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Innovative Technologies for Enhancing Knowledge Access in Academic Libraries

Tlou Maggie Masenya

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institutions. This chapter provides a general overview of the experiences of school libraries in a selected district in Manicaland, Zimbabwe. It highlights how the digital divide disadvantages school libraries that are resource famished. Using a qualitative methodology, the chapter interrogates how the adaptation of social media platforms has helped school libraries to contribute towards learning amidst the complications of the COVID-19 pandemic.

Searching and retrieving relevant research materials from electronic databases are difficult for many students and early career researchers. Many researchers have abandoned beneficial research projects because they believe that related literature is unavailable to ground their work. This chapter serves as a guide to students, professionals, and internet users on how to pull information from electronic databases easily. The chapter begins by clarifying the concept of electronic databases, the evolution of electronic databases, and the processes involved in indexing scholarly works in an electronic database. The advantages and disadvantages associated with the use of electronic databases are also discussed. The chapter describes how electronic database search works, with insights into some poor practices. The concept of Boolean operators and how they can be used to easily mine desired contents from electronic databases are discussed. The knowledge and use of Boolean operators might become unavoidable in enabling researchers to locate relevant materials for their projects.

Dissemination of the literature is crucial in scholarship for it to meaningfully contribute to development. The establishment of the Open Archives Initiative and the BOAI transformed the scholarly communication landscape. Open access institutional repository (IR) is one innovative technology through which scholarly literature can be made freely available and accessible to the public. Academic libraries across the globe, including Africa, embraced and established IRs to enable cost-free access to their institutional research output on the internet, thus increasing its global visibility and reach while ensuring long-term preservation of the intellectual output. This chapter explores the role of open access repositories in enhancing access to information and knowledge generation in academic libraries, catalogues the success of IRs in Southern Africa, and ascertains the challenges faced by universities in Southern Africa in the establishment and management of IRs.

Integrating artificial intelligence (AI) into Library and Information Science (LIS) curricula is gaining momentum as scholars engage on the subject. Lots of research publications have emerged on AI in LIS. This chapter conceptualized a theoretical framework that should underpin the AI curriculum for University of Eswatini. The study is anchored on the interpretive research paradigm, which surrounds a systematic literature review. This conceptual study was preliminary, and the researchers hoped that further empirical studies based on the findings of this study could be pursued in the future. This chapter, therefore, addresses the following issues: rationale for integrating AI in the curricula of the University of Eswatini, a theoretical framework for AI curriculum, and prospects for integrating AI into the curricula of the University of Eswatini.

Globally, the role of academic librarians as online teachers at higher education institutions is experiencing a tsunami of change. This is due to the Fourth Industrial Revolution and the influence of technology on pedagogy. The 21st-century academic librarian is challenged to adopt innovative teaching methods using technology in a digital environment. The purpose of this study was to explore the pedagogical and technological preparedness of academic librarians at University of Technologies in South Africa for online teaching. The technology pedagogy content knowledge framework guided the methodology in exploring the pedagogical and technological preparedness of academic librarians. A pragmatic approach using quantitative techniques was used in the data collection process. The data collected from the findings were analyzed and validated resulting in emerging themes. The results show a lack of pedagogical and technological skills among academic librarians at UOT in South Africa.

Preface

Knowledge is considered as a fundamental resource, and it is critical to the long-term sustainability and success of any organisation. Information also played an important role in the world today. Academic libraries serve as reservoir and repositories of knowledge and information from all fields of learning to ensure that knowledge remain accessible and available to users and future generations of scholars. Most of the academic institutions, globally are thus realizing that knowledge is their greatest competitive asset and a key strategic resource of the future. The new normal environment has also repositioned library's operations, services and user's expectations. Academic libraries are now providing online or digital services to meet users' needs during this COVID 19 era. There is thus a need for proper management of knowledge and information resources to ensure the library's ability to function effectively and provide documentary evidence of scholars and citizens, and to improve library service delivery. Innovative technologies have transformed the way knowledge and information have been managed across different organisations and are easily making knowledge accessible from anywhere. Inclusion of all these newer technologies have shown the fast pace at which the digital transformation is rapidly evolving. Academic institutions, across the globe, have embraced digital transformation in order to meet information needs of library users in the digital era, characterized by globalization and knowledge-based economy. This transformation necessitates a need for best practices, reimagine strategies and implement innovative technologies for managing and preserving knowledge in academic libraries to ensure a sustainable knowledge access and increase knowledge sharing.

Increasing number of academic libraries and Information centres worldwide are thus positioning themselves by actively implementing knowledge management systems and innovative technologies to provide their patrons with high-quality information in a reasonable time. These institutions are increasingly adopting digital technologies such as Internet of Things (IOT), LibChain, Cloud computing and Blockchain in creating, organizing, storing, managing, disseminating, preserving, enhancing access to their vital knowledge and deliver their services more effectively and efficiently. The key areas of digitalisation and global challenges that are faced during digital era and COVID-19 pandemic period is new and unique, and thus requires new knowledge that is gained from a deep understanding of complex issues. The overall objective of this book is to determine the role of innovative technologies in enhancing knowledge access in academic libraries in the digital era. Although these modern technologies have the potential to revolutionize information services delivery in libraries, however, adopting these technologies can be a daunting task as many libraries and information centres are faced with the challenges of fully incorporating emerging and innovative technologies in their libraries. The process for knowledge management and strategies for digital transformation is therefore not straight forward and is rather complicated. This book shares diverse reflections, practical experiences and perspectives drawn from scholars and researchers globally, on the subject matter related to the application of innovative technologies in the management, preservation and enhancement of knowledge access in academic libraries. It will serve as a valuable and useful tool for many researchers and it will provide the students, records managers, archivists, information specialists, knowledge managers, ICT professionals, policy makers, system analysts with state-of-the art knowledge on the adoption of innovative technologies in managing and accessing knowledge and to learn about new trends, technologies, innovations and developments in digital transformation of libraries from a global perspective.

ORGANIZATION OF THE BOOK

A brief description of each of the chapters follows:

Chapter 1, "Futurizing Library Services in a Technology-Driven Dispensation: Reflections on Selected Academic Libraries in Zimbabwe and South Africa," focuses on futurizing academic libraries through technology adaptation and the application of modern technologies such as Internet of Things (IOT), Blockchain, Cloud computing, etc. in enhancing knowledge access, in providing effective services to their users and to extent their relevance in this digital era. these technologies have brought about transformation in the way library services are delivered. Innovative technologies have brought about transformation in the way library services are delivered and can revolutionise library practices and information service delivery.

Chapter 2, "Academic Libraries Innovation Through a Business Model Canvas Lens: A Case of South African Higher Education Institutions," explored the value of the business model canvas in supporting digital libraries in South African Higher Institutions and creative digital services to internal patrons such as students, academics, researchers and external patrons such as policymakers and industries.

Chapter 3, "Contemporary Trends and Technologies in Research Libraries: An Overview," discusses some of the contemporary trends and emerging technologies in research libraries including big data, blockchain technology, podcast, vodcast, data everywhere, drones, robotics and artificial intelligence (AI) technology, unplugged, makerspace, and the Internet of Things (IoT). The book chapter will provide insights and support for academics, records managers, knowledge managers, librarians, archivists, computer scientists, Information Technology specialists, data curators and policy makers in the above-mentioned fields.

Chapter 4, "Infusion of Digital Technologies in the Sustainability of Academic Libraries: Opportunities and Threats," investigated how digital technologies could be used in the sustainability of academic libraries through accessing, processing, gathering, manipulating, presenting and communicating information in different format such that library users' information needs are met. Digital technologies such as smartphones, ebooks, blogs, social media, digital computers, scan machines, digital cameras, robotics, drones etc. are adopted by academic libraries to support their information services.

Chapter 5, "Knowledge Organisation in Academic Libraries: The Linked Data Approach," discusses the introduction of Linked Data in the organization of knowledge in academic libraries and how academic libraries can use the advantages of Linked Data technologies in the organization of knowledge to increase availability of library resources on the World Wide Web. Findings indicated that academic libraries that adopted LD increased the visibility of their products on the internet.

Chapter 6, "A Digital Library for Researchers, Scientists, and Scholars: Mendeley Desktop Application," discusses the application of Mendeley desktop in academic and research libraries, and the importance of Mendeley desktop application as a digital library as compared to a traditional library. This chapter provides an extensive guide on how to work with the Mendeley Application to perform various tasks and should thus enable anyone without prior knowledge of Mendeley to effectively utilise it as a digital library.

Chapter 7, "Implementation of SharePoint Platform as a Record Management System in Universities," assesses the advantages and disadvantages of implementation of the SharePoint platform as a records management system at South African universities. The research found that implementation of SharePoint platform as a records management system requires universities to assemble a records management team with skills and knowledge on archives management and information communication technologies, organisational culture, collaboration of divisions, departments, and units of universities.

Chapter 8, "Social Media and School Libraries in the Wake of the COVID-19 Pandemic: General Overview of Schools in a Selected District in Manicaland, Zimbabwe," provides a general overview of the experiences of school libraries in selected district in Mutare, Zimbabwe. It highlights how the digital divide disadvantages school libraries that are resource famished. This chapter interrogates how the adaptation of social media platforms has helped school libraries to contribute to learning amidst the complications of the COVID-19 pandemic, using a qualitative methodology.

Chapter 9, "A Data Mining Algorithm for Accessing Research Literature in Electronic Databases: Boolean Operators," serves as a guide to students and researchers on how to easily pull information from electronic databases and it describes how electronic database search works, with insights into some poor practices. The advantages and disadvantages associated with the use of electronic databases, the concept of Boolean operators and how they can be used to easily mine desired contents from electronic databases are also discussed.

Chapter 10, "Adoption of Institutional Repositories Towards Realization of Digital Libraries: The Southern African Perspective," explored the role of Open Access Repositories (OAR) in enhancing access to information and knowledge generation in academic libraries, it catalogues the success of Institutional Repositories (IRs) in Southern Africa and ascertain the challenges faced by universities in Southern Africa in the establishment and management of IRs.

Chapter 11, "Supporting Data Preservation Through Institutional Repositories of the Academic Libraries in South Africa: A Case Study of Three Academic Libraries," investigated the use of Institutional Repositories (IRs) in preserving data at selected academic libraries in KwaZulu-Natal province, South Africa, guided by the Digital Curation Centre (DCC) Lifecycle Model. A lack of resources is the biggest threat to preserving data for most academic libraries. The findings show a strong need for training and workshops to equip the librarians and researchers with the necessary skills and knowledge for preserving data in the IRs.

Chapter 12, "Application of Blockchain Technology for Distributed Management of Digital Research Library Holdings," discusses the distributed management of digital research library resources through blockchain technology. It explains the meaning, features and components of blockchain technology. Concepts such as distributed library management and digital research library were clarified. The digital research library materials were highlighted and how they can be managed. The chapter thus argues that blockchain technology can be used in the distributed management of digital research library resources.

Chapter 13, "Adoption and Maintenance of the Next Generation Integrated Library Systems (ILS) in Academic Libraries," investigated the adoption and maintenance of next -generation ILS in academic libraries and reviewed literature published between 2016 -2022. Roger's Diffusion of Innovation (DoI) was used as a framework to examine ways of understanding and accepting new technologies. Existing research indicates that academic libraries in South Africa are using next-generation ILS to ensure interoperability between the various systems, platforms and devices that are part of modern library systems. Despite its potential benefits, there are significant barriers to the widespread adoption of next-generation ILS in academic libraries

Chapter 14, "A Framework for Integrating Artificial Intelligence Into Library and Information Science Curricula," addresses the rationale for integrating AI in the curricula of University of Eswatini, a theoretical framework for AI curriculum and prospects for integrating AI into curricula of University of Eswatini.

