
Review Article

A Review of Digital Libraries and Their Impact in Africa

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Abstract: Digital libraries, recommender systems and information retrieval are some of the most celebrated breakthroughs in the book of internet evolution. Digital libraries are referred to digital resources that are a collection of electronic materials and technical facilities used in searching, creating, and making use of information. They became important sources of information sharing which are extensions and enhancement of information storage and retrieval system used in manipulating data or materials in digital medium. This designed digital storage are used by set or group of users were they will collect and organize the said storages in a way their contents along with their usability supports the information needs of the said of group of users. These digital information resources have revolutionized many aspects of human lives that includes, in especially, the academia. This research is an attempt to show how internet has paved way for a much easier means of information sharing in various communities across the world. The paper is also an attempt to review the idea behind digital libraries and investigate the use of digital resources among African communities and their socio-economic importance and impact to the continent. The research did also review construction and networking of digital libraries among African institutions, some of which roles are played by e-libraries and information decimation in socio-economic development, sectorial information needs and the issues involved in the lack of establishment of these digital libraries. Lastly, after the paper reviewed works in progress across Africa, it clearly outlined that in a global neighborhood, large work needs to be done in order for African nations to use information in harnessing their full potentials

Keywords: Digital Library, Recommender Systems, Electronic Research, Information Retrieval, User Interfaces, Library Management, E-library, Image Processing, Electronic Database, Africa

1. Introduction

Digital library, as defined by researchers, is used to refer to a library where some or all of the holdings are available in electronic form, and the services of the library are also made available electronically – frequently over the Internet [1]. Research showed that attempted work on digital libraries began not more than two decades ago, with the 1994 Digital Library Research Initiatives in the US [2] and the 1995 Electronic Libraries programme (eLib) in the UK [2] as those responsible for large scale orderly research and development activities in digital libraries. Moreover, it was phase1 and phase2 of the US projects and phase1, phase2, and phase3 of the eLib of UK digital library initiative projects that played a vital role towards these initiatives [3].

As part of services provided in libraries, librarians in the

1960s through 1970s made use of electronic database to store digital information to be accessed by users, but it was only in the 80s that libraries replaced these versions of database with CD-ROMs. As demand for information increased, electronic information also became broadly available on tapes and CD-ROMs, thus the need for interfaces and Local Area Networks (LANs) [4] became necessary in order to solve the rising issues associated with information selection. As human activities and information sharing further advanced making information sources to multiply rapidly, the importance of these selection processes became even more crucial. In addition to other factors, selection processes applied by users are parameters like links to other information sources, password protection mechanisms, training standards and full-text availability. Traditional means of these selection processes became ineffective as the dynamism of this

electronic information further advanced thus the need for new criterion to be developed and adopted.

In 1990s and from 2000 onwards, Internet access and consortia approach of journals subscriptions diversified the availability of electronic information. Presently many libraries across the world have provisions to get access to electronic data in multiple numbers of ways. With rapid growth in digital information and its access, methods of selecting sources of these information had become complex. As these complexity led to limited alternatives, access and cost became primary factors of selecting these sources [5].

Various research issues in the academia such as collection development and management, organization, information format, storage, search features, retrieval, display format, user interface, networking, and so on, where been introduced by digital library of research projects. Various forms and format of collection of these digital libraries have improved due to the advancement in network technology, image-processing software, telecommunication technology and multimedia software. It became clear that resources and potentiality owned by an organization, a community or even a country cannot be accessed and/or utilized unless digital libraries of such resources are built and maintained.

Over the years, internet technology has made an outstanding impact on academic activities of member researchers across the world. The manner of approach, the way users search for information and the methods with which they use in their research has improved significantly since the advent of this internet technology. The internet provided a powerful alternative to the traditional ways of learning and research and constantly supplying vast amount of new research or course materials. Today, the internet is seen to facilitates universities and other higher institution of learning across the world with thousands thesis and dissertations containing vast amount of intellectual contents. These works are intellectual efforts of huge numbers of researchers across the world that is made used, in not only the institutions of learning but in the commercial world or even the government as well.

