



The Impact of Cloud Computing Resource in Tertiary Education

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Abstract

The cloud computing is becoming an adoptable technology for many organizations with its dynamic scalability and usage of virtualized resources as a service, through the internet. Cloud computing has a significant impact on the educational environment, it's an excellent alternative for educational institutions which are especially under budget shortage in order to operate their information systems effectively without spending any more capital for the computers and network devices. Tertiary institutions take advantage of available cloud-based applications offered by the service providers and enable users to perform business and academic tasks. This paper will review the cloud computing infrastructure in the educational arena, especially in the tertiary institutions where the use of computers are more intensive and what can be done to increase the benefit of common applications for Academic staff, students, lecturers faculty staff, developers, researchers as well as governmental and private sector. The cloud is a combination of technological resources such as networks, servers and applications in a common tertiary educational series of services and storage to their specific needs. The objectives of this research were to synthesize the features, elements, develop models, and evaluate the models of cloud computing Resource Management in Tertiary Education. The research findings were as follows: the models Resource Management in Tertiary Education by cloud computing technology comprised of 6 elements: Cloud Computing Technology, Curriculum, Center, Connectivity, Client and Consumer, which are called C6. It is a very popular technology in the present time to be used for administration in tertiary education of Nigerian tertiary institutions. It is the integration and sharing common resources of computer technology including software, hardware and database, the results evaluated by 3 experts showed that the model of cloud computing Resource Management in Tertiary Education system had appropriateness at a high level. Advance in technology offers new opportunities in enhancing teaching and learning. The new technologies enable individuals to personalize the environment in which they work or learn a range of tools to meet their interests and needs. Nature and educational potential of cloud computing in order to exploit the affordance of its impact in teaching and learning in a tertiary education context. It is evident that cloud computing has a significant place in the tertiary education landscape both as a ubiquitous computing tool and a powerful platform. Although, the adoption of cloud computing promises various benefits to an organization, a successful adoption of cloud computing in an organization, particularly in educational institutes requires an understanding of different dynamics and expertise in diverse domains. This paper aims at providing the impact and challenges of Cloud Computing in Tertiary Education.

Keywords: *Cloud computing, Cloud Resource, Tertiary education, Scalability, Networks*

1. Introduction

Cloud computing is a term referred to storing and accessing data over the internet regardless of the hard disk to store any data in the personal computer and accessed data from a remote server (Erdogmus, 2009). Nowadays the progress of Information and Communication Technology (ICT) accelerates the development of public service administration which is implemented by the government to the people with effectiveness. Especially, hardware and software have progressed dynamically. One of computing technologies which is very popular in the present time is Cloud Computing Technology. It is very crucial technology for the nation's



development, especially in the education (Henderson, 2010). In order to get ready for entering the information and communication technology arena, needs to prepare for the readiness of higher education institutions to meet a variety of changes such as international exchange of youths, students and working staff, credit transfer, defined occupation standards, cooperation of tertiary education.

Tertiary education landscape around the world is in a constant state of flux and evolution, mainly as a result of significant challenges arising from efforts in adopting new and emerging technologies. This is mainly as a result of a new genre of students with learning needs vastly different from their predecessors, and it is increasingly recognized that using technology effectively in tertiary education is essential to providing high quality education and preparing students for the challenges of the 21st century. Although the new technologies have the potential to play an important role in the development and emergence of education system, where control can shift from the teacher to an increasingly more autonomous learner, and to rescue the tertiary education from this appalling situation, the change is very slow or not forthcoming at all for various reasons. It is becoming clear to many people, including students, that traditional methods are unable to address the needs of tertiary education where the emphasis is on higher order learning experiences and outcomes demanded of a changing knowledge and communication-based society. It is hoped that this need can be effectively facilitated by adopting the benefits of cloud computing through innovative research approaches.