Chapter 15, "Digital Pedagogies of Academic Librarians in the Fourth Industrial Revolution," examines the pedagogical and digital skills of academic librarians at University of Technologies (UOTs) in South Africa. The Technology Pedagogy Content Knowledge (TPACK) framework guided the methodology in ascertaining the pedagogical and digital skills of academic librarians. The results show a lack of pedagogical and digital skills among academic librarians at UOT's in South Africa.

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I would like to acknowledge the help of all people for making a valuable contribution to this book, "Innovative Technologies for Enhancing Knowledge Access in Academic Libraries". I thank all the authors for sharing their valuable insights, knowledge and considerable expertise. Without their contribution, this book would not have become a reality. The accomplishment of this intellectual discourse would not have been possible without the support and commitment of reviewers drawn from different countries but not limited to India, Nigeria, Zimbabwe, Pakistan, Botswana, Swaziland, Lesotho and South Africa. I appreciate their thoughtful comments, and efforts towards strengthening the quality of the book and for the priceless commitment and dedication that added value to the book. Their generous support, commitment to meet review deadline and time taken out of their very busy schedule is much appreciated. The book went through a vigorous blind-peer review and editing by professionals in accordance with the best research practices and global ethical standards. This book has brought all researchers together from different parts of the world, and we have a valuable working relationship and we became very close colleagues in this journey. I look forward to working with this great team again in other future projects. I am greatly indebted to IGI-Global development team for their technical and managerial support throughout all the stages of publishing this book. This publication would not have been possible without their persistent help.

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Section 1

Digital Innovation in Academic Libraries

Chapter 1

Futurizing Library Services in a Technology-Driven Dispensation:

Reflections on Selected Academic Libraries in Zimbabwe and South Africa

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ABSTRACT

Many libraries and information centres are faced with the challenges of providing effective services to their users in the digital era. Modern technologies such as internet of things (IOT), blockchain, cloud computing, just to name a few, have brought about transformation in the way library services are delivered and are providing libraries with an opportunity to extend their relevance in the digital era. These technologies have the potential to revolutionize information services delivery in libraries and how libraries interact with each other in networked environments. Academic libraries are thus positioning themselves to take the advantage by implementing these innovative technologies to provide effective services to their users. This study reviewed related literature on futurizing academic libraries through technology adaptation to analyse the application of emerging technologies in the provision of electronic library services with the view to highlight how these technologies can revolutionise library practices and information service delivery.

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INTRODUCTION

Before modern digital technologies, library books, journals and other printed resources were kept on shelves and accessed by consulting catalogue cards in catalogue cabinets. The emerging technologies are transforming the way libraries operate from the analogue to the digital paradigm. Library information resources continue to increase in multiple forms and formats: printed, audio-visual, electronic, and multimedia formats. Bhat, Rao and Pai (2014) stated that electronic resources(e-resources) had become an inseparable part of libraries and researchers because they provide an enviable comfort that their print counterparts failed to provide. The emergence of modern technologies has transformed library information service provision for the benefit of users irrespective of time and space. Rehman and Mujtaba (2021) argued that rapid, dynamic and innovative changes in the technological sector and globalisation continue to drive the digital revolution in libraries. The adoption of modern technologies is changing every aspect of the library, for example, acquisition, processing, storage, retrieval and dissemination of information. The storage of information resources is now digitally driven, kept in data centres and accessed via the Internet to aid large information storage and ensure flexibility in access and retrieval (Adetoro & Ayeni, 2020). Therefore, today's library information services provision ensures access to electronic or digital resources. However, there can be a delay or no access to these resources if they are not adequately organised. Academic libraries are thus playing a significant role in providing access to credible digital resources, organising them and helping users locate, discover, retrieve, utilize, reproduce or produce and share information they need.

Atkinson (2020) highlighted that innovative library technologies now typify the fifth generation of libraries powered by fifth-generation technologies. For example, self-service technologies, online repositories, mobile or wearable devices and social media have become the order of the day. Academic libraries have moved from collections-based to service-based institutions focusing on research data management, bibliometrics, open access presses, virtual reference services, and digital and metaliteracy. Atkinson (2020) also noted that while libraries have transitioned from physical to online collections and the provision of access to an increasing range of electronic resources, they continue to encounter opportunities and challenges in areas such as the adaptation of the technologies of the Fourth Industrial Revolution (4IR), for example, artificial intelligence, the Internet of things and wearable technologies. Ashiq, Madge and Robu (2019) further observed that the technological revolution in the twenty-first century had contributed immensely to shaping library users' expectations, preferences, and behaviors. Benedetti et al. (2019) also highlighted the need for libraries to adopt new skills for change management in an era of Volatility, Uncertainty, Complexity and Ambiguity (VUCA) and the need to be relevant in the digital era. The VUCA phenomenon and digital trajectory demand librarians to leverage their mental alacrity and highly sought-after critical skills for engaging with new technologies and the dynamic needs of diverse users and an appreciation of emerging technologies to move the library profession forward.

Preparation for technological developments requires a *future thinking* approach in order to unearth the inclinations and dynamics manipulating the present moment and that are creating the future (Schlak, 2020). According to the author the futures thinking approach aids librarians to recognize and strive toward a future that will reflect our choices and is informed by stratagems to discover alternatives, possibilities, and choices in the era of technological progress. The library collections of the twenty-first century continue to evolve due to technological change and this justifies the need for futures *thinking.* The futurization of academic libraries is necessary for an era whereby the change is the only constant thing. Sarfraz, Sarfraz, Iftikar and Akhund (2021) argued that the rate at which information was being processed and made available in larger volumes than it was in the twentieth century would soon overwhelm and render 4IR technologies incapable. Sarfraz, Sarfraz, Iftikar and Akhund (2021) further noted that the COVID-19 pandemic and infodemic was likely to steer the world into the next industrial revolution creating Society 5.0 or Fifth Industrial Revolution (5IR), whereby the amount of information may be impossible for processing by Industry 4.0 technologies. However, it should be noted that there are still libraries grappling with embracing the digital transformation because of the digital divide. Tanner (2009) urged libraries to rethink the digital divide and further described the digital divide as the lacunae between those with effective access to digital technologies and those without. The digital divide can be attributed to the lack of material resources concerning access to hardware and software, lack of technical infrastructure (connectivity and power), challenges of usability (Information technology skills) and the limitations of the paywall (Tanner, 2009). The study aimed to determine how academic libraries adopt modern technologies and how these technologies are revolutionizing academic libraries in selected academic libraries in Southern African countries. The study focused on selected libraries affiliated with the South African Library and Information Consortium (SANILAC) and the Zimbabwe University of Library Consortium (ZULC). Using purposive sampling, four academic libraries were selected from SANILAC and two from ZULC. The criterion for inclusion in the study was based on the ranking of the academic library's parent university on SCIMAGO in 2022. The SCIMAGO Institutions Rankings (SIR) is an academic and research-related ranking that combines three different indicators based on research performance (50%), innovation outputs (30%) and societal impact (20%). These indicators are measured by the visibility of the institution on the web using the Scopus database (University Institute of Lisbon, ISCTE, 2022). SIR is defined as a rating agency that syndicates three different indicators, namely, based on performance: research (weight 50 per cent), innovation results (weight 30 per cent), and social impact (weight 20 per cent) as measured by web visibility (SCIMAGO, 2021). South Africa has 23 Universities on the SCIMAGO Institutions Ranking (2022), while Zimbabwe has 2, namely, the University of Zimbabwe and the Midlands State University.

STATEMENT OF THE PROBLEM

Academic libraries serve as the nerve centres of academic institutions, and as such, they should be seen to lead to the adaptation of emerging technologies that enhance service delivery. The future provides academic libraries with the world over with an opportunity to leverage their services in support of teaching, learning and research. However, the lackadaisical approach in planning for the digital transformation era might result in libraries losing their lustre as the first choice for access to credible and reliable information. While there is a myriad of digital platforms providing because of the proliferation of digital platforms performing the same functions faster. The onus is on academic libraries to rethink and re-strategise the progressive way forward. McGills (2016) highlighted that the key challenges being experienced by libraries related to the ability to engage potential modern users and to provide them with the necessary information. The modern academic libraries face the long-term challenges of technological impact, leadership, education, digitisation, scholarly communication, support for modern learners and funding. However, these challenges provide a fecundated ground for librarians to think without a box by resetting, rethinking, reprofiling and strategizing the way forward in an era of constant change. The evolution of libraries has progressed through three stages: modernisation, automation, and digitization (Nahak & Padhi, 2019). Similarly, library materials have also evolved from stone tablets, clay tablets, papyrus, cuneiforms, books, CDs, microforms, e-books, database resources, and open access to virtual resources (Orji & Anyira, 2021). The technical progress of libraries is now being shaped by emerging digital technologies, including smart technologies.

Ashiq, Rehman and Mujtaba (2021) bemoaned that the traditional armchair culture, mindset and insouciant_librarianship continue to inhibit innovation and creativity among the techno-savvy young professionals. The latter expect higher standards of library services. Technological developments should thus be viewed as opportunities for creativity and innovation within constant technical progress. Many libraries and information centres have increasingly adopted modern technologies to provide effective library and information services in digital environments. Academic libraries have also grasped the opportunities presented by applying new technologies to revolutionize the technical processes required to deliver services and are taking advantage of new technologies to make the library collection available to users anywhere, anyhow and anytime. The majority of academic libraries are now 'hybrid', combining physical space and collections with a virtual library of electronic materials and services, and are among the most advanced in developing electronic-based services. The adaptation of modern technologies allows libraries to provide users with better service by offering user-friendly access to what they want, when they want it and how they want it. Libraries are thus expected to use various types of emerging technologies to provide services more quickly and in greater volume than before. During the second half of the twentieth century, libraries started providing access to information in electronic formats such as CD-ROMs, World Wide Web and online databases, and the Internet became the primary platform for libraries to build and deliver information resources, services and instructions, since the 1990s (Mayega, 2008). Uddin and Hasan (2012) noted that new technological developments have profoundly affected libraries. Almost every function in a library has been altered by advances in electronics, computerization, and telecommunications. With these new trends, the libraries have, therefore, changed from printed collection to Web-based publishing platforms for digital collection; reference desks have been changed to Online Reference Service Web 2.0, manual indexing and bibliographies have been changed to full-text databases; manual library catalogue changed into web-based Online Public Access Catalogue or web OPAC, manual sharing of information changed into the networking of libraries and inter-library loan service changed into digital Interlending and document delivery of information, to name a few. However, this transformation has brought a challenge in the field of library information services with regards to the processes and procedures of dealing with the ever-increasing complexity of information, differentiating useful information from misinformation and fulfilling the growing, complex, dynamic needs and expectations of the users (Mayega, 2008).

