Exploration of cloud computing practices in university libraries in Kenya

Elisha Ondieki Makori

Introduction

Across the world, the information landscape is rapidly changing due to modern technological solutions or innovations. Cloud computing is dramatically reshaping the information environment in the same way other disruptive technologies have done in the past. Cloud computing provides effective and efficient utilization and sharing of information service and has brought new and innovative ways of empowering the creation, diffusion, utilization and sharing of information, knowledge and intellectual property in libraries, while reducing management-related issues.

Libraries are powerhouses of information, knowledge and communication (Makori, 2015). Parliamentary libraries provide information and research services to Members of Parliament and staff in relation to their duties. In institutions of higher education and learning, academic libraries are fountains of knowledge that manage, preserve, organize, distribute and use information to support research, teaching, learning, scholarly communication and community engagement services. Libraries exist for the sake of clients whose major interests are that desired information materials should be readily made available when needed and in the appropriate format (Khan and Rubina, 2009). The modern library extends beyond the physical walls of the building through technological and digital applications such as social computing, cloud computing, mobile phones and Web-based solutions.

In the twenty-first century, cloud computing is displacing client server architecture and reshaping the delivery of information services, and librarians need to play a leadership role in its implementation. In Kenya, cloud computing is gaining momentum in business organizations. In libraries, cloud service can play a crucial role in management of information services, particularly due to hard economic realities facing organizations. Libraries are "agents of change" that proactively should be involved in implementation of new and smart technological solutions to enhance and support delivery of services to its clients. The purpose of this paper is to provide an up-to-date account of the potential of cloud computing in the management, utilization and sharing of information, knowledge and intellectual assets in libraries and for the creation of online communities for scholarly communication, collaboration and participation. The research methodology adopted for this study involved a literature review and environmental scan that included scholarly journals, conference proceedings, websites and textbooks.

Cloud computing

Forrester Research, Nuance Communications (2009) reports, that [. . .]:

> [. . .] cloud computing is one of the top 15 technology trends and that it warrants investment now so you can gain the experience necessary to take advantage of it in its many forms to transform your organization into a more efficient and responsive service provider to the business.

Historically, cloud computing is a critical new paradigm and emerging technology (Leimeister *et al.*, 2010). Cloud computing is the provision and enhancement of services through various systems having large data centers and powerful servers that host Web applications. This involves creation, integration and diffusion of resources and services using distributed computers on the internet. Provisioning and sharing of resources, software, applications and information on public cloud services are made available to the clients.

The modern knowledge environment is increasingly adopting innovative business systems with the help of technological solutions such as data mining, artificial intelligence, geographical information, cloud enterprise resource planning and cloud computing. Cloud computing is a Web-based solution that provides speed and quality information services to customers across the globe. Cloud computing is the mechanism where massively scalable information technology-related capabilities are provided as a service using the internet for multiple external customers (Plummer *et al.*, 2008), while Buyya *et al.* (2008) noted that cloud computing is:

> [. . .] a type of parallel and distributed system consisting of a collection of interconnected and virtualised computers that are dynamically provisioned and present as one or more unified computing resources based on service level agreements established through negotiation between service provider and customer.

Additionally, Nimis (2010) agrees that building on computer and storage virtualization, cloud computing provides scalable, network-centric, abstracted information technology infrastructure platforms and applications as on-demand services that are billed by consumption.

Cloud computing architecture

Cloud computing is emerging as the new information and communications technology paradigm with the greatest impact since the invention of the World Wide Web. Cloud computing architecture is the systems architecture of the software systems involved in provision and delivery of *cloud computing*. Typically, this involves multiple *cloud components*

communicating with each other over application programming interfaces of Web-based services. The "cloud" is the collection of networked features with on-demand services used to share computing resources such as networks, servers, storage, applications and services.