The concept of computing in the cloud is about the delivery of IT services that run in a web browser; the type of services ranges from adaptations of familiar tools such as email and personal finance to new offerings such as virtual worlds and social networks. Storage of digital data is an important service among these. Cloud computing is a computing platform that resides in a service provider's large data centre Nelson (2019), and is able to dynamically provide servers the ability to address a wide range of needs of clients. The cloud is a metaphor for the internet. Some people call it the World Wide Computer. Technically, it is a computing paradigm in which tasks are assigned to a combination of connections, software and services accessed over a network Sedaghat (2018). This network of servers and connections is collectively known as the Cloud. Computing at the scale of the cloud allows users to access supercomputer-level power. Instead of operating their own data centers, firms might rent computing power and storage capacity from a service provider, paying only for what they use, as they do with electricity or water. This paradigm has also been referred to as "utility computing," in which computing capacity is treated like any other metered utility service—one pays only for what one uses Beizer (2018). According to Standard and Quality Assurance in Education of the National Education and Amendments, it said there shall be a system of educational quality assurance to ensure improvement educational quality and standards at all levels, Qualification Framework for Higher Education was prepared to be used as guidelines to improve and develop curriculums, administration of education in order to produce qualified graduates to the society. Tertiary education institutions aim to improve the quality of education by using ICT and Ministry of Information and Communication Technology has defined Smart Nigeria 2020 Strategy as Fig. 1 to prepare readiness for dynamic development in order to compete with other countries in the region and become the ICT leader in 2020.

2. Background of Related Fundamental Concepts

This section reviews background concepts of different cloud computing resources. Authors in Liao, Li, Sultan and Zhang (2010) outlined related works on cloud computing resources with issues that are peculiar to each method. The rapid advancement of information technologies (IT) has contributed to the downward trend of the cost of computing resources. While prices of computing resources keep slumping, the technologies that depend on these resources are becoming more powerful, sophisticated and ubiquitously available than ever before. This advancements in network and Internet technologies have led to a computing model known in as cloud computing Schubert (2018). The model enables services providers known as Cloud Service Providers (CSPs) to provide computing resources as utilities through the Internet to Cloud Service Consumers (CSCs). Cloud computing is defined as a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction Herhalt (2019). The three most

common cloud services are Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS) and Infrastructure-as-a-Service (IaaS). The model is also described by how it is deployed. The most popular among them are private, community, hybrid and public clouds.

2.1 ICT Shift Education

This complements method and techniques through which artificial shift systems can be implemented and employed in a reasonable way for practical applications. This is to raise the quality of Nigerian education by using ICT wisely and efficiently in order to develop the education and produce potential human resources through mobile computer and interactive instruction (Iyer, 2010).

In order that the academic administration of Nigeria's tertiary education institutions would be the highest effectiveness, researchers has developed the models of ICT management for academic work by cloud computing technology. The cloud computing technology is used for academic administration which is consistent with the National Act of Education, the quality assurance in education and Smart Nigeria 2020 Strategy. Due to the cloud computing technology, hardwares and softwares will be used through the internet, the cost of expenses can be reduced. The service on cloud computing technology can be divided into three levels, which are called SPI Paradigm, such as SaaS, PaaS and IaaS. All parties are able to use the data and working system from the center and they will share the common resources, such as internet system, servers, storages, applications and any other services which will be provided very quickly.



Fig.1 SMART 2020 strategy

2.2 The Technological Impact of Cloud Computing in Tertiary Education

Cloud computing increases the flexibility and access of educational users to a wide range of educational resources. The users of cloud computing in tertiary educational institutions include students, lecturers, administrative staff, faculty staff, developers, programmers and researchers.

The cloud based education system requires the use and creation of knowledge in tertiary education as a decisive factor for social, economic, cultural and technological transformation. Achieving this goal necessarily involves the use of technology, which would allow knowledge transmission and create new areas for education, research and development. The impact of cloud in education has attracted researchers and countries attention all over the world, especially due to technological implications of and open access to knowledge Derejey (2016). The general infrastructure for providing conceptual and operational integration of ICT in all activity fields and daily life areas translates, in the case of tertiary education, into management, education and research. Thus, the conceptual

framework of integrating cloud computing in tertiary education is reflected in aspects concerning: policy, objectives and incentives; resources and facilities; computer resources; teaching and learning activities; processes of performance monitoring and evaluation as in “Fig.2”. The rapid evolution of technology provides many opportunities.