As observed by the Council of Canadian Academies (CCA) (2015), libraries and related institutions are experiencing numerous challenges in adapting to the digital age. These include dealing with but are not limited to the rapid obsolescence of the technology currently in use, making accessible mass quantities of digital data and maintaining trustworthy of the repositories as special databases that hold documentary evidence of scholars and citizens (Council of Canadian Academies, 2015). Generally, for digitally competent library users, e-resources are relatively easy to discover, locate and retrieve, depending on the nature of the user interface. The aforestated resources possess significant research value to the researchers, but they can be cumbersome to catalogue, manage and administer and librarians still grapple with managing them. Librarians need to develop a set of critical skills and competencies in order to perform successfully in the digital era. The adoption of modern technologies will also depend on the digitisation programmes and the motivation and attitudes of librarians and information professionals. Adebayo (2013) argued that the overabundance of robust information found on the Internet obliges librarians to be technologically apt in organising the content and strategizing on the *modus operand* on how it can be integrated onto institutional databases and OPACs. The research objectives formulated for this study aimed to:

- Determine the application of emerging technologies in selected academic libraries in Southern African countries;
- Review the development of institutional repositories in selected academic libraries in Southern African countries;
- Determine the role of maker spaces in promoting the use of modern technologies in academic libraries; and
- Make recommendations on how academic libraries can manage technological change.

APPLICATION OF MODERN TECHNOLOGIES IN ACADEMIC LIBRARIES

Libraries are expected to add value to the products and services by facilitating access through the implementation and adoption of modern technologies, making information more logically organised and easier to find, discover, retrieve and share. Enakrire and Ocholla (2017) asserted that modern technologies affect the organisation and access to library information resources. Emerging technologies facilitate the provision of information resources in various forms and formats, including printed and electronic. Saeed and Rafia (2014) stated that emerging technologies could increase the efficiency of information retrieval and stock verification, document digitisation, and circulation control within university libraries. Therefore, modern technologies should be implemented for digitisation and quick information retrieval and better service to the client. With the rise of electronic resources and innovative technologies, academic libraries interested in enhancing user services and providing access to library services and collections have begun to look at ways of creating online communities. Nowadays, many academic libraries have sophisticated searching tools available to students and faculty. The technology-based library services can increase library quality with higher accuracy, consistency, and space-saving. Online catalogues have also revolutionized how materials are made available and accessible in the digital era.

The automated library is now becoming a trend to provide fast services due to this rapid technological change. The trend of technology in the library has reflected many opportunities and made the academic library a fully automated library nowadays. An automated library provides effective services to users while also saving their time. Many companies provide technologies for the library in big countries such as the United States and China. For example, Bibliotheca, a western transforming libraries company, has made efforts in a particular field, including self-service, returning and sorting, open plus library access, cloud library, holds pick-up locker, security and detection, staff tools and library supplies. The need for effective library services thus calls for academic libraries to adopt modern technologies such as web-based Online Public Access Catalogue (OPAC), Web 2.0, Internet of Things, Blockchain, Cloud computing and the development of Institutional Repositories (IRs).

Web-Based Online Public Access Catalogue

Moran and Morner (2017) noted that developing the latest information organising tools is imperative to pinpoint issues about strategies for the organisation of hybrid information sources in the academic library environment. These include the utilisation of the latest developments in cataloguing and classification tools and their impact on cataloguing information resources, policies about the cataloguing processes of library resources and possible measures that could be put in place to improve the effectiveness of the cataloguing of library information resources (Ifijeh, Segun-Adeniran and Igbinola, 2019). Lazarinis (2014) defines cataloguing as the sum of all practical operations a cataloguer undertakes to organise documents and their description to be efficiently located, discovered, managed, identified and accessed. The cataloguing process enhances the creation of metadata found in a library using standardised cataloguing tools to achieve the bibliographic description, authority control, subject analysis and assignment of classification notation to generate a library catalogue (Park & Morrison, 2017). The cataloguing process takes place in two forms: original cataloguing and copy cataloguing. Original cataloguing refers to the preparation of a bibliographic record from scratch without a pre-existing catalogue record for the same edition of the same manifestation, which is usually time-consuming for the cataloguer since the cataloguer must record all the bibliographic information of the manifestation (Kim,2003).

Over the past decade, an increasing number of academic libraries have been replacing the traditional card catalogue as a means of access to their collections and switching over to OPAC. Library users can thus be served much better if they can have access to other library collections through resource sharing and electronic databases such as the Online Public Access Catalogue (OPAC) (Buchholz, 2011). OPAC has revolutionized how materials are made available and accessible in the digital age. Fabumni and Asubiojo (2013) define Online Public Access Catalogue (OPAC) as an interface of an information retrieval system which assists information searchers in accessing library resources using several access points. OPAC, or simply a library catalogue, is a digital database of materials such as text files, e-books, journals, etc., held by a library or group of libraries. It is concerned with searching for and retrieving bibliographic records of information items instead of full-text of the content of resources (Fabumni & Asubiojo, 2013). Library users can now search for information from their desktops and download e-books onto their PDA. Full-text retrieval of information sources is becoming commonplace, and services increasingly become personalised and paid for. Nahotko (2020) categorised the historical development of OPACs into seven (7) generations beginning in the 1970s to the twenty-first century, as illustrated in the table below:

The fourth to the latest generation of OPACs known as Web OPACs has evolved from the first generation to an expanded generation, reflecting changes in functionalities, technologies and interface (Nahotko, 2020). Information literacy (IL) and meta-literacy skills are a pre-condition for effective use of OPAC, enabling information users to formulate successful search strategies, locate information sources, and use acquired information effectively and ethically. In assisting users to achieve such goals (Ndumbaro & Kassim, 2021). OPAC displays the query search results in an easy-to-understand format to enable patrons to find digital material quickly. With the help of OPAC, users can check the availability of any library material on the Web without leaving the place. It informs the library users whether the required material is available or not. It is, therefore, clear that the use of various information technologies in the organisation of library resources by cataloguers can save them time while library resources are made available and more easily accessible (Ntui, Robert & Usang, 2017). Online Computer Library Centre (2011) also noted that the use of Online Public Access Catalogues (OPACs), computerised cataloguing and classification standards make the processing and organisation of library collections more accurate, exciting and faster. OPACs allow searching for any word in a title or other field, thereby increasing the ways to find a record (Eserada, Okolo & Ideh, 2019). The descriptive cataloguing and subject headings thus help users search books in the OPAC. For example, the Durban University of Technology uses a

Table 1. The evolution of library OPACs

Generation	Year	Characteristics
First generation	1970s-1980s	Mainly used to search for previously known items according to a limited number of basic metadata attributes, such as author, title, and call number or possibly subject headings.
Second generation	Late 1980s	Second generation (late 1980s) were underpinned by solutions offered by commercial providers, providing integrated systems (ILS) for library management. This generation of OPACs provided such functionalities as subject access, keyword access, Boolean searching, index term browsing, shelf list review, full standard bibliographic records, multiple display formats among others.
Third generation	From 1996	Third generation of OPACs (from 1996) aimed at building on the weaknesses of earlier generations by incorporating new interface techniques and search tools to enhance discoverability.
Fourth generation	Late 1990's	Web OPAC are characterised by the use of many tools typical for the Web, such as the graphical user interface (GUI), sharing resources using the Z39.50 protocol, hypertext (links) and the ability to process metadata in various formats including, MARC and Dublin Core.
Fifth generation	From 2000	An extension of Web 2.0 enabling integration of the library OPAC with CMS (Content Management System),
Sixth generation	2010	An extension of Web, 2.0 integrates library OPAC with Content Management Systems.
Seventh Generation	From 2010	Commonly known as (Linked Open Data, LOD), includes a set of good practices and rules for interlinking machine-readable data sets using URIs and the RDF metadata schema to display, disseminate and merge data in a Web environment.

(Nahotko, 2020)

free app library catalogue called "bookmyne" that makes it quick and easy to access library services and helps library users search the library catalogue and access the library resources without physically appearing in the library. Library users can check what the library has on loan through the bookmyne app and can also renew items that they have borrowed and extend the due date if they still need to use the item. Library users can also communicate with librarians if the book or item is checked out, and they can place a hold and get it when it is back.

Resource Description and Access

Resource Description and Access (RDA) is an entirely new standard developed by the Joint Steering Committee (JSC) that provides proper structure and guidelines to cataloguers so that the bibliographic records they produce can meet the challenges posed by digital information resources (Ducheva, 2016). It was designed as a content standard for the digital world to replace AACR2, serve the print environment (Yuling, 2018), and assist cataloguers in describing better and providing access to various types of content and media. The concept of RDA is premised on the Functional Requirements for Bibliographic Records (FRBR) in order to relate the user task of retrieval and access in an online library catalogue and biographic database from a user's perspective. The model is noteworthy because it is separate from specific cataloguing standards such as Anglo-American Cataloguing Rules (AACR) or International Standard Bibliographic Description (ISBD) Functional Requirements for Bibliographic Records (FBRB, 2019). The development of RDA, FRBR and other related initiatives permits library holdings to be visible on the Web to be discoverable by users on a wider scale (Sprochi, 2016).

Dunsire, Fritz and Fritz (2016) confirmed that RDA served a special purpose in information discovery because of its package of data elements, guidelines and instructions for creating library and cultural heritage resource metadata that are well-formed according to international models for user-focused linked data applications. These guidelines and instructions govern resource description and choice and form of both authorized and variant access points. Ifijeh, Segun-Adeniran and Igbinola (2019) further stated that RDA aids in simplifying cataloguing rules and transforming cataloguing by bringing it in line with 21stcentury web technologies. It is, therefore, the main goal of RDA to provide the opportunity for all librarians to be involved in the evolution of cataloguing practice, especially in terms of who does the cataloguing and how it is done. The global use of RDA has an important effect on union catalogues as it enhances and supports the creation of consistent metadata content among metadata organisations and library consortia responsible for sharing cataloguing services, copying local metadata to a central catalogue, harvesting metadata from local repositories and defines who can contribute cataloguing to union catalogues (Haynes, 2018). This is because RDA provides instructions and guidelines for descriptive catalogue records that meet the needs of centres that provide any resource cataloguing, whether locally or internationally. Therefore, understanding the basic RDA rules is essential because RDA reaches beyond the earlier cataloguing codes by providing guidelines for cataloguing digital resources and emphasises helping patrons find, identify, select and obtain the information they need.

Dunsire, Fritz and Fritz (2020) also posited that RDA is meant to support the creation of well-formed data that can be managed using current technologies and technologies, showing the importance of this tool for cataloguing library resources of any kind. In addition, it also defines the elements needed for description and access and provides the instructions on how to formulate the data recorded on each element. Seeman and Dean (2019) recommend using RDA to describe the traditional and non-traditional, analogue and digital resources within or outside library collections. RDA records can be encoded using existing schema such as MARC21, Dublin Core and Metadata Object Description Schema (MODS). They can also be mapped to another schema, current or future, which makes RDA a robust cataloguing standard that every library in this technological era, including libraries in Africa, would like to implement. Ifijeh, Segun-Adeniran and Igbinola (2019) postulate that RDA is not a standalone metadata standard. However, it is a cataloguing tool based on the foundations established by AACR2, which is the standard for bibliographic metadata content worldwide.