Cloud computing architecture consists of two main components, namely, the *front end* and the *back end*. The front end is the part seen by the client, the computer user. This includes the client's network, computer and applications used to access the cloud via s user interface such as the Web browser. The back end is the "cloud" itself consisting of computers, networks, servers and data storage devices.

Cloud computing incorporates four types of "clouds", namely, *public cloud*, *private cloud*, *community cloud* and *hybrid cloud* (Peter and Timothy, 2011). The public cloud computing environment is normally available and open to the general public. This is managed and supported by organizations selling cloud services such as Amazon Web Services and Google AppEngine. Private cloud computing environment is purely managed and operated within the organization or through the third party that exists on the premise (internal) or off premise (external) for the purpose of controlling own resources. Community cloud computing environment is made up of several organizations supporting particular community having shared values such as vision, mission and security issues. In addition, community cloud is managed and supported by the respective organizations or through the third party that exists on the premise or off premise. Hybrid cloud computing incorporates both public and private clouds based on standardized or proprietary technology.

Cloud computing services

Cloud computing allows users to choose from a pool of hardware, software and networking infrastructure managed independently within an organization or externally by a vendor (Armbrust *et al.*, 2010; Joint *et al.*, 2009). This involves provision and delivery of services through the internet. The main purpose is to effectively and efficiently improve utilization and sharing of resources. These include service orientation, infrastructure virtualization and cloud computing.

In general, cloud computing services are broadly divided into the following three categories:

1. Software-as-a-Service (SaaS);
2. Platform-as-a-Service (PaaS); and
3. Infrastructure-as-a-Service (IaaS).

SaaS provides software or applications and related services involving deployment and hosting of the application by the service provider to the serving clients or customers through the internet. SaaS is the business purchase software based on the needs and demands of the clients or users. This helps organizations and firms to save on initial and upfront costs, as the software is paid based on the number of clients. The concept provides the platform for small and medium enterprises to enjoy the benefits of commercial software with minimum costs, as the applications are installed, handled and managed by the service provider. In addition, minimum management issues are involved, as the user does not need to worry about the maintenance and support of the software and the actual resources. Web-based applications (Hotmail, Google Apps and Skype) and Web 2.0 solutions (Facebook, Twitter and Flickr) are examples of SaaS useful in libraries and information centers.

The PaaS model offers services dealing with the development, creation, testing environment, deployment, hosting services and maintenance of software and Web-based applications. The end users write their own code, and the PaaS provider uploads the code and presents the same to the Web (Kayeyia, 2010). Kayeyia adds that PaaS providers offer faster service that is cost-effective and manages and supports upgrades including routine maintenance. The PaaS platform is based on subscription or a metering model where clients pay for what is used or consumed. Basically, payment is only made on what is consumed, and the more the client consumes, the more the pay and vice versa.

PaaS services provide the necessary business tools that support the needs and interests of the clients. The service provides four types of solutions, namely, s*ocial application*, *raw compute application*, *Web application* and *business application*. The use of social networking tools like Facebook provides the opportunity for third parties to develop, create and write new applications for the clients or end users. The best example of commercial cloud computing is Amazon's elastic compute cloud that allows clients to rent compute cycles on Amazon's infrastructure. This service is used in conjunction with the simple storage service that provides data storage services (Thomas, 2011). In libraries and information centers, cloud computing applications offer free solutions such as Google Apps for information, a free online suite of tools that include Gmail for electronic mail (email) and Google Docs for documents, spreadsheets and presentations; and Microsoft's cloud service like SkyDrive. Google also provides the platform to develop and create Web applications. This provides instant and real-time access, retrieval, dissemination, publication and sharing of information, knowledge and intellectual records for scholarly communication, online collaboration and participation.

