

The Implementation of Emerging Technologies for Sustainable Academic Libraries: A Comparative Analysis between Developed and Developing Countries

Priscilla Abike Agbetuyi¹, *Abdulmumin Isah²

^{1,2}Department of Library and Information Science, University of Ilorin, Ilorin, Nigeria,
agbetuvipa@gmail.com¹ isah.a@unilorin.edu.ng²

*Corresponding author

Abstract: Library and Information services across the globe have witnessed a paradigm shift brought by Information and Communication Technologies (ICTs) which has not only changed the format of information resources and library services, but have impacted tremendously on mode of access and retrieval of information. One of the concerns of academic libraries in this industrial age is to ensure a sustainable information service delivery to the techno-savvy information users. The purpose of this paper is to carry out a comparative analysis of emerging technologies implementation for sustainable academic library services on a global scale. A systematic review of empirical studies exploring current emerging technologies in academic libraries was carried out. Comparative analyses of the existing studies were conducted on the level of implementation of these technologies between developed and developing nations of the world. Literature search was conducted using two reputable academic databases namely GOOGLESCHOLAR and SCIENCEDIRECT. Relevant criteria were used to screen a total of 64 papers out of about 247 retrieved literatures. The study revealed the level of implementation of some emerging technologies in academic libraries of developed and developing countries. Based on widespread acceptance, five (5) out of these technologies were critically reviewed and how they have impacted on information access and retrieval examined. Namely: “Online Public Access Catalogue (OPAC)”, “mobile-based technology”, “Web 2.0”, “Institutional repositories”, and “cloud computing”. The study informs the understanding of libraries and librarians’ about emerging technologies being deployed in academic libraries for information service delivery in developed and developing nations of the world. It was concluded that sustainability and continued relevance of academic libraries requires full deployment of emerging technologies in their services. Hence, they must strive to meet the information needs of the techno – savvy library users through a synergy between librarians and university management.

Keywords: Cloud computing; emerging technologies; institutional repositories; mobile – based technology, OPAC; web 2.0.

1. Introduction

The present age which is characterised by Information and Communication Technologies (ICTs) has transformed library and information resources and services globally. As a result of the transformation brought by ICTs, there are emergences of new technologies in the libraries which have brought a paradigm shift from print collections to electronic resources and the conventional methods of accessing and retrieving these collections are now giving ways to ICT-driven approaches. Due to changes in the format of information resources and services, it becomes imperative for academic libraries to harness the full potential of these new technologies for sustainable library and information service provision.

Scholarly records are going through paradigm shift, from monographs and articles to blog posts, software, multimedia digital archives and data repositories. Academic libraries are also changing in the way they archive, store, access, retrieve, manipulate, and disseminate scholarly communication and information to users (New Media Consortium, 2017). Previously, all scholars’ output could be kept on a bookshelf, however, complex databases are now needed to store and retrieve a scholar’s output. Products such as D-Space, Digital Commons, Islandora Fedora

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and Hydra are being utilized to aid access (Uzwyszyn, 2017). Therefore, librarians and libraries are concerned with continued relevance and sustainability of information products and services as right of access to information without any limitation or barrier becomes important right in the information age.

Furthermore, the changing information age is marked by proliferation of information resources in varieties of formats which in a way, leads to information explosion. Hence, librarians are saddled with the responsibilities of coping with the challenges of information explosion and making accessible relevant information from reliable sources to satisfy the needs of the techno-savvy information users. Today, librarians are striving to remain relevant in the midst of alternative information sources via the internet and worldwide web by adopting and deploying the current emerging technologies to providing access to resources in order to satisfy the information needs of users.

However, developed and developing countries are not at the same level of adoption and deployment of these technologies which may be attributed to a number of factors. Therefore, there is the need to aggregate ideas on how academic libraries can improve on full deployment of these technologies for sustainability and continued relevance. Despite the fact that scholars have given much attention to the emergence of new technologies in libraries, there is dearth of research on the level of implementation of these technologies in developed and developing countries. Hence, the concern of this study is to systematically review related literature on emerging technologies, carry out a comparative analysis of level of implementation between developed and developing countries and examine how academic libraries can sustain and improve on the deployment of the technology in this information age.