Libraries across the world have automated the manner with which they operate and increased the volume of their electronic information over the last decade, but digital library development has been uneven in Africa. The philosophy of the academic library as a passive repository has taken longer to change, and librarians have not had the opportunities to critically reflect on what has been developed, and what their priorities are for the future. A survey was carried out by INASP in 2004 [18] to measure the status of digital libraries across Africa and to draw conclusions on where developments and investments stood for the future, and what is there to be learnt from implementing digital libraries within the continent. This clearly indicates digital libraries are essential tools in both developmental and investment opportunities in and around neighboring Africa [6]. The aim of this paper is to review the need for digital libraries in especially the academia, their application for critical information needs among African countries and some of the major challenges that lies when

trying to establish these digital libraries as a means of bridging the great information shortfall in the region.

2. Related Work

One of the most important initiatives towards propagating knowledge through technology was a project designed by a serious group headed by Edward Fox from the Virginia Tech., USA. As among the first of its kind, Universities and other academic institutions of learning from the US and other parts of the world came to an agreement to publish their thesis and dissertation so that it became available to the world in electronic format. Their effort will letter be a network of digital prints of various researches and will go down in history lanes as one of the foremost generous gesture towards knowledge sharing. The Networked Digital Library of Theses and Dissertation (NDLTD) is one of the most famous digital libraries of thesis and dissertation as presented by the authors in [9]. Some of these electronic thesis and/or dissertations are made available for free while access to others is restricted. Lessons can be drawn here from the principles of agreement which were clearly outlined and documents to be signed are presented to any institution that wishes to join and be part of the member federation. These agreements may not have provided all general public with access to their digital library but it was undeniably a gigantic step taken at that time.

Another important work that will further take knowledge sharing to an advanced phase is a project carried out by computer science department of university of Waikato, New Zealand. They implemented a similar digital library that will index every word in a technical report that has been uploaded to the archive so that it covers most of computer science reports and support different variety of search format. Their work was published in [19] which explained extensively how the approach to which this digital library is constructed can reduce Internet as well as local storage costs. The University of Waikato project was pioneered to explore the potentiality of networked-based digital libraries but then its most fascinating features are the indexing and support for multiple search formats. Today, the project provides user access to over 11,200 research documents worldwide (310,000 pages, 130 million words).

Today the ACM portal and IEEE/IEE Xplore are among the several organizations that operate outside of hybrid libraries which have collections of digital resources that are strictly related to their domain. Both the ACM and the IEEE have and give access to their publications that includes conference proceedings as well. They referred to as the societal digital libraries that include many articles about digital libraries that appeared over the years and their publications were the major outlets for reporting from digital libraries today. Initiatives like these among African institutions of learning can produce surprisingly an astounding record when properly utilized. For example, 403 documents were retrieved when the IEEE Xplore was queried for “digital libraries” and 1,057 resources were retrieved from the ACM Digital Library but not fewer than 25 researches where retrieved on the vast information on

Africa. The authors in [20] described ACM digital Library background and other design principles, while the authors of [21] described the background of IEEE Xplore that also includes extensive information from other articles and websites, hence they can as well share resources with a serious and reputable African library of digital information if it did exist. Africa, with vast resources and very diverse population, can clone a library as big as these two because even researchers came to a conclusion that their design and operations mirror a number of other operational digital libraries.

To further breakdown, this research will review construction and networking of digital libraries among African institutions, some of which roles are played by e-libraries and information decimation in socio-economic development, sectorial information needs and the issues involved in the lack of establishment of these digital libraries. Next section will highlight simple steps on how institutions in African countries can own their network of vast library of knowledge.

3. Design and Implementation

In [14] the author argued that hundreds of universities and academic institutions of higher learning which supports the needs of millions of users in India are far behind in Digital Library access and management, hence proposed 3 simple but guiding steps to building them. Today India, a developing nation, has since moved far ahead in digital networking and computing. This section will look at the simple steps towards developing and networking digital libraries among institutions and/or organizations in African countries.