IaaS is the best alternative for outsourcing that provides storage and computing power on scalable, flexible or elastic basis. IaaS is also known as Hardware-as-a-Service or utility computing. In Kenya, companies offering cloud solutions include Safaricom, MTN Business, Biashara Cloud, Flexus Technologies, Connections and InfoConnect, in addition to, international firms such as Google, IBM and Amazon.com. Hardware-as-a-Service is a costly business venture for organizations and firms. The best option is for organizations to purchase only the required infrastructure based on the requirement, need and demand or outsource all the resources instead of acquiring the entire infrastructure including servers, networking facilities and software that might be unused. Like PaaS, IaaS is based on requirement and need model where the client "pays as you go". The client pays only for what is consumed or used. IaaS provides better numerous advantages such as unlimited access to superior technological resources, reduced costs, cost-

effectiveness services and dynamic scaling (Table I).

Application of cloud computing

In cloud computing, the clients normally pay for the physical infrastructure instead of owning the entire system. The client outsources cloud services by renting from a service provider or third party. Many internet-based companies and firms have huge storage database capacities that are normally underused. This has led to the need to rent out the extra space and storage of resources on remote servers or clouds. The organizations and companies must be in a position to provide the necessary infrastructure, software and platform applications. In cloud computing practice, the client avoids use of direct capital expenditure on infrastructure or hardware, software and service, instead preferring to deal with the service provider. Cloud computing implies that the client uses or uses resources as a service and only pays on the resources consumed based on the individual need and requirement. Additionally,

Table I.
Top cloud enterprises/organizations

Business enterprise	
Kenyan	International
Safaricom	Google
MTN Business	Microsoft
Biashara Cloud	Amazon.com
Flexus Technologies	IBM
Connections	Salesforce.com
InfoConnect	Rackspace

payment is based on what the client consumes as exemplified in other utilities such as electricity and water. This helps the client to enjoy business opportunities at a relatively minimum cost instead of purchasing all services (Figure 1).

**Potential opportunities for cloud computing in libraries and information organizations**

Globally, the information landscape is in a constant state of change and revolution. At the center of the debate is the development of the knowledge society, leading to the commoditization of information and knowledge in the market place of ideas. Additionally, the information environment is characterized by the information explosion or what some coin as glut on the Web that has forced information centers to look at effective methods of providing quality services to their clients. Modern technological trends brought by personal computing and networking are forcing information centers to create online communities. Other factors include globalization of information services, unlimited access to information and communication services, mass provision of information services, economics of information and open source systems. Cloud computing is the "emerging new guru" of handling and supporting information services that takes advantage of numerous open source applications, modules and components.

In the twenty-first century, university libraries must change the

traditional practices of handling and managing information services. Traditional management practices are proving hard to address all the informational and technological needs of the clients where the emphasis is on the quality delivery of services. There is a need to embrace modern management and technological practices in information work and activities. Many internet-based organizations, vendors and institutions are involved in various activities or initiatives meant to promote the cloud computing model in libraries and information centers. Yahoo, Google and IBM are engaged in funding universities whose purpose is to promote research in cloud computing projects. These companies provide hardware, software and services to augment university curricula and expand research horizons for the academy using the cloud computing model (Erenben, 2009; Thomas, 2011). In addition, these authors agree that Yahoo's partnerships with several universities, colleges and K-12 schools and districts in the USA is already reaping the benefits of switching to the cloud computing model. Research on information technology executives and chief information officers across the Asia/Pacific region excluding Japan (APEJ) in relation to utilization of cloud computing found numerous reasons for adoption of this technology in organizations (APEJ, 2009, p. 9) as indicated in Figure 2.

