of Higher Education

IT and the deluge of digital data have undoubtedly altered higher education's approaches, goals, and perception of its potential. Without ICT, universities and colleges could not operate. It is essential for communication, administration, research, and information collection, and it is quickly becoming the same for teaching and learning (Wang et al., 2023).

The followings briefly describe how IT has affected Higher Education

Convenience and Availability (Changes to Learning and Teaching)

A large number of universities provide online learning. Additionally, having access to vast information databases improves learning and has trained students to be makers and participants in creating and accessing information discourses. Technology has also changed how instructors educate. With online video conferencing, for example, teachers may now add exciting new elements to their lessons.

Purpose of Education: Information technology has changed the goals of education, from teaching and learning to the creation, preservation, integration, transmission, and application of knowledge for societal advancement.

Potential of Education: Information technology allows educational services to be delivered anywhere, anytime, and liberates higher education institutions from temporal and spatial limitations.

IT infrastructures have been noted to offer higher education institutions a good platform for conducting fruitful scientific research and carrying out instructional activities [5] and [6].

Cloud Computing and Sustainable Development of Higher Education

As an improved computing paradigm, cloud computing has emerged and offers previously unheard-of, cost-effective ways to supply educational services based on current IT infrastructures. Higher education must adopt a systematic and sustainable developmental strategy to accomplish a functional and goal-oriented delivery of education services. Numerous writers have illustrated in their works how commercial enterprises are already reaping the rewards of this novel computing strategy. So, how does this technology impact the advancement of higher education? How might this 21st-century IT grace help educators, learners, administrators of higher education, and society at large sustainably?

Cloud computing is a reality with several business applications; it is not only a futuristic technological notion with plenty of interesting potential applications. For example, Amazon's Elastic Compute Cloud (EC2) provides various services. A virtual computing environment enables users to launch instances with different operating systems, load them with customized customer application environments, and control access permissions on their networks through Web service interfaces [7].

What is the meaning of cloud computing? Cloud computing is a word that is still developing and refers to the many ways that many current computing technologies and techniques have evolved. Application and information resources are isolated in the cloud from their supporting infrastructure and delivery methods. In addition to improving availability, scalability, agility, and collaboration, cloud computing offers cost savings through streamlined and effective processing. In general, cloud-supported assets fall into one of two categories:

Data Applications/Functions/Processes Cloud computing provides anytime/anywhere services that can be accessed from any device [1]



Fig 2

The architectural framework for Cloud computing was provided by the U.S. National Institute of Standards and Technology (NIST), as illustrated in Figure 3 [8]

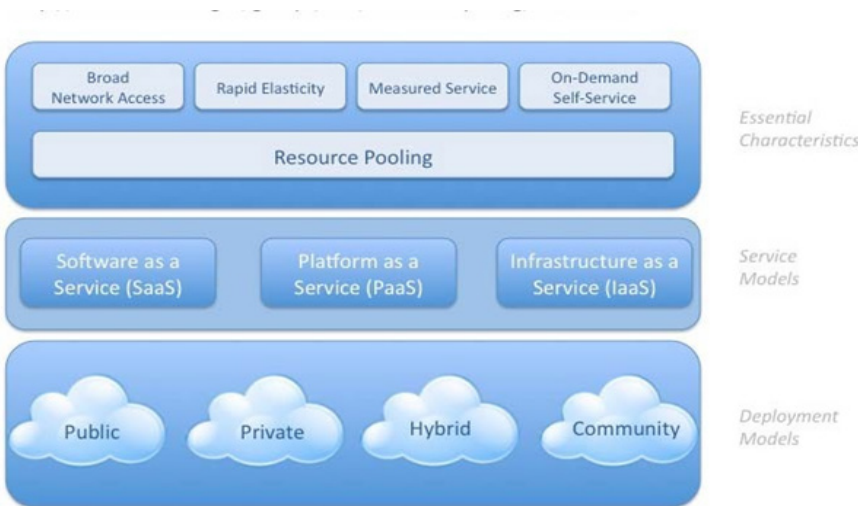


Fig 3: Architectural Framework, [8]