Internet of Things

Academic libraries are at the forefront of the Internet of Things (IoT) to enhance the efficiency of library services. IoT is a dynamic and global network infrastructure in which "Things" are expected to communicate among themselves and interact with the environment by exchanging data generated by sensing while reacting to events and triggering actions to control the physical world (Liu, 2015). It is a new technology that can also be used in library activities such as management of inventory, access authentication and control of data array (Yusuf, Ifijeh & Owolabi, 2019). IoT can enhance library services by supplying users with software that enables efficient use of databases, continuous contextual support and optimisation processes. The implementation of IoT in libraries can improve access to library services, manage library collections, and check the statistics of library resources usage (Yusuf, Ifijeh & Owolabi, 2019). IoT devices can help academic libraries collect, exchange information, promote library services, document location, and maintain security access levels. However, several studies on the adoption and benefits of using IoT within academic libraries have been reported worldwide. For example, Pujar and Satyanarayana (2015) investigated the benefits of IoT for libraries. The proposed innovative approaches such as a virtual library card, smart digital shelve, cloud services, and integrating RFID tags or member cards to access the library and its resources. Wojick (2016) also explored the potential impact of IoT on library services and proposed a theoretical model of IoT application in library service that librarians can use to improve library services through sharing information, tracking and tracing services and pushing notification services.

Oyelude (2016) introduced an innovative application of IoT in Oracle Digital, delivering value-added service through the cloud platform for library use. Renold and Rani (2013) designed a system with RFID technology for library management, such as stock management, tracing misplaced and mis-shelved books, and promoting easy access to library materials. Liu (2015) analysed the integration of library information resources digitally and proposed a library data resource object model and the process of library personalised information service management. Knowledge maps refer to the processes, methods, and tools for analysing knowledge areas to discover features or meaning and visualize these in a comprehensive, transparent form (Euiho and Hyunseok, 2003). They refer to tools used in business and industry, but they also have been applied within the realms of computer and information science (Zins, 2007). Knowledge maps may be useful within librarianship in facilitating access to knowledge and expertise within organisations.

Intelligent Return and Sorter System

Some academic libraries use an Intelligent Return and Sorter System to automate their check-in and sorting process. With these systems, users can quickly self-return their issued items with "real-time check-in" and be assured that they have been returned by receiving return slips from the machine. Abdulla (2020) noted that Intelligent Return and Sorter System are explicitly designed for libraries with limited space and are easy to use, and can also perform administrative tasks such as configuring receipts, generating statistics, and system diagnostics. The systems can thus help in decreasing the time, increasing staff productivity while enhancing user satisfaction. Academic libraries are implementing Radio Frequency Identification (RFID) technology for data input as part of the book returning system. Arduino Uno R3 is used to control the system, from picking a book to putting back the book to the shelf through the robot arm with the aid of a gripper when the book was detected (Abdulla, 2020).

Web 2.0 Services

Web 2.0 made a revolution in libraries and has changed the traditional libraries to library 2.0. Modern libraries are using web-based services to provide more comfortable services to library users. These services include web access of e-materials like e-books, e-journals, e-thesis, etc. The library users can get the user id and password from the library. They can access the material on the library website. Library users can make queries, see any notification from the librarian, and chat with the librarian on the Web by using the Web2.0 services. With the help of Web 2.0 services, users can read and write important information anytime and anywhere without the constraint of time and place. Web 2.0 services include folksonomies and social tagging, video sharing, photo sharing, instant messaging, social networking or social media technologies, blogs and wikis, RSS Feeds, Web Mashups and Podcasting.

Academic libraries commonly use social media technologies in providing library and information services in the 21st century. Social media technologies are computing-mediated technologies that enable individuals or groups of people to create, share, and exchanging information in real-time within an online community. These technologies are making visible the boundaries of library services and are classified into collaborative tools (Wikipedia), blog and microblogs (Twitter), content communities (YouTube) and social networking (Facebook, LinkedIn, Google+). Web 2.0 was popular in the early 2000s; it has evolved into Web 5.0, which maps library users' emotions whereby users will interact with content that interacts with their emotions and changes in facial recognition. The ability to adjust to these emerging technologies resonates with Ranganathan's fifth law of the library "libraries are growing organisms". Web 5.0 and Library 5.0 both adds value to human and computer interactions within the context of providing techno-centric library services in the era of constant technological change. The future will point out to Web 6.0 characterised by the migration of human consciousness to cyberspace or an unspecified "cloud" (Król, 2020). Human-computer interaction in the provision will never remain static but will evolve to a higher. Moreover, a more advanced level is shaped by the emerging technologies of the 21st century.

Blockchain and LibChain

Blockchain is an innovative technology that has the capacity to transform the delivery of private and public services through new applications. Deloitte (2016) describes a blockchain as a distributed ledger of all transactions recorded in discrete blocks and linked together in a chain. Each block contains private data and a public header used to link to the next block on the chain (Blockgeeks, 2016). Shaw (2016) further describes blockchain technology as a shared electronic database in which the data records are immutable and encrypted. These data records can be shared within a group of people, organisations or a community. The shared document is encrypted and verified to ensure that the data it stores is always correct. Every record added to the blockchain ledger has a unique key that can be trusted (Shaw, 2016).

It is, therefore, an append-only data store, and no deletes or edits are allowed. Hence this technology has its capability as an unimpeachable record keeper (Umeh, 2016). Therefore, digital information can be accessed anywhere in the country through blockchain, leaving a digital trail for a system that can be trusted inherently. Therefore, academic libraries can consider using blockchain technology, especially for the security of their digital information. With this technology, it is impossible to change information without leaving a digital trail (Lemieux, 2016). Blockchain technology also creates a digital trail to verify the current state of the digital information, including all changes that have been made along the way. On the other hand, blockchain can also help academic libraries digitize analogue information and manage it within a secure infrastructure. Once digital information is committed onto a blockchain, it is permanently stored and impossible to manipulate or hack. This technology has a tracking system to ensure the integrity of data at all times. As a result, academic libraries can operate more efficiently with greater trust in information security. Information Technology departments in academic libraries may also be able to create rules and algorithms that allow data in a blockchain to be automatically shared with third parties once predefined conditions are met (White Paper 2019). Another emerging technology is LibChain, a decentralized library management system based on blockchain technology developed for borrowing books from libraries. Library users can transfer books directly to other users without even sending them back to the library using Libchain technologies. LibChain transfers can be made independent of the registry site, as long as the sponsors are associated with the participating site. Smith (2019) highlighted the potential of Libchain technologies in libraries since such technologies can be used for interlibrary loan, scholarly publishing, credentialing, the development of a universal library card and answering reference questions.

Cloud Computing

Today, cloud computing has emerged as one of the most popular virtual technology for libraries to deliver services in an effective manner, offering great benefits for libraries to connect their services promptly and in new formats with flexibilities (Adetoro and Ayeni, 2020). The National Institute of Standards and Technology (NIST) (2011) defines cloud computing as a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. It is a computing technology which facilitates the sharing of resources and services over the Internet rather than having these services and resources on local servers/nodes or personal devices (Kaushik & Kumar, 2013).

Gartner (2017) further describe cloud computing as a style of computing in which scalable and elastic IT-enabled capabilities are delivered as a service to external customers using Internet technologies. Cloud storage allows a large amount of data to be stored and ensures easy retrieval when needed via the Internet. Therefore, cloud computing has been regarded as a powerful tool that offers excellent scalability and flexibility, making it possible for librarians and users to access file storage, databases, and other library applications anywhere at any time. There is ample evidence that cloud computing has enhanced library services by adding more values, attracting the users, and ensuring cost-effectiveness (Goldner, 2011; Mavodza, 2013). JISC (2011) also points out that cloud-based services are set to transform the way libraries work, unleashing librarians from the administrative burden to focus on services for users and researchers. The need for adoption of cloud computing in libraries has also been due to information explosion, problems in accessing the information, saving the time of the users and staff, resource sharing problems, problems in library resources management, complex demand of users and attraction of users towards cutting edge technologies (Kaushik & Kumar, 2013). Cloud-based applications offer libraries new ways to present information or offer previously unaffordable or unavailable services, thereby making libraries more efficient in information provision (Sorensen & Glassman, 2011). Yang and Tate (2012) assert that the cloud-based integrated library systems allow many libraries to share useful data, such as sharing full-text journal titles from electronic databases. Cloud computing technology enables librarians to shift from the ownership and maintenance of resources towards the provision of access to information maintained and controlled by others (Scale 2010).

THE DEVELOPMENT OF INSTITUTIONAL REPOSITORIES FOR ELECTRONIC THESES AND DISSERTATIONS

Van Wyk and Mostert (2014) noted that the developments in the global information science landscape have seen the adaptation of open access (OA) institutional repositories (IRs) and that they have now become a rooted part of available information sources in an academic library. The content of the institutional repositories in South Africa includes but is not limited to Electronic Theses and Dissertations (ETDs), journal articles, inaugural lecturers, conference proceedings, archival materials, photographic materials, books and book chapters. According to Van Wyk and Mostert (2014), the initial steps toward the electronic submission, storage and dissemination of theses and dissertations (TDs) in South Africa date back to the early 1990s. Bongani (2018) argued that while the ETDs are still the overriding content, they are set to be replaced by journal articles in the near future because of the velocity with which this content is growing and as more IR managers start to populate their IRs with journal articles. Bangani (2018) noted that IRs in South African universities have a rich continue to grow both in frequency and measure of content undergoing digitisation. The proliferation of the panoply of digital technologies has also enabled academic libraries to adapt Institutional Repositories (IRs) as a progressive way to manage and share intellectual content in support of research, teaching and learning. Adam and Kiran (2019) viewed IRs as one of the common platforms used for green open access and as innovative methods for knowledge management that emphasise preserving, sharing and providing free access to research findings produced by faculty members, research staff and students, as well as increasing citation rates and making institutions more visible to the global research community. Christa and Chiparausha (2021), citing Sompel, Payette, Erickson, Lagoze, and Warner (2004), foresaw the growth of institutional repositories increasing exponentially as their role in scholarly communication value chain became more broadly recognised. According to Sompel, Payette, Erickson, Lagoze, and Warner (2004), the value chain has its foundation in registering new knowledge from research outputs archived in repositories. Van Deventer and Pienaar (2008) noted that establishing the South African Research Information Services (SARIS) Project provided a framework for e-research services to all South African researchers. Institutional repositories should thus be viewed as part of a more extensive set of strategies emerging across academic institutions and nations to provide for the stewardship of scientific research data and mobilise data for ‘e-Research’ and ‘e-Learning (Cragin, Palmer, Carlson & Witt, 2010). The Open Access Movement (OAM) and I have the potential to contribute significantly to economic growth by broadening the market for scholarly publications and research results, especially in science and medicine, as access costs would broaden usage (Drake, 2004).

Table 2. The size of ETD collections in academic institutions in Zimbabwe

University	Number of ETDs	Year of Establishment ETD	Repository Software
University 1 (UZ)	**4 212**	2006	DSpace
University 2 (MSU)	**3 034**	2008	DSpace
University 3 (BUSE)	**2 556**	2009	DSpace
University 4 (NUST)	**1 345**	2010	Greenstone
University 5 (CUT)	**1 022**	2010	DSpace
University 6 (AU)	**623**	2010	DSpace
University 7 (Lupane)	**390**	2011	DSpace
University 8 (Catholic University)	**168**	2011	DSpace
University 9 (HIT)	**125**	2012	DSpace
University 10 (GZU)	**78**	2014	DSpace

(Chisita, Enakrire, Muziringa & Chikonzo, 2021)

Drake (2004) stated that the future would bring greater innovation and technologies through open access and institutional repositories. Chisita and Chiparausha (2019) argued that the IR wave has also swept through Zimbabwe's academic landscape, with all universities using Free Open Source Software, including DSpace and Greenstone. Chisita and Chiparausha (2019) further noted that academic libraries were taking advantage of the explosion of emerging technologies to leverage their content as a strategy to contribute toward the realisation of institutional goals and enhancing visibility. Bashir, Gul, Bashir, Nisa and Ganaie (2021) argue that the functions of IRs are massive when reflected from the institutional perspective; they try to deep root themselves in the research world and firmly establish all the literary elements associated with them.