In the Kenyan context, cloud computing adoption and usage is gaining popularity in business establishments especially with small

Figure 1. *Cloud computing*
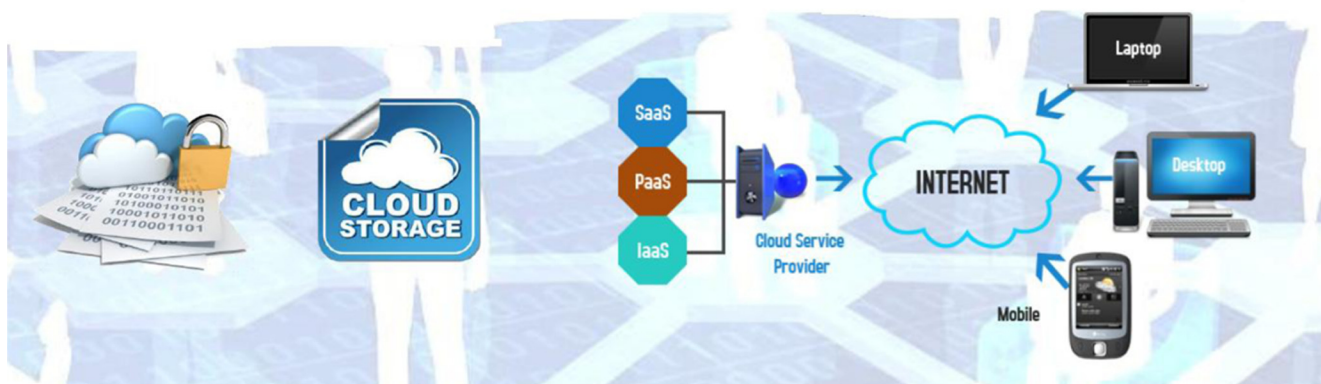
Source: Cloud Computing in Higher Education Conference (2014)

and medium enterprises (Awale, 2012). Awale adds that from the start of 2012, more companies were warming up to the idea of cloud computing because of the immense benefits associated with this technology. Business organizations are increasingly conducting and delivering services using this model of computing. The same applies for library and information centers, although there is minimum development in the sector. Cloud computing cannot be ignored particularly in libraries and information establishments, where information services keep on changing with many competing needs and demands. In Kenya, libraries and information centers face numerous operation needs due to hard economic situations. Cloud computing is increasingly gaining momentum as the best means to handle and support the delivery of services in libraries and information centers.

In recent years, rapid advances in the knowledge and communication-based society have had significant impact on how information professionals handle and support delivery of services in library and information establishments. In particular, the development of cloud computing in libraries in developing countries is slow to implement. Cloud computing has the potential to enhance and improve utilization and sharing of information resources in libraries. This business approach is beneficial to libraries and information centers, as payment is based on the resources and services used or consumed. Through consortium practices, libraries and information centers can develop and

manage datacenters, acquire superior technological solutions and share professional expertise and other crucial services.

In the digital environment, the cloud has positive implications of creating online communities, and virtual communication and collaboration with clients. Cloud computing has the potential for scholarly communication, storage and sharing of information, knowledge and intellectual records. In the library, the ultimate goal of cloud computing is to create virtual communities of information professionals and clients. This creates a strong social interaction, collaboration and friendly environment in the information center. Web 2.0 applications can be used effectively to provide and deliver information services to clients through online scholarly communication, discussion, collaboration and presentation.

The core value and driving force of cloud computing in any library is to provide information services to support research, teaching and community services of respective academic institutions. Technology has been instrumental in handling and supporting information services in libraries and information centers. Information professionals should play the leadership role in the development and use of cloud computing applications. Information services are driven by the needs, demands and interests of clients in relation to technology-based sophisticated tools. The vast majority of clients are young

adults who are technology literate. Application of Web 2.0 tools (Facebook) makes online scholarly communication, collaboration and participation faster and possible. The kinds of technological solutions needed in libraries and information establishments of the twenty-first century are by far different from the requirements of the predecessors of the past century. Information professionals have no choice in adopting and embracing cloud computing approaches so as to effectively handle and support information services to the satisfaction of their[4] clients (Figure 3).

Top benefits of cloud computing

Cloud computing offers the opportunity for provisioning, consuming and enhancing of services based on need and a pay by use basis. This helps in shifting the cost structure from capital expenditure to operating expenditure and also helps make the information technology systems more agile (Dhar, 2012). The cloud service provider handles and supports all services including issues of installation, licensing, upgrading and maintenance of the systems. Cloud computing organizations provide infrastructure, networks, servers, applications, platforms and related services. Fundamentally, this allows information professionals to handle service needs with minimum costs.