2. Literature Review

The application of technology in libraries is not a new phenomenon and libraries as an institution have a very long history of the application of technology. Libraries, according to Arms (2012), were pioneers in using technology such as typewriters and microfilm. For example, the growth in the volume of human knowledge and the inability of the traditional library technologies (card cabinet, book shelves) to keep up with the growth of knowledge informed the application of automated information systems in libraries in the 20th century.

Academic libraries, being the primary hub in the network of information provision for teaching, learning and research in academic environments, have continuously invested heavily in the procurement, maintenance and management of information and communication technologies. These ubiquitous and quintessential ICTs and its applications have reshaped the outlook of academic library services as a lot of technologies were developed and deployed which has impacted positively on information service provision across the globe. The changes came with intervention supported by ICTs which offer opportunities for knowledge and information dissemination to a wider audience irrespective of time and location. It also presents an avenue to provide value - added information services and wider access to a wide variety of digital – based information resources (Tiwari & Sahoo, 2013).

Recognizing the dynamics of the information age; brought about by ICTs which have birthed new information format, academic libraries resort to automation of their services. Hence, the contents of library resources have received significant shift from print to electronic and online resources. Authors like Bawack (2019); Nnadozie and Nwosu, (2016) supported the view that libraries are shifting from traditional printed resources to the use of

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electronic-driven services. Today, the resources of the library are available in print and electronic formats which can be accessed on the shelves by physically visiting the libraries and electronically through ICT enabled devices. Also, new and dynamic roles are also being emerged for librarians.

There are lots of benefits derived by academic library users with the application of ICT. One of the benefits offered is boundless access to library resources from users' remote end. Authors like Bawack and Nkolo (2018); and Adindu and Chinyere (2015) averred that online accessibility and wide access to digitized information, and value added – service are provided which have transformed the dimension of information services provision in the information age.

Despite the benefits, the new information age presents some challenges for librarians, information specialist, and information users in developed and developing countries. Bawack and Nkolo (2018), noted some challenges like institutional policy, inadequate library budget, lack of basic ICTs, insufficient and unqualified library staff and the inability for directors of academic library to adopt innovation, the absence of inadequate technology and lack of state of the art ICT infrastructure to build and manage sustainable institutional repositories that will enable free access to research and scholarly publishing, poor internet penetration and connectivity, unstable electricity supply, and low bandwidth are some major challenges that has negatively impacted the transition of academic libraries to the digital era in developing countries. In the same vein, Kadli and Kumbar (2013) noted that the emergence of new information environment brought new challenges and problems. He stated that the retrieval of information in response to users' real needs has become ever more complex and assessing the validity and reliability of retrieved information is another problem.

3. Methodology

This paper presents a systematic review of literature on emerging technologies and information access and retrieval in academic libraries globally. The keywords “emerging technology/s AND academic library/ies”, “technology AND library/ies”, “academic library/ies AND information access”, and “academic library/ies AND information retrieval” were run on two reputable databases namely GOOGLE SCHOLAR and SCIENCE DIRECT between February and May 2020 to identify peer – reviewed literature on the subject matter. In addition, GOOGLE search engine was also used with appropriate search terms. Comparative analysis of level of implementation between developed and developing countries were carried out.

In total, 247 papers were retrieved. Inclusion criteria employed to select 64 papers for the review focused on:

- Peer – reviewed articles reporting on emerging technologies in academic libraries;
- Articles which were published between 2010 – 2021;
- Articles which are reporting specifically on adoption of some of the technologies in academic libraries; and
- Articles written in English Language.

Furthermore, a set of exclusion criteria were adopted to judge the relevance of the identified literature and to screen – out articles that were not relevant to this study. The exclusion criteria used were:

- Papers reporting on adoption of ICTs in general context were not considered because they were perceived as too broad and not being directly relevant to academic library;
- Papers published earlier than 2010 were considered too old to be included in the study; and
- Papers reporting on information access and retrieval in public libraries, museums and archives centres only.

The majority of the papers collected (61) were journal articles, whereas only three (3) were published in conference proceedings.