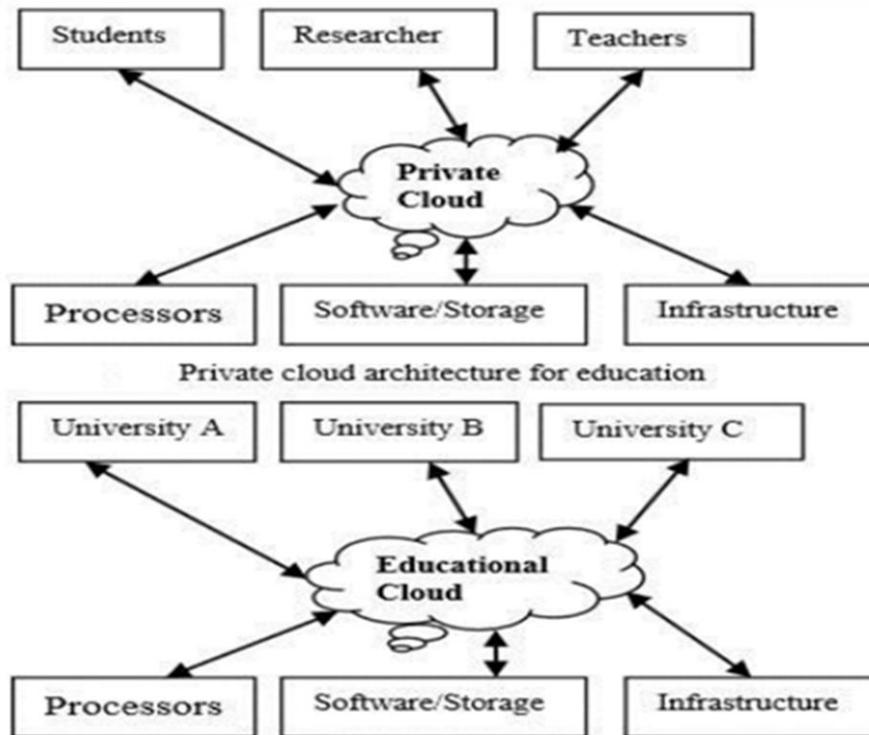


Fig. 2 Conceptual Framework of Cloud Integration

2.3 Cloud Computing: Issues and Challenges

Although many formal definitions have been proposed in both academia and industry, the one provided by U.S. NIST (National Institute of Standards and Technology, 2019) appears to include key common elements widely used in the Cloud Computing community:

Cloud computing is a model for enabling convenient, on demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction Martins (2019). This definition includes cloud architectures, security, and deployment strategies. In particular, five essential elements of cloud computing are clearly articulated: On-demand self-service: A consumer with an instantaneous need at a particular timeslot can avail computing resources (such as CPU time, network storage, software use, and so forth) in an automatic (i.e. convenient, self-serve) fashion without resorting to human interactions with providers of these resources. Broad network access: These computing resources are delivered over the network (e.g. Internet) and used by various client applications with heterogeneous platforms (such as mobile phones, laptops, and PDAs) situated at a consumer's site. Resource pooling. A cloud service provider's computing resources are 'pooled' together in an effort to serve multiple consumers using either the multi-tenancy or the virtualization model, "with different physical and virtual resources dynamically assigned and reassigned according to consumer demand" Joshi (2018). The motivation for setting up such a pool-based computing paradigm lies in two important factors:

economies of scale and specialization. The result of a pool-based model is that physical computing resources become 'invisible' to consumers, who in general do not have control or knowledge over the location, formation, and originalities of these resources (e.g. database, CPU, etc.) . For example, consumers are not able to tell where their data is going to be stored in the Cloud. Rapid elasticity. For consumers, computing resources become immediate rather than persistent: there are no up-front commitment and contract as they can use them to scale up whenever they want, and release them once they finish to scale down. Moreover, resources provisioning appears to be infinite to them, the consumption can rapidly rise in order to meet peak requirement at any time. Measured Service. Although computing resources are pooled and shared by multiple consumers (i.e. multi-tenancy), the cloud infrastructure is able to use appropriate mechanisms to measure the usage of these resources for each individual consumer through its metering capabilities.