Kapasule and Chawinga (2016) noted academic and research libraries as the main producers of primary research and intellectual and scholarly content centres. These institutions are expected to take an interest in creating, disseminating, and preserving knowledge. Kapasule and Chawinga (2016) commended the role of academic and research libraries in leveraging scholarly communication through Open Access institutional repositories. However, Dlamini and Snyman (2017) and Nwagwu (2013) attributed the slow adaptation of institutional repositories in Africa to the lack of support from government and institutions and inadequate infrastructure. The study sampled selected institutional repositories to illustrate how academic libraries in selected countries and universities in Zimbabwe and South Africa to illustrate how academic were adapting to emerging technologies.

The above Table, 1 shows that academic libraries in Zimbabwe that are members of the ZULC have made tremendous progress made in technological adoption as evidenced by establishment of digital repositories. This development is a result of cooperative and collaborative iniatives among academic libraries in Zimbabwe. Partnerships with the Electronic Information for Libraries (EIFL) helped to build capacity for the first open access ETD mandate in the country that was introduced by University of Zimbabwe, thereby opening their research to the world.

Table 3. The size of ETD collections in academic institutions in South Africa

Cape Peninsular University	**2963**	2009	DSpace
Nelson Mandela Metropolitan University	**4098**	2015	DSpace
Stellenbosch University	**53004**	2006	DSpace
University of Pretoria	**51016**	2000	DSpace
North West University	**12720**	2008	DSpace
University of Johannesburg	**35213**	2008	DSpace
University of KwaZulu-Natal University	**16924**	2009	DSpace

(Chisita, Enakrire, Muziringa & Chikonzo 2021)

It can be deduced from the above Tables 1 and 2, that DSpace remains the standard repository software for academic libraries in South and Zimbabwe. DSpace is an open software package characteristically used for creating open access repositories for scholarly and/or published digital content, including ETDs and other Open Educational Resources (OERs). This software is free and relatively easy to install. DSpace has no licensing costs and highly configurable. While DSpace is popular, it also has its limitations; for example, during implementation, there are challenges with Metadata structure, poor user interface, lack of scalability and extensibility, Limited API, Limited Metadata Features, and Limited Reporting Capabilities and lack of support for linked data. Digital repositories have the potential to host scholarly content in multimedia format for the benefit of students and researchers.

MAKERSPACES AS PLATFORMS FOR PROMOTING THE USE OF MODERN TECHNOLOGIES IN ACADEMIC LIBRARIES

Makerspace is another innovative development in the technical progress of academic libraries. Hussain and Nisha (2017) viewed makerspace as places that provide various tools and materials to facilitate making and creation. Davis (2018) viewed such spaces as hackerspaces, tech shops, fab labs, and creative spaces. The adoption of makerspaces in libraries keeps the library clients busy and productive, which means that through makerspaces, libraries can promote inventions, creativity and ingenuity (Adejo & Babatude, 2021). Technology endowed academic libraries adapt makerspaces to encourage maker mindsets and skills in using technology. The issue of library space or spatial configuration of libraries has become critical in the wake of the proliferation of digital technologies (Chisita & Fombad, 2021). Nagle (2020) in academic libraries, maker services take many forms, including a single 3D printer, a dedicated space with high-end fabrication tools, a small corner of the library set aside for gaming and paper crafting, or a mobile cart that is brought out whenever making activities take place.

Nagle (2020) further observed that academic libraries are increasingly incorporating makerspaces into their service models to leverage and solidify the library's position on campus as a place for collaboration, learning, and inspiration. The majority of the participants considered that the library space should be transformed and used as a maker space. A 'makerspace' is a collaborative place where learning occurs through ideas sharing, partnership and collaboration, using various materials, tools and resources. Most academic libraries organised makerspace activities such as learning common, workshops and in-house seminars. Makerspaces provide an opportunity to attract current and potential library users and improve the image, identity and value of the academic libraries and academic librarians. Library management develops makerspace programs to help users learn, create, use, share and do their own (DIY) knowledge. Therefore, acquiring and sharing knowledge through makerspaces will increase the ability of critical thinking of the learners and users. However, it will also help them be innovative, creative, and inventive while creating resources, information, and collaboration.

Abram (2013) further identified the benefits of using makerspaces, including allowing access to a wide variety of technologies and tools that aid resources sharing, knowledge and group interaction; encouraging individual project development through the provision of access to physical space; creating a disclose environment for innovation and creativity and provide access to tools used in the companies for prototyping project purpose. The community can thus share techniques, information or the tools underlining creation at the library (Okuonghae, 2019).

CONCLUSION AND RECOMMENDATIONS

Effective organization and management of the library's information resources ensure the academic library's ability to function effectively and provides access to its valuable resources. Recently, modern technologies such as web-based Online Public Access Catalogue (OPAC), Web 2.0, blockchain, cloud computing and Internet of Things (IoT) have increasingly been adopted by some the academic libraries for digitization, management and access of library information resources as well as for the provision of library services. In contrast, other academic libraries are slow to adopt them. Academic libraries should strategize on the way forward in adapting to innovative library technologies. Modern technologies thus need to be adopted by academic libraries to enhance the organisation of library information resources, coordination and efficiency of library services in terms of increasing access to quality library information by information users (Chawinga & Selemani, 2017). It is also relevant and timely that librarians continue to analyse, investigate and assess the information service needs of all stakeholders, acquire knowledge of policies, procedures, issues and standards, systems and technologies, be acquainted with information sources and services and be committed to life-long learning (Osuchukwu & Ayeni, 2019).The twenty-first century requires academic librarians to develop clairvoyant minds in order to plan for technological changes than can be disruptive. On the same note (Schlak, 2020) hinted that the twenty-first century demonstrates the need for a "crystal ball" and that this could be achieved by adapting futures thinking which is a strategy for dealing with the growing intricacies that is reshaping our world.

The study suggests the following recommendations:

- Academic librarians should strategise on maintaining sustainable technological buoyance in response to the seismic technological changes in the information landscape;
- Academic libraries should rethink and strategise on the adaptation of emerging technologies in order to develop a sustainable culture of creativity and critical thinking with regards to the utilitarian value of such emerging technologies;
- Partnerships between academic libraries, publishers and Internet Service Providers will be worth considering to leverage technical progress.

- Futures thinking should be incorporated into the strategic direction of academic libraries as way of managing seismic shifts in the library and information landscape
- Further research needs to be conducted in order to unpack and strategise on how academic libraries can manage changes associated with emerging technologies.

REFERENCES

Abdulla, R. (2020). Intelligent Return and Sorter System using Internet of Things. *Solid State Technology*, *63*(1).

Adebayo, O. (2013). Challenges Associated with Cataloguing Electronic Resources in Selected University Libraries in Southwest Nigeria. *Chinese Librarianship*, (36).

Adejo, A. A., & Babatunde, K. A. (2021). Creation and utilization of maker spaces in academic libraries: Bridging the gap between theory and practice. *International Journal of Library and Information*, *13*(2), 34–40. doi:10.5897/IJLIS2021.0981

Adetoro, N., & Ayeni, P.O. (2020). The library in the cloud: Examining the realities of cloud computing adoption and application in Nigerian libraries and information centers. *Media resources and information and communication technology use*, 225-235.

Ashiq, M., Rehman, S. U., & Mujtaba, G. (2021). Future challenges and emerging role of academic libraries in Pakistan: A phenomenology approach. *Information Development*, *37*(1), 158–173. doi:10.1177/0266666919897410

Atkinson, J. (2020). Reflections on technology, change and academic libraries. In J. Atkinson (Ed.), *Technology, change and the academic library: Case studies, trends and reflections* (pp. 185–193). Chandos Publishing.

Bangani, S. (2018). The history, deployment, and future of institutional repositories in public universities in South Africa. *Journal of Academic Librarianship*, *44*(1), 39–51. doi:10.1016/j.acalib.2017.12.003

Bashir, S., Gul, S., Bashir, S., Nisa, N. T., & Ganaie, S. A. (2021). Evolution of institutional repositories: Managing institutional research output to remove the gap of academic elitism. *Journal of Librarianship and Information Science*. Advance online publication. doi:10.1177/09610006211009592

Benedetti, A., Boehme, G., Caswell, T. R., Denlinger, K., Li, Y., McAllister, A. D., & Wesolek, A. J. (2020). *Top Trends in Academic Libraries*. https://digitalcommons.unf.edu/cgi/viewcontent

Buchholz, I. M. (2011). *Provision of access to information in academic libraries in Southern Africa: Two case studies* [Master's Thesis]. University of South Africa.

Catalano, A. J., Glasser, S., Caniano, L., Caniano, W., & Paretta, L. (2018). An analysis of academic libraries' participation in 21st century library trends. *Evidence Based Library and Information Practice*, *13*(3), 4–16. doi:10.18438/eblip29450

Chisita, C. T., Enakrire, R. T., Muziringa, M. C., & Chikonzo, A. (2021). Development of Transferable Knowledge: Electronic Theses and Dissertation (ETDs) Publications in Academic Libraries in Zimbabwe. In *E-Collaboration Technologies and Strategies for Competitive Advantage Amid Challenging Times* (pp. 266-281). IGI Global.

Chisita, C. T., & Fombad, M. (2021). Spatial configuring for wider access to public library services at the Harare city library: Towards a new strategy for inclusivity. *Public Library Quarterly*, *40*(3), 221–243. doi:10.1080/01616846.2020.1771936

Council of Canadians Academies. (2015). *Leading in the digital world: Opportunities for Canada's memory institutions. The expert panel on memory institutions in the digital revolution.* Author.

Cox, A., Pinfield, S., & Rutter, S. (2019). Academic libraries' stance toward the future. *Portal (Baltimore, Md.)*, *19*(3), 485–509.

Cragin, M. H., Palmer, C. L., Carlson, J. R., & Witt, M. (2010). Data sharing, small science and institutional repositories. Philosophical Transactions. *Series A, Mathematical, Physical, and Engineering Sciences, 368*(1926), 4023-4038. . doi:10.1098/rsta.2010.0165

Davis, A. M. L. (2018). Current trends and goals in the development of makerspaces at New England college and research libraries. *Information Technology and Libraries*, *37*(2), 94–117. doi:10.6017/ital.v37i2.9825

Dellaca, M. (2018). Leading Libraries in a VUCA World. *Austl. L. Libr.*, *26*, 134.

Dempsey, L., & Malpas, C. (2018). Academic library futures in a diversified university system. In N. Gleason (Ed.), *Higher Education in the Era of the Fourth Industrial Revolution* (pp. 65–89). Palgrave Macmillan. doi:10.1007/978-981-13-0194-0_4

Dlamini, N. N., & Snyman, M. (2017). Institutional repositories in Africa: Obstacles and challenges. *Library Review*, *66*(6/7), 535–548. doi:10.1108/LR-03-2017-0021

Drake, M. A. (2004). Institutional repository: hidden treasure. *Inf Today, 12*(5), 1-7. https://www.infotoday.com/searcher/may04/drake.shtml

Eserada, R. E., Okolo, S. E., & Ideh, P. N. (2019). Computer self-efficacy as determinant to the use of online public access catalogue: A case study of selected universities in Niger delta region. *The Computer Journal*.