4. Results

Preliminary examination of the selected sixty-four (64) relevant articles for the review indicated that implementation of emerging technologies revolves around five major technologies that have been grouped under the following sub themes: OPAC, mobile-based technology, Web 2.0 technology, institutional repositories, and cloud computing technology. How developed and developing countries have been able to deploy these technologies for continued relevance and sustainability were analysed and their impact on information access and retrieval in academic libraries were explored in the next sub section.

5. Discussion

This sub section systematically analyse the level of deployment of each of the five major technologies across the globe as reflected in extant literature reviewed.

5.1 Online Public Access Catalogue (OPAC)

Online Public Access Catalogue (OPAC) has been reported to be a widely used information access and retrieval tool in academic libraries across the globe. It is an interface of information retrieval system which assists information searchers to access resources of libraries using several access points (Fabunmi & Asubiojo, 2013). The technology had impacted positively on access and retrieval of library information resources in that information retrieval rate is increased especially in locating books and other reading materials in libraries. Studies across the globe have attested to the ubiquitous nature of OPAC in academic libraries (Swaminathan, 2017; Kumar & Vohra, 2013; 2011). Kumar and Vohra (2011) studied the use of OPAC at university of Punjab library and found out that a significant number of users searched their desired information regarding the library materials through OPAC despite encountering problems. In the same vein, studies on the use of OPAC as a document retrieval tool at University of Kashmir by Qadri (2012) revealed that most students searched their library materials through subject, author and title access.

However, studies on the use of OPAC in Nigeria indicated low level of utilization (Eserada & Okolo, 2019; Fati & Adetimirin, 2015; Bamidele, et.al. 2014; and Onuoha, Umahi & Bamidele, 2011). Factors responsible were attributed to low level of awareness, users' preference to browsing directly through the shelves, lack of knowledge and familiarity with the system, navigational frustration and the OPAC system not friendly. Hence, library resources were mostly accessed manually by browsing through the shelves.

Despite the popularity of OPAC, as one of the first technologies adopted in libraries, countries of the world are not on the same page in the deployment of this technology because developing countries are still faced with a lot of problems impeding its usage in their libraries. This is clearly seen from the studies reviewed, it seems that the adoption of this technology in developing countries like Nigeria is low due to a number of constraints affecting the automation of academic libraries. Developing countries must strive to keep pace with the revolution brought by ICTs for sustainable information services. While some developing countries are still lagging behind in the implementation of OPAC, most users of the libraries in the present digital mobile technology revolution now access the library OPAC through their mobile devices like tablets, cellphones, PDAs, androids, and iphones.

5.2 Mobile Technology-based Library Services

Mobile technology, as viewed by Hamad, Farajat, and Hamarsha (2018) are handheld information Technology (IT) objects that encompass hardware (devices), software (interface and applications) and communication (network services); augmenting the way people access, receive and interact with information, and providing new channels for collaboration and communication. The emergence of mobile - based technology has condensed the diversified and distributed world in a compact form creating the concept of global village.

Several studies had shown high adoption and usage pattern of the technology across the world for general purposes of communication, interaction and information dissemination (ITU, 2015; Larry, 2016). Hence, some academic libraries are embracing the new technology to enhance their information service delivery because students and researchers can access library catalogues, databases and search for library mode of operation in their respective comfort zones without necessarily visiting the library using this sophisticated and portable technology as it provides the platform for information access and retrieval.

Extant literature and several empirical studies have investigated the adoption of mobile technology in academic libraries across the globe, with high level of adoption in developed countries and low evidence of its adoption in developing countries (Dei, 2020; Hamad, Farajat and Hamarsha, 2018; Ocran, 2017; Rainie, 2012). For example, Torres-Pérez, Méndez-Rodríguez, and Orduña-Malea, (2016) studied mobile web adoption in top ranked university libraries and found out high level of adoption of mobile technology in elite universities. In the same vein, Liu and Briggs (2015) investigated mobile services in top 100 university libraries using website visits and survey; the authors studied each of the top 100 university libraries' experiences with mobile services. Results showed that all of these libraries offered at least one mobile service, and the majority offered multiple services. The most common mobile services offered were mobile websites (81.6%) or mobile apps (29.2%), text messaging services (77.2%), e-books (92.6%), augmented reality (5.0%), QR codes (58.7%) and mobile access to databases (81.7%) and the mobile OPAC (88.0%). In addition, chat/IM services, social media accounts and apps were very popular. Survey responses also indicated a trend towards responsive design for websites so that patrons can access the library's full site on any mobile device. Aldrich (2010) also conducted a research by selecting 111 English-speaking members of the Association of Research Libraries (ARL). Mobile websites were found at 39 universities, either for the university or for the university's library, there was adoption and implementation of mobile website and mobile apps for library information service.