Cloud computing is a mature and stable technology and tool for commoditizing computing resources. The “cloud first” drive is aimed at addressing the challenges of acquiring and deploying IT systems in the public sector and by SMEs that provide IT enabled services to the government. Even though IT systems of some Federal Public Institutions (FPIs) have significantly advanced individually, some are still struggling to effectively digitize their operations due to lack of resources for acquiring and deploying appropriate computing resources. On the other hand, there is no deliberate plan or incentive by the government to ease business environment for local CSPs in Nigeria. Therefore, the Nigeria Cloud Computing Policy is to address the duo categories of challenges, National Information Technology Development Agency (NITDA), Nigeria Cloud Computing Policy, 2019

The specific challenges being experienced currently by majority of public institutions and SMEs, among others are:

- i. High cost of IT investments and poor sustainability of IT projects.
- ii. Shadow IT environment that is tough to manage, difficult to operate and nearly impossible to secure.
- iii. Inefficient and un-scalable IT environment.
- iv. Poor interoperability of IT systems and inability to effectively share information and IT resources.
- v. Highly competitive environment and lack of enabling business environment for local CSPs

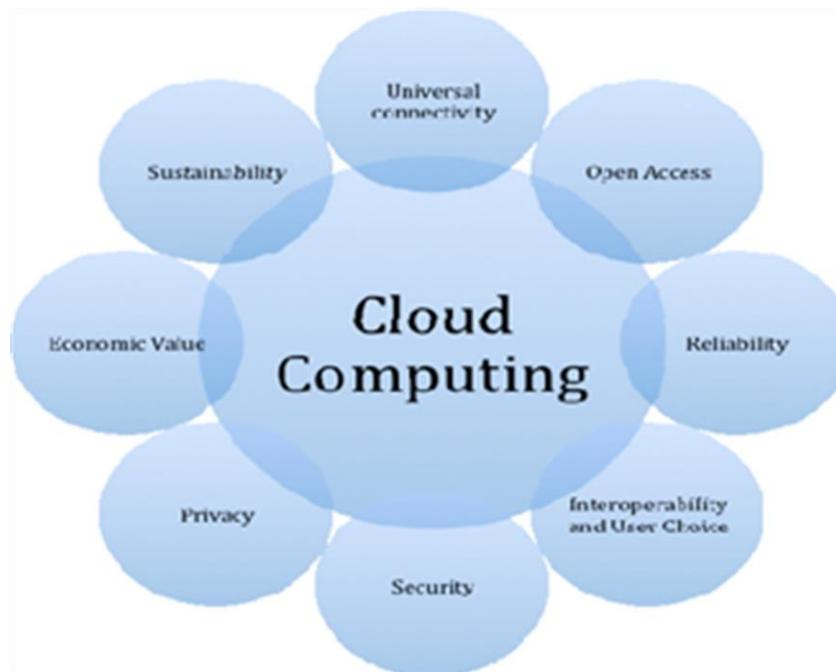


Fig. 3 Fundamental Elements of Cloud Computing

2.4 Cloud Computing Policy: Key Facts

The Cloud Policy is hinged on the following facts:

- i. Implementation of the country's Economic Recovery and Growth Plan (ERGP) cannot be achieved without efficient deployment of computing and digital resources. Specifically, the ERGP recognizes the need to promote digital-led growth by ensuring there is increased contribution of ICT and ICT-enabled activities to GDP through significant expansion of broad band, increase in e-government and establishment of ICT clusters. Cloud computing in Public institutions and SMEs that provide service to the government can leverage cloud to enhance digital-led growth.
- ii. Understanding the value that cloud computing can have in enabling efficiency, transparency, and security of public sector information and communication technology operations, in line with the spirit of the National Digital Agenda 2020, the National ICT Policy and the National Cyber security Strategy;
- iii. The Federal Government is promoting Open Data Initiative aimed at ensuring substantial amount of public data is released for transparency purpose and creation of innovative digital services that will add value to the country socio-economic development. The best and fundamental technology to promoting Open Data is Cloud adoption.
- iv. The need to lower business or market entrance barrier for SMEs by creating an enabling environment for them to safely adopt cloud computing. This ensures there is considerable reduction in capital cost due to the need to pay upfront costs for IT infrastructure including hardware, software and associated maintenance, National Information Technology Development Agency (NITDA), Nigeria Cloud Computing Policy, 2019

3. Background of Cloud Computing Resources

Cloud computing was first born in Google, in the cloud computing research and application, to the analysis of its revolutionary impact on information industry and IT industry, focusing on the connection between software trade development and cloud computing. Proposed cloud computing healthy development definitely makes the software trade to change from the pure SaaS model to PaaS/IaaS, software on demand is the mainstream in the future (Sangnapaboworn, 2010).