Developments in technological innovation have led to shifts in ways libraries and information centers should handle and provide information services. With cloud computing, information professionals create virtual communities through social software systems such as blogs, RSS feeds, instant messaging, wikis, podcasts, vodcasts, Facebook, Twitter, Skype and Web conferencing to provide services on 24/7-hour basis. The virtual information environment creates scholarly communication, collaboration, discussion and participation. A cloud service provider also provides the infrastructure used to handle, manage and support integrated library systems. For information professionals, cloud computing model provides a convergence of information services, client needs and technological solutions.

**Figure 2.** *Need for adoption of cloud computing in organizations*
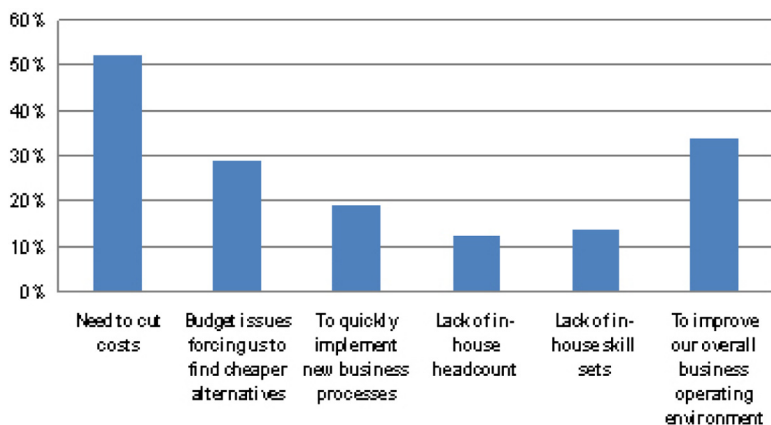
Source: APEJ (2009)

Transitioning from Web- to application-based systems has brought new ways of handling and supporting delivery of services. This has seen the emergence of outsourcing services without owning the complex and expensive information infrastructure. Outsourcing is the best management and technology strategy for organizations to deliver cost-effective quality services to the clients.

Once the contractual agreement between the client and the service provider is signed, then cloud computing services are immediately deployed to the client. This business paradigm of utility computing is based on subscription or metered model, where clients pay only for what is consumed, the same way clients pay for electricity or water. Cloud computing represents a paradigm shift in how organizations conduct and pay for resources and services (Armbrust *et al.*, 2010, Badger *et al.*, 2011, Daniele, 2010; Dhar, 2012). Cloud computing is built on scalable, flexible and elastic principles, and this helps organizations with the option to seamlessly increase services based on user needs and requirements.

Cloud computing involves the centralization of the technological infrastructure and resources available on the internet. The concept of sharing involves many organizations leading to

Figure 4. *Cloud benefits 2014 vs 2013*
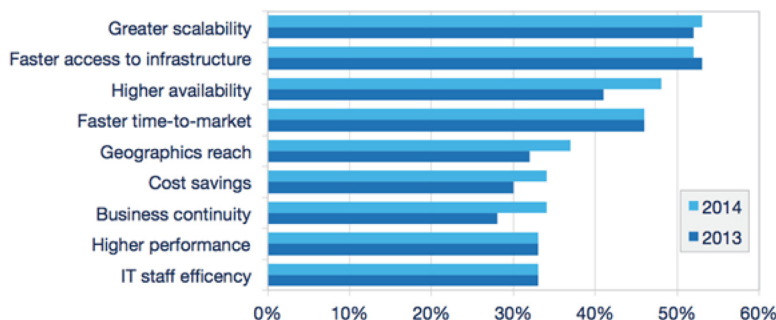
Source: RightScale (2014)

increased utilization of resources. In economies of scale, this is beneficial to libraries and information centers that face competing demands and limited financial budgets. Library consortia may also develop and provide cloud services.