Phase 1: In this part, world distributed approach will definitely be the best whereby African universities can have their digital library resources accessed by user, both locally and otherwise remotely. The use of common structural database design will provide access to the resources housed by digital libraries located in various institution of learning across Africa, through the use of common user interface [7]. Digital library design and software selection are vital issues, and to start with, this paper proposed the used of simple bibliographic database approach [8], like the modified version of the ones implemented by the NDLTD which suits the African environment as well as provide access to search facilities with abstract and bibliographic details. The software that implements simple text retrieval is best advised, in as much as it can crawl on the web environment and work perfectly. However, the ideal choice for future preference is software that can support full text search capabilities.

The proposed design development in this phase allows user to query for specific local academic institution in the said African country as well as a collection of national or regional data for thesis and dissertations with abstracts and bibliographic details. In order for this approach to succeed efficient document delivery service is needed. The software chosen will determine which of search and retrieved features will be provided [15].

Phase 2: As soon as phase 1 of the project is completed the next step will be to publish these articles provided by the participating African universities online so that users no longer need to go through the time-consuming and expensive traditional method of document delivery service. Making and providing these documents in PDF format will be the simplest approach to providing the resources available online. The PDF file format has a larger advantage since users cannot edit or alter document content and can provide a much smaller file sizes that can contain both text and images together. The resources can be housed on a central location where they can be retrieved and downloaded by users during search sessions or placed on web server that is maintained by each of the member institutions that formed the networked digital library.

It is almost impossible and not feasible for all the previous theses and dissertation produced in the past to be converted to PDF format, since it is resource-intensive to convert paper document to PDF file format [16]. In a situation where the file conversion has to take place; there is need for a policy framework to be drawn in order to effectively make the selection. It is much more straight forward for participating institutions to make clear an instruction that all researchers should submit their work as softcopy which is stored electronically in PDF format. However, this may not be capital intensive for the researchers since most things are now word processed today, and all there is for them is to submit the softcopy of the work along with the hard copies of the theses or dissertations. When the necessary processes related to submission and examination becomes entirely online, it will be completely unnecessary for the participating researchers to submit hard copies of their work. It is worthy to note that the primary purpose for the ETD Project at the Virginia Tech, USA [1] was to replace all of the hard paper copies of their theses and dissertations with their equivalent digital softcopies.

In order to retain the intellectual property rights, access management systems and copyright regulations are considered as soon as the full texts of the theses or dissertations are made available online. Nonetheless, the fact remains that is easy to make intellectual forgery today, therefore it is better to place watchdogs (examiners, supervisors, authors themselves, etc) to keep check of the electronic digital library.

Phase 3: It is very important to provide full text search capabilities once the PDF file format of the theses are made available on the network. Since one has to make a major choice between utility/speed and superiority of the system [17], it clearly becomes a prime policy decision. Today some digital libraries still limit searches on certain selected bibliographic fields and abstracts while many others will provide a detailed or full text search capabilities of these bibliography and abstracts.

Apart from the digital resources provided, sometimes users will require additional access to special collections that varies from subject to subject or from institution to institution. In some instance, local digital libraries are built and in which case, access is given to all or certain selected few users of the

system. This way the numerous researches full of distinctive ideas and knowledge that comes from the said African country or Africans in general can be available for mining locally or to the outside world. The return will however, be immense; research information will be available to the users fast, and this will help African researchers avoid duplication of research efforts and thus preventing intellectual forgery as well as wastage of intellectual resources. The availability and access to vast research resources will further sharpen minds and eventually leads to new ideas and breakthroughs that will benefit the society or the continent at large.

4. Digital Libraries and Education

The ever growing need to assist in finding solutions to problems like environmental degradation, globalization, and hunger had placed Education above all others when it comes to influencing country's projections for human development [22]. The major prerequisite for any social growth is one's ability to read among the population, therefore its absence will place the community on a narrow degree of self-reliance, and the inability of society to actively participate in politics, civil and development activities. Universities are among the few institutions with organization, logistics, skills, resources and network, capable of undertaking quality training in Africa; hence they vested with bigger roles of development above elsewhere [10]. They remain the only capacitated institutions to support the society as well as address national issues like education and health through conducting advance researches [23].