A study of mobile library service in key Chinese academic libraries by Li (2013) revealed that only 12.8% surveyed had a section of their web pages devoted to mobile library service. In a similar survey of community and junior colleges nationwide by Osika and Kaufman (2012) to determine the categories of mobile services being offered, 62% offered vendor database apps, 14.7% had a library website. In line with this, Liu and Briggs (2015) analysed the top 100 university libraries' mobile services through in-depth website visits and survey questionnaire. Results showed that all of these libraries offered at least one mobile service, and the majority offered multiple services and the use of library apps for various purposes was widespread. Advanced countries are keeping pace with mobile technology as reflected in the reviewed literature which has enhanced continued relevance and sustainable information service delivery to their users.

However, African studies such as Acheampong (2019); Muriithi, Horner, and Pemberton (2016); had reported that adoption of mobile technology was not yet implemented as in the case of Kenya, and Ghana university libraries. Similarly, the Nigerian situation was not too different from what is obtained in other African countries as several studies reported low adoption of mobile technology in their academic libraries (Amuni, Adetoro & Olatunji, 2014). Furthermore, Ocran (2017) studied implementation of mobile technology based library service in the University of Cape Town, South Africa, and found out among other things, that they all possessed mobile phones like Infinix, Nokia Lumia, ITEL tablet, Samsung tablet, and most of them accessed library web pages through their laptops. Similar study by Buruga (2016) on the use of mobile technologies for social media-based service in Uganda revealed high positive perception (98%) of the usefulness of mobile technologies to library services by respondents with wide range of services listed such as MOPAC, view library map, and accessing library news among others. They admitted that the technology, if implemented fully, will assist in the easy access to information relevant to their areas of study. Internet disruption, bandwidth and personnel problem were some of the identified challenges to the full implementation of the technology.

In the same vein, Amuni, Adetoro and Olatunji (2014) investigated the perception of library users in two selected academic libraries in Nigeria on the provision of information services through mobile technology and discovered among others that library users make use of mobile devices to get information mostly through facebook (75.8%) and in least cases through visit to library websites (21.43%) and other means (3%). However, it was revealed that none of the respondents had information service through mobile technology from their libraries; which gives a 100% non-response on the question posed.

From the foregoing, it is crystal clear that academic libraries in developing countries are still at preliminary or preparatory stage in the adoption and deployment of mobile applications for mobile websites or library apps. It is revealed that users make use of mobile phones to access information from other sources but not deployed fully for libraries. Despite the popularity and preference for this technology by students, African countries are cumbered with challenges which hinder its full deployment.

5.3 Web 2.0 Technology

Globally, literatures abound on the adoption and deployment of web 2.0 tools in academic libraries for communication, research, and collaboration (Aina, Babalola & Oduwole, 2019; Oyovwe – Tinuoye, Khrubu & Ijiekhuamhen, 2017; Rehman & Shafique, 2011). It contributes to improving the level of learning and research, building a new study environment, increasing motivation levels among the students and presenting new windows for self-study; thereby enhancing the learning skills of students, librarians and academic staff (AlKarousi, Al Harrasi, Jabr, Bouazza, 2015). Web 2.0 tools used in academic libraries are Really Simple Syndication (RSS), Blogs, Podcast, Vodcast, Wikis, Instant Messaging (IM), WhatsApp, and Facebook YouTube and Flickr, Twitter and Facebook as well as blogs (Yi, 2014; Hinchliffe & Leon, 2011).