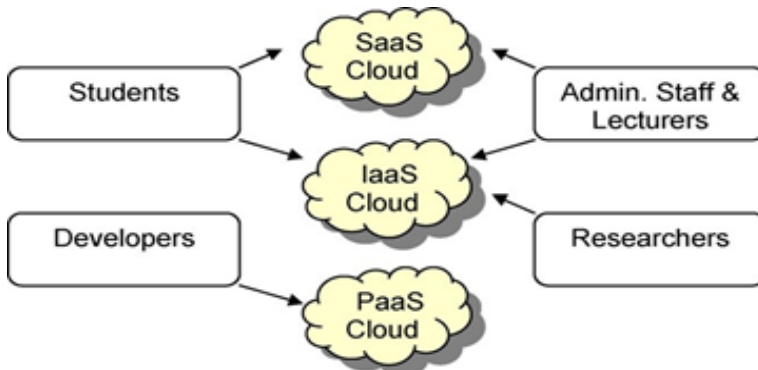


Fig: 4

NIST described cloud computing as consisting of five essential characteristics, three service cloud models, and four cloud development models

Prior research on cloud computing has focused on security concerns as a novel technology, corporate sector cloud computing, and potential future developments. By[13], the methods for modeling Cloud computing as a newly developed application platform for data, computation, and business service sharing were investigated.

[9] Gave a summary of the technical research conducted in HP labs. [10] Built a cloud-based architecture designed for the performance of wide area networks, with features to facilitate data mining applications. Infrastructures for cloud computing have supported many technical advancements and made resources widely accessible for higher education institutions as on-demand services [11]. Gaining a comprehensive comprehension of the many services provided by cloud computing aids in comprehending the essence of this innovative IT methodology. According to Gartner, cloud computing is “a style of computing where massively scalable IT-enabled capabilities are delivered ‘as a service’ to external customers using Internet technologies” [12]. We offer a typology of cloud computing as a service that is distinguished by the attributes listed below:

Infrastructure as a Service (IAAS)

Products or services offered via this mode include the remote delivery, over the Internet, of complete computer infrastructure (e.g., virtual computers, servers, storage devices, etc.);

Platform as a Service (PAAS)

The old computing paradigm, in which each program maintained locally necessary hardware, an operating system, a database, middleware, Web servers, and other applications, must be remembered to comprehend this cloud computing layer. It's also essential to remember that the network, database, and system administration professionals must maintain everything operational. These services are now offered remotely by cloud providers beneath this layer thanks to cloud computing;

Software as a Service (SAAS)

In this layer, you may avoid complicated software and hardware management by only accessing the program via the Internet rather than installing and maintaining it locally. This kind of cloud service provides full application capability, encompassing productivity apps (such as office-type programs) as well as enterprise resource management (ERM) or customer relationship management (CRM) tools. Figure 4 below shows how this may be used in an educational setting.

Fig 4: Cloud computing services in an academic Institution
The evolution of cloud computing as a technology for on-demand infrastructure, application, and support services is vital as a possible means of sustainable development of the transformational higher education framework.

Cloud Computing: Virtualization and Higher Education Services Delivery

The budgets of companies, notably higher education institutions like universities and colleges, will continue to be heavily pressured by the rapidly rising rate of change in IT equipment and products. However, cloud computing is more than a futuristic technology; it already offers business

applications that leverage resources and costs. Elastic Compute Cloud (EC2) from Amazon is one example. It provides a range of services. A virtual computing environment enables users to launch instances with different operating systems, load them with customized customer application environments, and control access permissions on their networks via Web service interfaces. To offer more services, Google also provides Google Apps. Google Apps is a collection of Web-based messaging (e.g., Gmail, Google Talk, and Google Calendar) and productivity and collaboration tools (Google Docs: text files, spreadsheets, and presentations) [7].

One of the main components of cloud computing is virtualization, which is mainly concerned with the technology that makes it possible to create a virtual version of an object rather than an actual one, such as an operating system, server, storage device, or network resource. This idea enables the delivery of a wide range of services via various device types.

A categorization of services available through virtualization in cloud computing is illustrated in Figure5 below.



Fig 5: A categorization of education services [1]

Conclusion and Recommendation

Implementing sustainable developmental reforms in higher education, particularly in light of the global economic crisis, is now possible by utilizing cloud computing's facilities and services. Using cloud computing may decrease costs by

hiring fewer employees, which frees up funds for other uses. Additionally, licensing issues with some institutionally used software are resolved, freeing up funds for other uses. When cloud computing is used, employees and students can use tablets and other portable mobile devices more often than desktop or laptop PCs. Higher education institutions may successfully deploy cloud computing technology services from companies like Google, Postini, Cast Iron, Salesforce, etc.

In conclusion, cloud computing is here to stay. It will continue to play a significant role in transforming higher education, particularly in poor nations that are severely financially strained. Concerns about risk and security related to data and sensitive information held by organizations are being researched.

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