However, the prerequisite condition to a quality research is getting access to updated scientific information. The only way scholars can keep up to developmental disciplines as well as pass on the same to their various students, is if they are well-equipped with intellectual information resources. [23] describes the level of learning which includes basic skills (e.g. literacy, oral expression, and numeracy, problem solving) and content delivery (e.g. knowledge, skills, values and attitudes) to involve information resources if they were to be actualized. There is need for the access to these information resources to support learning activities at schools, universities or research centers if research and education within African countries were to improve. The author of [11] made an observatory survey on some of the major factors that improve a country's education and proved that digital libraries do possess a strategic role amongst them.

The content of dissertations and theses are sincere and intellectual output of logical research carried out by researchers while it's been reviewed as well as monitored by peers that includes examiners, reviewers, supervisors, journal editors and other experts of the said research field before the research results are published. Therefore, it is very important that such intellectual products are recorded properly and then made available to be shared with the public in the area and the rest of the world. Digital libraries that gave access to numerous collections of electronic theses, dissertation and articles in general, are built in several places across the world.

Presently, there still exist uneven gaps within African institutions as regard to these networked digital libraries.

Primarily, the NDLTD was an effort made in order to motivate researches, improve education standard in general and at the same time building a new electronic library and upgrading the resources and services of the existing ones. While educationist are allocating significant effort in sensitizing students on how best they learn from and gain access to these digital libraries, the idea behind NDLTD was not to concentrate on that important issue alone. They do educate student on how best they can prepare electronic articles as well as submit them to these digital libraries. In addition, the NDLTD made clear that the key to solving many academic drawbacks and bridges was to make sure that education itself is turned into a global village by preparing student to work with the world of publication.

It was only after work related to NDLTD had multiplied and their collections largely increased that surveys and analysis was used to determine how Electronic Thesis and Dissertation (ETDs) are used in graduate education among African universities and institute of learning. During the past years of widespread access to digital collection, the number of downloads per work to the number of circulations of the library copy appeared to be extremely poor among graduates of African institutes of learning. Research topics, length, the use of related academic multimedia, access to electronic materials, the profession of those downloading article copies and different types of ETDs usage, are among the additional factors to be analyzed in this context. Survey analysis was not promising for students from an average African university, infact many lack access to this vast digital library of knowledge throughout their academic career. It is undeniable that many great minds that made impact and academic breakthroughs are actually Africans that had the privilege of studying in developed countries with sound education and access to vast academic resources. Hence, one can only imaging the untapped knowledge that could impact Africa and the rest of the world if most Africans were to have sound academic environment with frequent access to the vast electronic resources on digital libraries.

5. Socio-economic Impact

The two world's most critical resources are identified as information and knowledge which are the driving force for any modern economic system and social development [23, 25, 27]. Researchers have made several efforts in trying to prove that both information and knowledge remains the most vital elements to advancement of education, professional development, environmental conservation, research and innovation [24, 23]. The report filed by the World Bank on 1998/1999 World Development clearly pointed out that "economies are built not merely through accumulation of fiscal capital and human skills but on foundation of knowledge, learning and adoption" [22].

The very tool which communities, firms as well as individuals can use in tackling economic and social challenges

with greater success is the combination of information and knowledge as declared in the 2000 G8 Summit [26]. It clearly indicates that whatever effort that has been made to improve the standard of human lives through developmental processes can greatly be a success if the people planning the projects and the beneficiaries create, obtain and made use of accurate information to assess needs, define objectives, set targets and guide the implementation and evaluation process.

[12] described the 21st century as the “Knowledge era” or the “information economy era” which is defined by the level of acquisition, developmental processes, careful storage, the usage as well as the method of sharing knowledge. Information society are created through efficient production, powerful organization, smooth transfer, and retrieval of digital information and its usage in creating new products and services, knowledge and values, as practiced by most world governments in especially the developed countries.