3.1 Current cloud computing research and applications

Cloud computing is a relative new concept, although have not formed a unified definition, but the domestic and foreign scholars, universities, vendors, government organizations from different angles are investing in research around the topic of cloud computing. The basic meanings as follow: A form of standardized IT-based capability—such as Internet-based services, software, or IT infrastructure – offered by a service provider that is accessible via Internet protocols from any computer, is always available and scales automatically to adjust to demand, is either pay-per-use or advertising-based, has Web-Cloud computing is to provide the applications of the previous hardware and software that require investment and technical capacity Web-based services to users; cloud computing means outsourcing, how much to buy cloud computing services relies on how much it is needed; Cloud is a huge resource pool, you pay-per-demand, cloud is virtualization, cloud can pay the same way as running water, electricity, gas, (Liao, Li, and Zhang, 2010).

3.1.1 Cloud Computing Layers

Cloud computing providers offer their services according to several fundamental models: infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS) where IaaS is the most basic and each higher model abstracts from the details of the lower models. Cloud Computing Layers consisted of IaaS, PaaS and SaaS can be seen in Fig. 2.

Infrastructure as a service (IaaS) In the most basic cloud-service model, providers of IaaS offer computers – physical or (more often) virtual machines – and other resources. IaaS clouds often offer additional resources such as a virtual-machine disk image library, raw (block) and file-based storage, firewalls, load balancers, IP addresses, virtual local area networks (VLANs), and software bundles. To deploy their applications, cloud users install operating-system images and their application software on the cloud infrastructure (Sultan, 2010).

3.1.2 Platform as a service (PaaS)

In the PaaS models, cloud providers deliver a computing platform, typically including operating system, programming language execution environment, database, and web server. Application developers can develop and run their software solutions on a cloud platform without the cost and complexity of buying and managing the underlying hardware and software layers (Henderson, 2010).

3.1.3 Software as a service (SaaS)

In the SaaS model, cloud providers install and operate application software in the cloud and cloud users access the software from cloud clients. This eliminates the need to install and run the application on the cloud user's own computers, which simplifies maintenance and support (Chen, 2011).

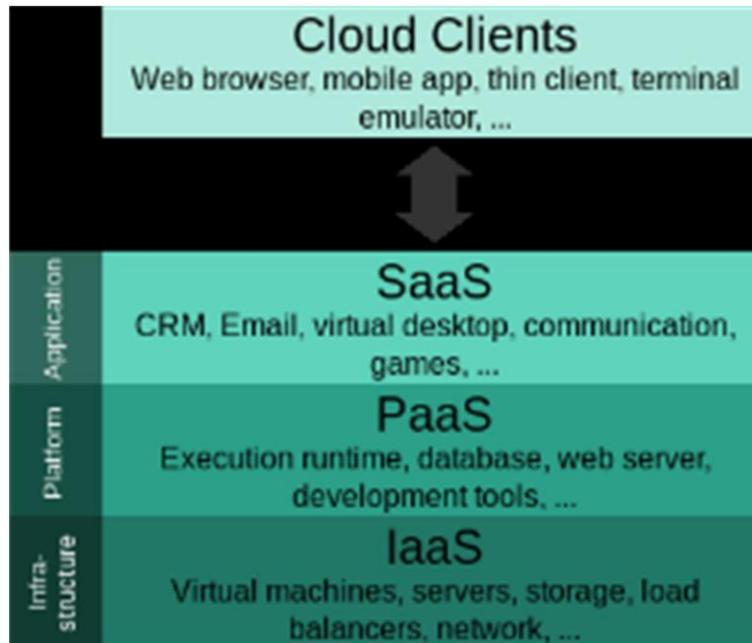


Fig. 4 Cloud computing layers

3.1.4 Cloud clients

Users access cloud computing using networked client devices, such as desktop computers, laptops, tablets and Smartphone. Some of these devices – cloud clients – rely on cloud computing for all or a majority of their applications so as to be essentially useless without it (Zhang, 2010). Examples are thin clients and the browser-based Chrome book. Many cloud applications do not require specific software on the client and instead use a web browser to interact with the cloud application. With Ajax and HTML5 these Web user interfaces can achieve a similar, or even better, look and feel to native applications. Some cloud applications, however, support specific client software dedicated to these applications (Li, 2010).