Ex Libris. (2019). Ex Libris Signs Definitive Agreement to Acquire Innovative. *Ex Libris Library Technology Reports*, *55*(1). Advance online publication. doi:10.5860/ltr.55n1

Fabumni, O. M., & Asubiojo, B. O. (2013). Awareness and Use of Online Public Access Catalogue by Students of Obafemi Awolowo University, Ile-Ife, Nigeria. *Library Philosophy and Practice (e-journal).* https://www.librarianshipstudies.com/2017/09/functional-requirements-for-bibliographic-records-frbr.html

Gartner. (2017). *Gartner insights on how and why leaders must implement cloud computing.* Available at: https://www.gartner.com/imagesrv/books/cloud/cloud_strategy_leadership.pdf

Goldner, M. (2011). Winds of change: Libraries and cloud computing. *Multimedia Information and Technology*, *37*(3), 1–8.

Gopalaswamy, M., & Kumar, S. N. (2012). Cloud computing technology: A boon for Library and Information Services. *Indian Journal of Library and Information Science.*, *6*(3).

Hussain, A., & Nisha, F. (2017). Awareness and use of library makerspaces among library professionals in India: A study. *DESIDOC Journal of Library and Information Technology*, *37*(2), 84–90.

Kapasule, A., & Chawinga, W. (2016). *Revolutionising Scholarly Communications Through Institutional Repositories: Empirical Findings from a University (College) in Malawi.* Paper presented at the 22nd Standing Conference of Eastern Central and Southern African Libraries Association (SCECSAL), Royal Swazi Sun eZulwini, Swaziland. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3004463

Kim, K. (2003). Recent work in cataloguing and classification, 2000-2002. *Library Resources & Technical Services*, *47*(3), 96–108. doi:10.5860/lrts.47n3.96

Król, K. (2020). Evolution of online mapping: from Web 1.0 to Web 6.0. *Geomatics, Land management and Landscape*. https://gll.urk.edu.pl/zasoby/74/GLL-1-3-2020.pdf

Liu, X. L. (2015). Analysis and management platform construction of library's big data based on Internet of Things. In G. Lee (Ed.), Advances in education research. Information Engineering Research Institute. Academic Press.

Madge, O. L., & Robu, I. (2019). Medical academic libraries in Romania–breaking with the past and turning towards the future. *Health Information and Libraries Journal*, *36*(1), 96–100. doi:10.1111/hir.12245 PMID:30811885

Mavodza, J. (2013). The impact of cloud computing on the future of academic library practices and services. *New Library World*, *114*(3/4), 132–141. doi:10.1108/03074801311304041

Mayega, S. (2008). *Library information services in the digital age*. Academic Press.

McGillis, L. (2016). The Lights are on but Nobody's Home: The Future of Academic Libraries? *Partnership*. *The Canadian Journal of Library and Information Practice and Research*, *11*(1). Advance online publication. doi:10.21083/partnership.v11i1.3657

Nagle, S. B. (2020). Maker Services in Academic Libraries: A Review of Case Studies. *New Review of Academic Librarianship*, 1–17.

Nahotko, M. (2020). OPAC development as the genre transition process, PART 1: OPAC generations historical development. *Annals of Library and Information Studies*, 107-117. http://eprints.rclis.org/40413/1/ALIS%2067%282%29%20107-117.pdf

Ndumbaro, F., & Kassim, M. (2021). The use of OPAC query logs to support evidence-informed information literacy (IL) training at The University of Dar es Salaam. *Information Development*. doi:10.1177/02666669211021619

Ntui, A. I., Robert, B. E., & Usang, E. I. (2017). Economic challenges and prospects associated with the utilization of Information and Communication Technology (ICT) for library services in universities in Cross River State Nigeria. *Computing and Information Systems*, *21*(1), 29–39.

Nwagwu, W. E. (2013). Open access initiatives in Africa-structure, incentives and disincentives. *Journal of Academic Librarianship*, *39*(1), 3–10. doi:10.1016/j.acalib.2012.11.024

Ocholla, L., & Ocholla, D. (2017). *The changing library and information research landscape: an analysis of Library and Information Science Research in South Africa by LIS academics in the last decade (2007-2016).* Academic Press.

Onyancha, O. B. (2018). Navigating the rising metrics tide in the 21st century: Which way for academic librarians in support of researchers in sub-Saharan Africa? *South African Journal of Library and Information Science*, *84*(2), 1–13. doi:10.7553/84-2-1762

Orji, S., & Anyira, I. E. (2021). What is "Smart" About Smart Libraries? *International Journal of Research in Library Science*, *7*(4), 265–271. doi:10.26761/IJRLS.7.4.2021.1482

Oyelude, A. A. (2016). What's trending in libraries from the internet cyber sphere-bookless libraries? *Library Hi Tech News*, *33*(6), 19–20. doi:10.1108/LHTN-06-2016-0027

Padhi, S., & Nahak, B. (2019). *The Role of Smart Library and Smart Librarian for E-Library Services*. INFLIBNET Centre. http://ir.inflibnet.ac.in/handle/1944/2338

Pujar, S. M., & Satyanarayana, K. V. (2015). Internet of Things and libraries. *Annals of Library and Information Studies*, *62*, 186–190.

Renold, A. P., & Rani, R. J. (2013). An internet-based RFID library management system. In *Proceedings of 2013 IEEE Conference on Information and Communication Technologies*. IEEE. 10.1109/CICT.2013.6558229

Sarfraz, Z., Sarfraz, A., Iftikar, H. M., & Akhund, R. (2021). Is covid-19 pushing us to the fifth industrial revolution (Society 5.0)? *Pakistan Journal of Medical Sciences*, *37*(2), 591. doi:10.12669/pjms.37.2.3387 PMID:33679956

Scale, M. E. (2010). Assessing the Impact of Cloud Computing and Web Collaboration on the Work of Distance Library Services. *Journal of Library Administration*, *50*(7/8), 933–950. doi:10.1080/01930826.2010.488995

Schlak, T. (2020). Futures Thinking and Library Leadership. *Journal of Library Administration*, *60*(8), 945–950. doi:10.1080/01930826.2020.1820280

Smith, C. (2021). *Blockchain Reaction: How library professionals are approaching blockchain technology and its potential impact*. Available from https://americanlibrariesmagazine.org/2019/03/01/library-blockchain-reaction/

Sompel, H. V. D., Payette, S., Erickson, J., Lagoze, C., & Warner, S. (2004). Rethinking scholarly communication: Building the system that scholars deserve. *D-Lib Magazine: the Magazine of the Digital Library Forum*, *2004*(10), 9.

Sprochi, A. (2016). Where are we headed? Resource description and access, bibliographic framework, and the functional requirements for bibliographic records library reference model. *The International Information & Library Review*, *48*(2), 129–136. doi:10.1080/10572317.2016.1176455

Tanner, S. (2009). The economic future for digital libraries: a 2020 vision. *Digital library economics: An academic perspective,* 291-309.

Uddin, J., & Hasan, N. (2012). Use of information technology in library service: A study on some selected libraries in northern part of Bangladesh. *International Journal of Library and Information Science*, *4*(3), 34–44.

University of Lisbon. (n.d.). *ISCTE*. Available https://www.iscte-iul.pt/contents/iscte/quality/accreditations-and-rankings/rankings/1276/scimago-institutions-ranking

Van Deventer, M., & Pienaar, H. (2008). South African Repositories: Bridging Knowledge Divides. *Ariadne*, (55), 3.

Van Wyk, B., & Mostert, J. (2014). African institutional repositories as contributors to global information: A South African case study. *Mousaion*, *32*(1), 98–114. doi:10.25159/0027-2639/1704

Verma, L., & Kumarz, N. (2018). Comparative Analysis of Open Source Digital Library Software: A Case Study. *DESIDOC Journal of Library and Information Technology*, *38*(5), 361. doi:10.14429/djlit.38.5.12425

Wojick, M. (2016). Internet of Things – potential for libraries. *Library Hi Tech*, *34*(2), 404–420. doi:10.1108/LHT-10-2015-0100

Yang, H., & Tate, M. (2012). A descriptive literature review and classification of cloud computing research. *Communications of the Association for Information Systems*, *31*, 35–60. doi:10.17705/1CAIS.03102

Zins, C. (2007). Knowledge map of information science. *Journal of the American Society for Information Science and Technology*, *58*(4), 526–535. doi:10.1002/asi.20505

ADDITIONAL READING

Adejo, A. A., & Babatude, K. A. (2021). Creation and utilization of maker spaces in academic libraries: Bridging the gap between theory and practice. *International Journal of Library and Information Science*, *13*(2), 34–40. doi:10.5897/IJLIS2021.0981

Anyaoku, E. N., Echedom, A. U. N., & Baro, E. E. (2019). Digital preservation practices in university libraries: An investigation of institutional repositories in Africa. *Digital Library Perspectives*, *35*(1), 41–64. doi:10.1108/DLP-10-2017-0041

Igbinovia, M. O., & Okuonghae, O. (2021). Internet of Things in contemporary academic libraries: Application and challenges. *Library Hi Tech News*, *38*(5), 1–4. doi:10.1108/LHTN-05-2021-0019

Makori, E. O. (2017). Promoting innovation and application of internet of things in academic and research information organizations. *Library Review*, *66*(8/9), 655–678. doi:10.1108/LR-01-2017-0002

Nwosu, M. C. (2017). The future of the 21st century libraries is hybrid. *Computing and Information Systems*, *21*(1).

Wada, I. (2018). Cloud computing implementation in libraries: A synergy for library services optimization. *International Journal of Library and Information Science*, *10*(2), 17–27. doi:10.5897/IJLIS2016.0748

KEY TERMS AND DEFINITIONS

Academic Library: An academic library is a big repository of information and knowledge from all fields of learning created to serve a college or university, to disseminate and store information for the users and it serves the reading and research interests of students, lecturers, and researchers.

Institutional Repository (IR): IR is regarded by the university communities as a locus for preserving their digital information or resources and maintaining access to these resources over the long-term.

Internet of Things (IoTs): IoT is a new technology that can be used in library activities such as management of inventory, access authentication and control of data array and can enhance library services by supplying users with software that enables efficient use of databases, continuous contextual support and optimisation processes.

Makerspace: A makerspace is a collaborative place where learning occurs through sharing ideas, partnership, and collaboration, using various materials, tools, and resources.

Modern Technologies: Modern technology is the advancement of old technology with new additions and modifications and makes it easy to access, collect and process high volumes of data at high speeds.

Chapter 2
Academic Library Innovation Through a Business Model Canvas Lens:
A Case of South African Higher Education Institutions

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ABSTRACT

Academic libraries need to play a central role in providing user-centred services and enhancing users' quality of experience through digital innovation in the era of digital transformation. In the process of digital transformation, the businesses are transformed whereby new emerging approaches, best business practices, and new business models such as Business Model Canvas, are developed to support digital libraries innovations. Digital libraries are at the core of achieving higher education strategic priorities and critical pillars that include teaching and learning, research, and community engagement in an environment undergoing rapid digitalization. The Business Model Canvas thus offers digital libraries a lens through which to design innovative digital services to support the critical pillars of South African higher education institutions. This chapter explores the value of the Business Model Canvas in supporting creative digital services to internal patrons such as students, academics, researchers, and external patrons such as policymakers and industries.