There is no single definition of “development” that is agreed to be used everywhere globally but instead it is used to a large extent in identifying an economic, social and political process which positively impacted an increasing population through improving their perceived standard of living [13]. Thus it implies that development is all about sustainability and positive change in all aspect of human lives regardless of their social class, gender, ethnicity, religious affiliation, age, or geographical consideration. In recent assessments filed by World Bank as reported in [22], Africa keep on experiencing slow developmental processes unlike other regions of the world due to slow educational progress, economic stagnation, high child mortality rate, and spread of diseases.

Quite some factors contributed to the slow developmental processes among African nations. Experts concluded that this is due to lack of accurate, relevant and timely organized information that is vitally needed for activities in many other sectors. [22] reported that all this has resulted in social stagnation, and decline in investment and economic growth. So also the current ongoing “information revolution” that uses huge volume of data and providing efficient knowledge transfer as well as efficient methods of organization to cater for poverty, inequality, environmental degradation among African nations. Countries in Africa can have the capacity of filling the information gaps in its various sectors if digital libraries are put in place to facilitate proper information gathering, processing, distribution, access as well as its application. By so doing African nations can gain from globalization of world economy and speed up the much needed economic, social and political change.

6. Digital Library Initiatives in Africa

The 21st century is characterized as “Knowledge era” and its recent years showed more and more initiatives in promoting access to information in third world countries. Countries around Sub-Saharan region of Africa have benefited from many programmes that will tackle their low gross domestic product (GDP) per capita. This paper highlighted some of the programmes initiated to benefit African region.

- i. Program for the Enhancement of Research Information (PERI). Oxford-based International Network for Availability of Scientific Publications (INASP) initiated this programme that will give sub-Saharan Africa access to electronic information. The major objectives of the programme was to: provide developing countries access to global countries; support the effort made in-country researchers through supporting their publication; and also provide researchers, publishers, and librarians with proper information skills. The programme allow millions of Africans to access many electronic articles by discounting the price in academic institutions in Africa.
- ii. Access to Global Online Research in Agriculture (AGORA). The programme was initiated by Food and Agriculture Organization (FAO) along with major publishers that is aimed at providing scholarship to thousands of agricultural and food science academicians and researchers in developing countries. The programme provides developing countries, including those in sub-Saharan Africa access to digital archives that specialized in the area of agriculture, food, environmental sciences and related social sciences. The AGORA programme currently supports over a thousand journals to institutions in 69 countries.
- iii. Health InterNetwork Access to Research Initiative (HINARI). The World Health Organization (WHO) along with other major publishers initiated this programme to support developing countries in gaining access to health and biomedical articles and other digital materials. Currently the programme has over 3300 electronic journals that are available to medical institutions in 113 countries. The programme is helping many thousands of medical workers in the benefiting countries to improve health or medical practice in the region and across the world at large.
- iv. African Digital Library (ADL). This programme is created by the Association of African Universities (AAU), netLibrary, a US based company that specializes in setting digital libraries for universities and Technikon SA (TSA) which is currently holding large collection of electronic books. The idea behind the programme was to essentially provide Africans with free digital library for both academic and business purposes. The digital library was established in 1999 and its currently holding over 8,000 book titles in its collection.

7. Evolution

The world is witnessing the evolution of accessibility to research materials and university information through various stages, leading to complex yet fascinating inter-library loan programs and catalogs for universally accessible library. As the use of internet further increase in, especially, colleges and universities, technology further advanced to support URNs better, it is now easier to migrate to fully functional digital

libraries. In the federated search and multilingual access however there still remain challenges. As universities braced forward in an effort to improve education as well as collaborative initiatives, networks like the NDLTD are likely to evolve along with technology itself.

In order to facilitate distributed processing, information processing, high-speed networks, user interface, storage and retrieval, geographical distribution, security, high quality presentation and perpetual availability of digital information, digital libraries must depend on ICT infrastructure [28]. In order to fully operate functional digital libraries, it is necessary for libraries around African region to start embracing and the use modern ICT as another alternative to providing a better information services.