In addition, cloud computing is useful in facilitating innovative services. Information professionals are freed from technological-related issues such as purchase, installation and maintenance of computing infrastructure to concentrate on core information services that satisfy the needs of the clients.

Cloud services provide adequate security as opposed to the situation where organizations develop and own the systems themselves. Economically, organizations or institutions may lack

the resources necessary to put in place an effective information and communications technology security system. Cloud service providers are in a better position to assure that adequate security services are maintained.

In 2014, state of the cloud computing trends identified similar benefits of this innovative practice as highlighted in Figure 4.

Challenges and risks

There are several reasons or factors negatively affecting adoption and implementation of cloud computing in organizations. One of the single biggest concerns (when not viewed as a benefit) is security issues. Cloud computing is prone to security lapses that end up

Figure 3. *Application of cloud computing paradigm in university library*

Source: Sanchati and Kulkarni (2011)

compromising the delivery of services. Once organizations adopt and embrace cloud computing, traditional information boundaries become small. In cloud computing, once the system breaks down, the damages caused due to security risks or breaches are potentially harmful to many organizations. In addition, outsourced data and resources are never safe. Based on a Deloitte East Africa study, Awale (2012, p. 34) reports, "that nearly 40 per cent of organizations in East Africa are reluctant to adopt cloud technology due to data privacy, legislation and security concerns". In addition, Thomas (2011) argues that, institutions with serious concerns about data security should build own private cloud services to keep costs down. Security concerns should not overshadow the benefits. Thomas adds that, the cloud is no less secure than more traditional information technology delivery models.

Concept of "centralizing" cloud computing and infrastructure services might affect or compromise the operations and services of the organization, if the machines "break down". With cloud computing, once the system fails, then entire resources and services are affected. In cloud services, the failure of the system becomes "catastrophic or a tsunami" issue greatly affecting organizational operations and services.

Transparent and honest business dealings and activities are useful in directing the success and continuity of cloud services in organizations. Numerous uncontrolled factors include honesty or trust and ownership beyond a county's political boundaries, especially if cloud services are provided by external companies. To share and exchange professional and personal experiences, there is a need for accountability and transparency.

Provision of cloud computing services is by far and large within the reach of the biggest internet-based business organizations such as Google, IBM, Amazon, Safaricom, MTN Business and Biashara Cloud. Dependence on internet-based organizations affects flexibility and innovation. There are a number of important issues including policies, appropriate rules and regulations for use and access of cloud services. Policies should guide organizations in protection and storage of data resources locally and across borders. Appropriate guidelines should be put in place to ensure continuity of services if the system fails. This will avoid situations of losing access to data resources and accounts by clients.

In cloud computing, connectivity services are critical. In traditional applications, lack of connectivity allows for some local functions to continue until the services are restored (Kayeyia, 2010). Bandwidth issues also play crucial roles, as some organizations may capitalize on the use of bandwidth and end up over-charging clients. Many cloud companies sell bandwidth services based on "average" or "peak" usage instead of "maximum" usage.

Conclusion

In the face of the present hard economic situation and limited financial budget, cloud computing is the best management and technological practice to help libraries. Libraries and other information centers should adopt and embrace cloud services in the delivery of services to their clients. This paper provides a roadmap into the possibility of using cloud computing to handle and support information services in an ever-increasing digital economy. Across the world, cloud computing has created a new business paradigm of a virtual information environment that can lead to the maximum utilization and sharing of resources and services. Libraries need to understand and weigh the underlying features, benefits and challenges of cloud computing. Despite any drawbacks, cloud services offer attractive opportunities for organizations and service providers leading to innovation and the satisfaction of users.

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Elisha Ondieki Makori (*elishaondieki@yahoo.com*) is based at University of Nairobi, Nairobi, Kenya.