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INTRODUCTION

Higher Education Institutions (HEIs) are significantly changing due to the emergence of advanced technologies such as artificial intelligence, argument reality Internet of Things and globalisation (Khalid et al., 2018). The covid-19 pandemic has increased the speed of digitization, and the necessity for innovation as HEIs go through unprecedented change, uncertainty and transition. Furthermore, the COVID-19 pandemic has forced digitalization and transformation in most HEIs, placing more significant pressure on offering an innovative learning experience (Rof et al., 2022). As a result, academic libraries are expected to play a central role in providing a creative learning experience, and as such, the fast pace of change has impacted academic libraries. Higher Education Institutions leaders must thus transform colleges and universities to benefit students and society (Keller, 2020). Historically, academic libraries have been reluctant to change, often waiting for a particular technology to reach market saturation before reacting to a new trend (Wheatley & Hervieux, 2019). However, in the increasingly digital, as technology evolves globally, academic libraries are also seeking innovative pathways to serve faculty and students more effectively and often adopting digital technologies for service functions (Adebayo et al., 2019). The current volatility in the HEIs environment offers a platform for academic libraries to innovate and play a central role in providing user-centered services and enhancing students' quality of experience. Such a transformation may include offering digital deposit services, digitization services, research data management, metadata creation, digital cataloguing and conserving, and counselling regarding digital copyrights and informational alphabetizing (Marginea & Kifor, 2021).

In transforming from the traditional mode of service delivery to a user-centric high-quality service provision, the business model canvas offers academic libraries a lens to innovate and transform into what, according to Marginean and Kifor (2021), is a user-led Digi modern library. As Peacemaker (2014) highlights, whilst there are few practical tools to explore innovation, the business model canvas offers librarians the potential to map and transform current practices and create new value for stakeholders. (Osterwalder & Pigneur, 2010) describe the business model canvas as an ontology that visualizes business models using the nine key components, namely: value proposition, key activities, partner network, essential resources, cost structures, revenue model, client segments, distribution channels and client relationships. Despite the business model canvass' potential in supporting innovation and transformation for academic libraries, the area remains relatively unexplored in South African Higher Education Institutions. This chapter explores the business model canvas potential for digital libraries in HEIs in South Africa.

PROBLEM STATEMENT

As observed by Juma, Wamukoya and Wekullo (2014), digital library initiatives in Africa largely revolved around university libraries whose efforts in this area were made possible by the need to transform and strengthen their highly inadequate print collections. Many digital library projects such as that of the Association of Africa Universities (AAU), Rhodes University in South Africa, the University of Nigeria and the African Digital Library (ADL) are some of the digital library projects being implemented in Africa to ensure that university communities can access the growing quantities of digital resources. Although a substantial number of HEIs and information centres have shown interest in developing digital libraries to adapt to changing library environment, one big challenge for a successful digital library project is the consideration of the economic issues. HEIs thus face increasing digital transformation and challenges such as daunting resource constraints with flagging public funding support. Moreover, the long-held notion of the academic library as the heart of the university is being challenged in the face of a changing higher education landscape and stakeholder expectations (Chelsa, 2021). Technological innovation has always been a critical challenge in academic libraries. The Council of Canadian Academies (2015) noted that libraries and archives face numerous challenges as they attempt to adapt to the digital age, including making accessible mass quantities of digital data and remaining trusted as repositories that hold documentary evidence of scholars and citizens. A change to the modern digital environment was never painless. Academic libraries' innovations continue to be a challenge due to a lack of funding, skills and knowledge of utilizing modern or innovative technologies and appropriate models to support innovation and transformation in academic libraries. Although business models offer a viable, trusted alternative to support digital libraries innovations, the level of adoption of these models is low in HEIs in South Africa. It also appears that little academic research has been conducted on the application of business model canvas in supporting academic libraries' innovation. This underscored the need to develop and adapt business models in supporting digital libraries innovations in HEIs. The study thus proposed a roadmap for developing a business model to support digital libraries innovations in HEIs. The research objectives formulated for this study were to:

- Determine the role of digital libraries in Higher Education Institutions (HEIs)
- Determine the applicability of the business model canvas in supporting digital libraries innovations in HEIs.
- Propose a roadmap for implementing a business model canvas to support digital libraries innovations in HEIs.

THEORETICAL FRAMEWORK

The evolution of digital technologies has resulted in more innovations such as institutional repositories, open access archives and digital libraries. The question of understanding innovations in academic libraries thus required a theoretical or conceptual framework to give grounded coherence to such an inquiry. Therefore, the business model canvas and the concepts of digital libraries were reviewed and analysed to explore its potential in supporting digital libraries' innovations and transformation in HEIs in South Africa.

The Role of Digital Libraries in Higher Education Institutions

In an era of ever-accelerating innovation, the libraries are moving into digital libraries in higher education institutions. Patrons had to walk into the libraries for many years to physically access services, which is changing as many libraries are now accessible online. Innovation in digital library technology and accessing digital libraries are increasing as digital libraries enable libraries to keep pace with the competition and ensure long-term relevance (Town, 2011). Digital libraries make information available in digital formats and allow the acquisition, storage, preservation, retrieval, access, and display through digital technology (Tunga, 2021, Jagatap & Shaikh, 2018). As such digital libraries can be a solution for easy user access to content (Hastuti et al., 2021). Moreover, digital libraries are essential to HEIs success and throughput as digital libraries services may be integrated into various teaching and learning and research aspects. In addition, academic aries present opportunities for HEIs to respond to the call by the government of South Africa for improved postgraduate throughput and pass rates as graduate students perceive library support as one of the most valuable services in postgraduate students' journey (Iwu et al., 2019). Moreso, graduation rates are concerning, with graduation rates for Doctoral studies estimated at 14% and 22% for Masters degrees (South Africa, 2021). The graduation challenge permeates undergraduate studies, with graduation for undergraduate certificates at 17% undergraduate degrees at 21% (South Africa, 2021). In supporting HEI graduation rates, Ntshuntshe-Matshaya (2019) indicates that HEI digital libraries' support for teaching and learning in a digital environment, research support and innovation are becoming core to the role of higher education libraries as academic library outcomes may now be linked to student experience and success rates from enrolment to graduation, student engagement, teaching, learning, and research productivity (Chelsa, 2021).

Digital libraries are essential for higher education institutions as they provide benefits such as ease of use and better and cheaper access whilst supporting users' personal, institutional, and social culture. In addition, digital libraries may enhance information quality, accuracy, completeness, consistency and effectiveness (Manduca, 2006). Furthermore, digital libraries are integral to higher education success (Maryati et al., 2022). Digital libraries are thus crucial, and as indicated by Adebayo et al. (2019), the academic library's primary role is acquiring, organising, preserving and creating access to information. As key to success in the migration to digital libraries, these libraries must ensure good response time and affordable cost (Gonçalves et al., 2007). Fox *et al.* (1995) highlighted that to achieve a competitive advantage in the digital library, higher education institutions must focus on the following key elements; availability and accessibility, usage, quality, long-term storage, cost and technology. As stated by IFLA/UNESCO (2010), the mission of the digital library is to also give direct access to information resources, both digital and non-digital, in a structured and authoritative manner and thus to link information technology, education and culture in contemporary library service. The following goals are pursued to fulfil this mission, summarised by I/UNESCO (2010):

- Supporting digitisation, access to and preservation of cultural and scientific heritage;
- Providing access for all users to the information resources collected by libraries while respecting intellectual property rights;
- Creating interoperable digital library systems to promote open standards and access;
- Supporting the pivotal role of libraries and information services in the promotion of common standards and best practices;
- Creating awareness of the urgent need to ensure the permanent accessibility of digital material;
- Linking digital libraries to high-speed research and development networks; and
- Taking advantage of the increasing convergence of communications media and institutional roles to create and disseminate digital content.

In addition, digital libraries will need a sustainable business model (Chowdhury, 2014). Kansen and Mantykangas (2014) observed that new business models emerge as libraries' management and patron relationships transform. The business model canvas as a tool presents an opportunity for digital libraries to design innovative business models. While the business model may have revenue and profit connotations, the business model has been used in non-profit contexts such as the public sector and non-profit organisations (Rasuli et al., 2018). Furthermore, the business model canvas may be adapted to design innovative digital services (Rose et al., 2019). In addition, the business model canvas may serve as strategic planning and communication tool among staff and senior management (D'Elia, 2016). Thus, enabling teams and stakeholders to understand how digital library creates value for users and captures value for organisations (Pokorna, 2015).

Business Models for Digital Libraries

Business models for digital libraries evolve from mere content providers to sophisticated service suppliers. They offer a rich variety of information services combined with collaboration, e-learning services and portal features (Markscheffel, Fischer & Stelzer, 2008). Markscheffel, Fischer and Stelzer (2008) define a business model as an architecture for the product, service, and information flows, including a description of the various business actors and their roles and a description of the potential benefits for the different business actors and a description of the sources of revenues. Dubosson-Torbay et al. (2002) also described a business model as an architecture of a firm and its network of partners for creating, marketing and delivering value and relationship capital to one or several segments of customers to generate profitable, sustainable revenue streams. Osterwalder and Pigneur (2002) described a business model as the conceptual and architectural implementation (blueprint) of a business strategy and represents the foundation for implementing business processes and information systems. Furthermore, a business model may be defined as the underlying economic logic of how a business makes money and creates value in serving the target customer, considering key activities, resources and partnerships as well as the value exchanges between the company and its partners (Motjolopane & Ruhode, 2021).

Barton (2005) stated that a digital library provides technology-based information and services to enable learners to access relevant information and services anywhere, anytime and inc. It includes meant for innovative and lifelong learning. It applies appropriate communication technologies to support e-learning and e-research by providing seamless access to electronic resources and services, including online catalogues, databases, multimedia, online journals, digital repositories, electronic books, electronic archives and online or electronic services (Barton, 2005). Digital libraries provide powerful search facilities to satisfy the increasing demand from their users for sophisticated information and knowledge management services, above and beyond searching and retrieving (Markscheffel & Fischer, 2007).

Business Model Canvas

Business models are strategic instruments that describe and analyse business concepts (Markscheffel & Fischer 2007). Timmer (1998) identified eleven business models on the internet: e-shop, e-procurement, e-mall, e-auction, trust services, information brokerage, value chain service provider, virtual community, collaboration platform, third-party marketplace, and value chain integrator. This chapter focuses on the business model canvas that facilitates detailed, accurate business model modelling taking the perspectives of a single company and highlighting the company's environment and concerns for delivering value to particular customer demands (Andersson et al., 2006). The business model canvas visualises business models using the nine key components: the "what" in terms of the value proposition, "how" the value proposition will be addressed comprising the key partners, key activities, and critical resources. Furthermore, the "how much" component of the business model canvas would include cost structures and revenue models. In addition, the "who" details the target customers, channels and relationships.

Digital Libraries and Value Proposition "What"

The value proposition provides an answer as to what value is offered to the target customer (Alt & Zimmerman, 2001, Osterwalder, 2004, Taran et al., 2015) and is linked to the company's vision (Almedia & Frias, 2009; Alt & Zimmerman, 2001). The value offered should have an economic value to at least one of the actors (Gordijin & Akkermans, 2006) and represents the value that is created for the customer (Chesbrough & Rosenbloom, 2002). Furthermore, the value proposition responds to a specific customer need, which is a great way to get an important job done, emphasising that the customer's condition must be regarded as necessary by the customer (Johnson et al., 2008). Hence the value proposition focuses on understanding customers' problems and producing products or services that solve them (Chadwell, 2011). Belleflamme and Neyse (2020) noted that the added value proposition must be defined to express reasons and motivations to prefer a given product or service over existing alternatives in the market. Such value proposition in a digital library may include e-books, customer content and digital information services (Kansanen & Mantykangas, 2014).