The design and maintenance of digital libraries anywhere across the world consist of huge financial investment in digitization and computer servers, information retrieval using network infrastructure, electronic information resources itself and library staff training on digital library management skills. With the ever-changing media technology, there will always be costs of continued upgrading of the digital infrastructure. There is need to maintain parallel conventional and digital system due to the uncertain nature of information and communication technology infrastructure in Africa [29, 30].

[31, 32] feared that this technology of digital libraries will only further consolidate information power to few individuals and further increase the information gap that exists between countries. Their fears can be supported since it is only in major cities and reputable academic and research institutes that digital libraries are currently located in Sub-Saharan Africa. Also, [29, 30] both argued that accessibility to modern ICTs falls on only few privileged category of citizens due to their high costs. In Africa the general fear is that communities might lose out in the information society due to the lack or limited accessibility of telecommunication lines, computers and internet connection and supply to the large majority. There is going to be hostile isolation and disempowerment of some of the ethnic minorities, youths and women, as well as rural communities if the issue of democratic and equitable access to information is not adequately and sincerely addressed. It is the duty of governments, professionals and other stakeholders in Africa to recognize the issue as a threat and come together to squarely address the problem of digital divide within groups and communities in the region.

Among the major problems faced by libraries across Africa in a bid to port to digital mode is the limited financial support to adequately build collections, to train or hire qualified staffs, and setup installations and buildings for modern information technology. Due to the weak and, in some cases, deteriorating economic stability within Africa, the funding and maintenance of modern libraries within the region is bleak. Most sinister is the lack of governments as well as the communities to accept the process of centralizing information to become a major factor in driving economic and social progress of the communities in the region. It is also important for these regions to recognize library services as efficient way of providing equitable access to information, hence embrace the

culture of building modern libraries. It is no secret that there has always been marginalization of these modern libraries which led to the critical loss in confidence from different stakeholders in the domain. This has further stall or jeopardize the ability of modern libraries of information to make contributions in nation development processes. Yet again, governments within the region can reverse the trend by making a deliberate move to improve infrastructure and come to head with committed players, stakeholders, as well as various development partners.

In light of all these, it is clear there is need for traditional library education to evolve in other to make possible the huge investment in digital libraries by professionals. There is need to train information professionals in the management of electronic information by giving them skills such as designing and administration of electronic networks, electronic reference services, skills for electronic information literacy teaching, and evaluation of internet information. Even more important would be training in digital library management activities such as supply models, searching, downloading, document delivery, archiving, software, copyright, licensing and managing and access. at this time, one can say building digital libraries is rather expensive but yet still, the components that generally made up the technology are fast becoming cheaper by day. Therefore it is very crucial that African countries seizes the opportunity and invest in digital libraries now so that communities can reap its long term benefits.

8. Conclusion

For years, libraries across the globe have doubled their reliability in electronic holdings, increased and further organized their digital materials, as well as automated the operations performed with the electronic information, but within African communities the digital development has left an uneven gap. The idea of modern libraries becoming passive depository is taking longer to change, thus leaving researchers, librarians and other academicians with no prime knowledge of what has been developed and what are their future lines of action based on priority. With the growing concerned brought by these electronic medium, such as socio-economic impact, trans-border education and trade, there is crucial need for solutions on how to propel African nations to operate in phase with this technology age.

This research was aimed at showing the gradual increasing speed in distribution of Digital libraries and ICTs across the world and as it relates to Africa. It clearly shows that institutions and research communities across Africa are no longer stagnant and strictly local but have steadily started going global. Nevertheless, in a global neighborhood, large work needs to be done in order for African nations to use information in harnessing their full potentials. It is essential that key players come together as a community and hold a conversation with a shared sense of participation and responsibility. Not only did the research advised on the importance of participation in conversation but also outlined

the steps that can be taken by governments, academic institutions, cooperates, professionals, communities and other stakeholders, if the continent were to harness its potentials through accessible information sharing and use it to improve standard of living within the region.

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