Rogers (2015) investigated academic and public libraries use of web 2.0 applications and services in Mississippi using a content analysis of libraries with a working website, it was found out that they have the following Web 2.0 services: customized websites for more indepth access to databases were the most frequently used service, followed by RSS, SNS, Mash-ups, media sharing, and blogs. None of the sampled libraries uses Wikis, only three libraries showed evidence of QR codes and tagging respectively. In the same vein, Boateng and lui (2014) examined how top 100 colleges in the USA used Web 2.0 tools and found out that more than 90% of the university libraries used SNS, blogs, RSS feeds and messaging while less than 40% used wikis and social bookmarking. Another study by Mahmood and Richardson (2013) revealed that RSS was the most popular Web 2.0 application in US academic libraries, for publishing news, sharing items published on library blogs, providing information on literacy instruction, information on new acquisitions, Podcasts, Vodcasts, databases and e journals. Other tools used included instant messaging (IM) (95%), social networking sites (SNS) (87%), blogs (85%), micro blogs (82%), social bookmarking (55%). It can be deduced that Web 2.0 technology is fully harnessed but there are variation with high preference for RSS and SNS whereas Wikis are least utilized.

In Asian countries, the deployment of web 2.0 tools and how it impact information access and retrieval varies. In Pakistan, for example, the use of this tool is significantly low; lack of computer literacy skills, unavailability of computers and Internet facility were the main hindrances towards adoption of Web 2.0 technologies in their libraries (Rehman & Shafique, 2011). To buttress this, Santosh (2017) investigated the adoption of web 2.0 applications in India and found out that the libraries were still at the early stage of web 2.0 technology and the blogs is the commonly used technology while the IM is the least used. Lack of training, technical support, and time along with lack of resources (financial and infrastructural) were other identified barriers.

In the same vein, AlKarousi, et.al., (2015) discovered that adoption of web 2.0 applications in Omani academic library is limited to Facebook, Twitter, and Ask librarians, Instagram and YouTube. However, these technologies promote their library and information services in providing: current awareness service, selective dissemination of information, getting feedback from users, marketing library activities and services and reference services.

In Africa, literature revealed that in Nigeria for example, the extent of use of web 2.0 tools for service delivery was about average; and that the tools were not sufficiently and efficiently used (Aina, Babalola & Oduwole, 2019). Other studies in Nigeria (Oyovwe – Tinuoye, Khrubu and Ijiekhuamhen, 2017; Anunobi and Ogbonna, 2012) also showed low usage of these tools in academic libraries. Earlier study by Pechnikov and Nwohiri (2012) used webometrics to study Nigerian university websites. The result revealed a weakly connected web structure.

Commonly used web 2.0 tools were found to be Facebook, WhatsApp and blogs. Erratic power supply, internet connectivity and bandwidth problems are some of the identified challenges of use of these technologies.

In the light of the foregoing, Web 2.0 tools are being deployed in academic libraries across the globe to enhance information access and retrieval by providing updates, feeds, specific and general information services. However, it is crystal clear that there are preferences in the choice of Web 2.0 tools deployed which none of the studies investigated.

Today, academic institutions have sought out means of providing open access to their scholarly output so as to make these contents freely available for users within and outside the institution via internet by adopting institutional repositories to digitally store and enhance access to their research communication.

5.4 Institutional Repositories

Institutional Repositories (IRs), is an open-access initiative to enhance visibility of research output, widely used to disseminate and communicate scientific information. Literature indicates that Europe, America and Australia have higher adoption rates of institutional repositories compared to other continents across the globe (Okumu, 2015 & Abrizah, 2010). Okumu and Abrizah further reported that India, Taiwan, Japan and Thailand lead other Asian countries in adopting and using institutional repositories. Increased adoption of institutional repositories in Asia is attributed to a number of factors which include user awareness of archiving and quality control policies, availability of documents in the repositories, types of the publications and ease of use of the institutional repository software and system (Ammorukleart, 2017). Other adoption factors in Asia are expected academic benefits, visibility, cultural issues, content availability, accessibility and quality, user awareness, fear of plagiarism, attitude and copyright issues (Kim, 2011).