4.0 Review of Related Literatures

A research was conducted titled “Implementation of Cloud Computing in Education – A Revolution”. It said that the cloud computing was used in the education about teaching, flexibility and expenses for fundamental structures as Fig. 3. The benefits and limitations of cloud computing are also mentioned in the research. According to the findings, a lot of tertiary institutions improved the fundamental structures of IT and data. The challenges could be solved by using cloud computing (Henderson, 2010). The challenges included expenses, flexibility, access to information and technology. Using cloud computing technology in the institutions, neediness should be defined and the privacy identification and cloud services are as follows:

4.1 Infrastructure as a Service (IaaS): can be used to satisfy the infrastructure needs of the students, faculties or researcher globally or locally with some specific hardware configuration for a specific task.

4.2 Platform as a Service (PaaS): certain providers are opening up application platforms to permit customers to build their own application without the cost and complexity of buying and managing the underlying hardware and software layers.

4.3 Software as a Service (SaaS): the application service provider is hosting the application which runs and Interacts through web browser, hosted desktop or remote client. It eliminates the need to install and run the application on customer own computer and simplifying maintenance and support.

4.4 Computing as a Service (CaaS): providers offer access to raw computing power on virtual server such as Amazons, EC2 service. Following figure shows the universty using the services of cloud computing.

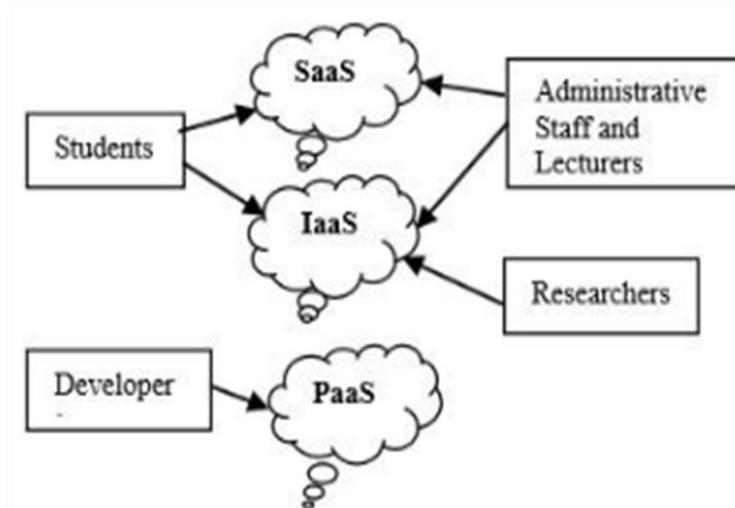


Fig. 5 University using the services of cloud computing

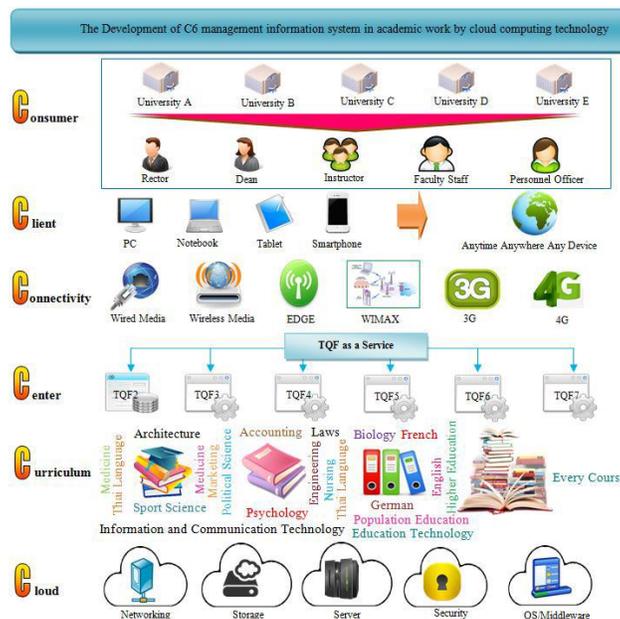


Fig. 6 The development of C6 cloud computing management information system in academic work.



5. Conclusion

The findings from the research study can be shown in Fig. 6. Consequently, an enhanced methodology to improve the existing method in cloud resource system is presented. Cloud computing is set to change how IT systems are deployed both in tertiary education and government because of its apparently cheap, simple and scalable nature. The main concern about adopting cloud services are security, privacy data location, universal connectivity, applicable educational institution

6. Recommendation

Based on the conclusion in this study, it is recommended that cloud computing resources should be encourage in Tertiary Education system and platforms should be develop in such a way that it will facilitate and enhance practical and technological manpower of the students and the institutions.

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