In Africa, Many academic libraries have embraced institutional repository as a useful tool to disseminate information, especially electronic theses/ dissertations. However, in Ghana, for example, their academic libraries faced several challenges such as the cost of acquiring and managing infrastructures, slow internet bandwidth, and inadequate competent technical staff. (Aviam, Popoola and Atuase, 2019). Others authors attested to low adoption rate of institutional repositories in African countries (Fasae, et al. 2017; Kathewera, 2016; Lwoga & Questier 2014; and Ezema, 2013). Saini (2018) observed that slow adoption and development of repositories in most developing countries is attributed to higher learning institutions still being in the process of establishing guiding principles and best practice.

In a recent study on institutional repositories adoption and use in selected Tanzanian higher education public universities by (Elia & Nunda, 2016), it was revealed that awareness and adoption was low. Factors contributing to the low adoption are lack of institutional repositories awareness, unreliable electricity, insufficient information communication and technology (ICT) skills and lack of skilled manpower. Slow adoption and use of institutional repositories in African countries is also being attributed to institutional challenges such as a reliable electricity supply, policies, internet access, awareness and cost (Ampong, 2016). Other critical adoption factors in Africa and most developing countries include expected repositories' benefits, awareness and understanding of self -archiving service (Anenene, Alegbeleye & Oyewole, 2017; Bamigbola, 2014).

From the literature reviewed, it appears adoption and usage of institutional repositories in developing countries like Africa is low due to a number of factors militating against them while adoption in developed countries is high. Hence, access to scholarly communications and output is hampered. Developed countries have been able to overcome some of the challenges faced by developing countries in using IRs, hence, it has positively impacted on management of research outputs and access to scholarly communications.

Academic institutions and their libraries are directly involved in the technicality of managing their IRs. However, as technology is advancing, another initiative which was developed in recent time is the storage of all forms of information in a virtual database called “cloud”. The need to confront the challenges of management of technology and to provide anywhere and anytime access to file storage, databases and other applications brought about the cloud technology which is an advancement of computing technologies over the years.

5.5 Cloud Computing Technology

Cloud computing technology is one of the latest emerging technologies adopted and deployed in academic libraries across the globe. It allows for more optimal resource utilization, easier access, and more effective cost reduction (Yuvaraj and Singh, 2013). Legal and jurisdiction issues, security and privacy, lack of compliance to the service level agreement and reliability of the cloud service providers are some of the identified challenges (Okai, et.al., 2014). More advanced and developed countries of the world have been fully grounded in the deployment of this technology in their universities and libraries alike. Owing to this, mode of access to information has been enhanced; there is improved users’ experience since information resources are housed in the cloud and readily available when needed.

Studies like Han (2013); Luo (2013); Yuvaraj (2013); and Sudhier and Seena (2018) have been carried out in developing economies of the world. These studies established the fact that the technology is being adopted in their academic libraries for both librarians and users, but it is still at developmental phase because most of them were not even aware that they were using the technology. Digital divide, low bandwidth, lack of good service providers and low IT skills have been identified as major setback to the adoption of this technology in their academic libraries.

In the African context, studies like Aviam, Popoola & Atuase, (2019); Seke (2015) had reported low (or minimal) adoption of the technology and many universities are yet to adopt it formally as a resource. The implication of this is that quality services using such cloud services might not be fully achieved. Aviam, Popoola and Atuase, (2019) indicated that academic libraries in most African countries are adopting more to Software as a Service model to extensively promote their services, resources and to interact with users through web 2.0 applications like Google apps and social media platforms such as Facebook, Twitter, blogs, Instagram. This indicated that few aspects of the technology were deployed to search scholarly contents and other information services provision. As a result, African countries may not derive the full benefits of this technology in their academic libraries.

6. Conclusion

In the light of the ongoing review and analyses of emerging technologies implementation for sustainable academic libraries on a global scale, low level of deployment and implementation have been reported generally in developing countries despite the benefits the technologies offer.

Academic libraries in most developing countries are far behind and are striving to attain the 4th industrial revolution characterized by the information age. Therefore, it is expedient to catch up with the global trend as continuous and sustained relevance of academic libraries in the information age depends solely on the full deployment of emerging technologies. Hence, management of academic libraries must be involved in strong advocacy for full implementation. There must be constant training and re – training on the use of the technology and priority should be given to ICT-enabled library services.

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