Digital Libraries and Value Configuration "How"

The value configuration depicts how value is created for the target customer (Osterwalder, 2004), identifying key activities, resources and partners (Richardson, 2008). In value configuration, resources and actions must be acquired, activated, and organised to improve offering quality concerning customer preferences and competitors (Hedman & Kalling, 2003). In the digital library, the value may be configured either as a hybrid where the users are served by a librarian and a data-based catalogue or the Web or the value is configured in such a way that a visitor meets a portal or Web page and creates a personal home page with links to various resources, blogs, notes, slides and web (Kansanen &Mantykangas, 2014). Hence, the configuration of values on academic Libraries' websites acts as virtual front doors, often as a primary interaction path with patrons. Therefore, libraries need to rethink websites to ensure that websites are user-friendly, scalable, responsive and customisable (Jadhav & Alur, 2021).

Digital Libraries and Financial Aspects "How Much"

Financial aspects in terms of how much value creation and delivery costs, as shown by the costs and revenue model, reflect the profit model for creating and delivering value to the target customer (Morris et al., 2005, Petrovic et al., 2001, Richardson, 2008, Pateli & Giaglis, 2004, Chesbrough & Rosenbloom, 2002). The revenue model defines how a supplier generates income (Rappa, 2007). The cost structure sums up the monetary values of creating and delivering value. Digital libraries' cost structures include hardware, software, and human resources required to provide services. Such digital libraries may explore offering personal human service for those tired of consistently interacting with a screen and willing to pay for the luxury services (Kansanen & Mantykangas, 2014).

However, pricing has a bearing on the revenue model. Thus, business model innovation will require an innovative approach to pricing. While Osterwalder and Pigneur (2010) suggest that pricing may be either fixed in terms of list price, product-based, customer-segment based and volume-based strategies, or dynamic, in the case of bargaining, yield management, real-time and auction pricing strategies. Hinterhuber & Lizoiu (2012) add that companies need to acquire sophisticated pricing skills, as the varying price realisation capabilities and price realisation capabilities impact the revenue model. Thus, digital libraries may adopt a dynamic pricing model for services, either cost-based pricing, competition-based pricing, or customer value-based pricing. The most advanced digital libraries use customer-based pricing with high levels of price realisation (Hinterhuber & Liozu, 2012).

Digital Libraries and Customer Interface "Who"

The target customer component provides answers as to who is the target customer to whom the company wants to offer value, specifying customer segments (Osterwalder et al., 2005, Pateli & Giaglis, 2004), delivery channels used (Osterwalder et al., 2005, Petrovic et al., 2001) and customer relationship strategies used per target market segment (Petrovic et al., 2001, Osterwalder et al., 2005, Morris et al., 2005, Osterwalder, 2004). Customers are typically referred to as patrons or borrowers in the digital library. According to Kananen and Mantykangas (2014), the term "visitor" is interpreted in various ways, while the "term" customer is avoided in public-sector thinking due association of "customer" with money, payment, and somebody else getting the profit. Furthermore, as a simplified starting point, visitors to the digital library may be segmented into two dimensions of time investment how m. How much time the visitor is prepared to spend on the library's Web and the ability to find the information (Kansanen & Mantykangas, 2014). The use of personas may provide a more dynamic approach to segmentation to create a flexible and personalised user experience through bookmarks being used to create a tailored service and subsequently expanded into a system of bookmarks (Kansanen & Mantykangas, 2014).

RESEARCH METHODOLOGY

This chapter explored the literature to critically analyse innovative technologies for digital transformation in academic libraries in HEIs in South Africa using qualitative content analysis. Although content analysis has served mainly to complement other research methods, it has also been used alone. In addition, some specialised forms of qualitative research rely solely on content analysis. For example, the study by Boamah and Liew (2017) on conceptualizing the digitization and preservation of indigenous knowledge was also based on qualitative content analysis. The qualitative content analysis method is defined as the systematic reduction of content, analysed with particular attention to the context in which it was created, to identify themes and extract meaningful interpretations of the data (Roller & Lavrakas, 2015). Content analysis is suitable for analysing various qualitative and unstructured data, such as those collected during unstructured or semi-structured interviews or web-based documentary research. The analytic procedure entails finding, selecting, appraising or making sense of and synthesising data contained in documents. Like other analytical methods in qualitative research, content analysis requires that data be examined and interpreted to elicit meaning, understand, and develop empirical knowledge (Corbin & Strauss, 2008).

Qualitative content analysis methodology was used to apply and increase knowledge in a particular area of research, thereby showing proficiency in reviewing, synthesising and critically analysing the relevant research literature. To carry out the literature review, the author searched the relevant articles on previous studies and initiatives reporting on the application of modern or new technologies for digital transformation within academic libraries in South Africa. Literature review on educational library innovation using the business model canvas and innovative technologies for digital transformation in major databases such as ScienceDirect, Wiley, Springer, Sage and Google Scholar were conducted to ensure all relevant studies in the literature review or content analysis. Therefore, data were collected from secondary sources, including books, journals, and research reports published by governmental and international agencies available on official websites. As noted by Ngulube (2018), conducting a literature review can also assist in developing a conceptual definition of a construct based on shared meaning, describe what theories or theories were used to explain relationships among concepts and establish how the images have been measured in an empirical investigation. Addressing these questions may enable researchers to check the coherence between the conceptual or theoretical framework and various elements of the research design and develop a conceptual model or framework for the study (Ngulube, 2018). The study also reviewed business model canvas elements in academic libraries, intending to create an abstract business model canvas for South African HEIs.

FINDINGS AND DISCUSSION

The role of HEIs in society is increasingly challenging. According to Lewis, Wolff and Bekker (2021), HEIs operate in an era of super complexity tasked with multiple, conflicting roles, with the overarching intention of educating graduates with the requisite knowledge, skills and citizenship values. Furthermore, HEIs, are under increasing pressure to demonstrate their relevance and significance to society due to globalisation, knowledge economies, liberalisation, and regulation and accountability regimes (Bekele & Ofoyuru, 2021). In South Africa, HEIs subscribe to the three broad strategic priorities: teaching-learning, research, and community engagement (Du Preez et al., 2016). Furthermore, Khanyile (2020) suggests a need to assume the so-called "third mission", which means that HEIs must include community engagement in the activities to be financially viable. In pursuing the three pillars, the business model canvas presents digital libraries with opportunities to explore how to integrate services to support HEIs in achieving strategic priorities around teaching and learning, research, and community engagement. Therefore, the business model canvas for South African HEIs digital libraries should be integral for these three pillars. The following sections examine the key elements HEIs business model canvas in digital libraries.

Digital Libraries' Higher Education Institutions Value Proposition

As depicted on various university library websites, digital libraries in South African HEIs offer several value propositions. A review of the HEI digital libraries' websites reflects several services provided to deliver fasters services as ddigital libraries may offer faster services, more users, and increased access to the collection (Maryati et al., 2022). As Mega (2022) highlights, the internet provides students with an unlimited repository of previous academic resources developed by experts in a specific field. In addition, the digital library offers rapid access to electronic resources such as books, articles, academic and non-academic journals, news, articles, statistics, and magazines in various formats like images, audio, video, pdf and multiple subjects' disciplines (Oshodi, 2022). In addition, In designing academic libraries' value propositions, Belleflamme and Neyse (2020) suggest that HEIs need to develop high demand products, identify customer needs and provide services that are easy to use and fulfil the customer needs account for the elements that customers need the most. The value proposition must align with the aim of the digital academic library to enhance and strengthen the teaching, learning and research process by installing a seamless document/information delivery system. In addition, the digital library needs to support HEIs' community engagement initiatives (Jadhav & Alur, 2021). South African HEI digital libraries services and activities are being designed to enhance critical thinking and graduate attributes;

promote a culture of reading and writing; inculcate information, academic and digital literacy skills; provide appropriate access to information resources, research and author support; utilize bibliometrics and altimetric for research output analysis (Chelsa, 2021).

Regarding teaching and learning, Swam (2008) indicates the value proposition may be designed around the functions of digital libraries to facilitate the development and sharing of digital teaching materials and resources. Thus, digital libraries are integral to HEIs teaching, research and community engagement. The essential function of the digital academic library is critical in supporting teaching and research in higher education (Adebayo et al., 2019). Thus HEIs value proposition may increase the qualitative value, advancing the type of services provided and user satisfaction, providing collaboration features that allow the users to use the features to co-create and share information with the other academic community members, thus building research collaborations (Maryati et al., 2022). Such differentiation may include offering low prices and providing better products. As a result, customers may benefit from the digital library on three levels: technical value, business value, and personal value (Black, 2016).

A review of the universities' library websites indicates varying levels of support for research support and teaching, and learning. However, what may be of notable concern is the information provided for teaching and learning reactive and proactive learning on most of the HEI libraries' websites is not clearly illustrated. The value proposition is a core element in teaching and learning and part of a more meaningful context and interdependent value proposition within the overall HEIs business model (Rof et al., 2022). Academic digital libraries and repositories are relevant in enhancing the student knowledge base and overall performance (Megwa, 2022). The digital libraries' value proposition for teaching and learning may include responsive and proactive services. Marchioni and Maurer (1995) noted that responsive services might consist of digital reference questions, media packages, and recommending books or films. Responsive services could be those value propositions that promote a responsive approach to course design and supports teaching and learning objectives. The library is an active learning community partner, helping learners become "information literates" by integrating literacy skills into the curriculum (Sharifabadi, 2006). In addition, Proactive service could entail selectively disseminating information to faculty and students, students, initiating thematic events, collaborating with instructors to plan instruction and introducing new instructional methods (Marchionini & Maurer, 1995).

Additional proactive value propositions delivered by digital libraries may support student-centered lifelong Learning as Rof *et al*. (2022) highlight that some HEIs are moving towards a more student centric-lifelong learning relationship, offering students a digital experience enabling new personalized online value proposition that guides students on what to study and how to improve employability and offering guidelines on how to improve teaching. The additional proactive value proposition may target a new student trainer relationship supported by multimodal learning tools, artificial intelligence, and data analytics to access a customized virtual campus (Jadhav & Alur, 2021). In the context of research, there is significant demand for improving the quality of research in higher education, thus challenging digital libraries to meet the market, with digital libraries playing a substantial role in various activities and features related to research support services (Maryati et al., 2022). HEI digital libraries in South Africa are offering several research support services with some the libraries support that b include data management planning, sharing, preservation and access and selecting funding agencies, legal advice and Intellectual property management. Si et al. (2019) further identified research support services adopted by academic digital libraries at the top 100 universities globally, including research tool recommendations, research consultation, research guides, research impact measurement, scholarly publishing, open access, and data management research. These services may be used as the basis for designing research support services in the context of South African HEIs. Moreso and Maryati (2022) indicate that the various trends in digital library development can be combined with research support services to produce an optimal business model. In addition, electronic theses and dissertations present a value proposition that is not limited to sharing information but often serve as input to National Electronic Databases and supporting research policy-making to answer questions such as how many thesis and dissertations a country has in a specific area, where the research is going to, which institutions are excellent in different subjects (Rasuli et al., 2018).

Digital Libraries Higher Education Institutions Value Configuration "How"

HEI Digital library's key activities have a bearing on the quality of services provided. As such, HEIs in South Africa need to continuously assess the quality of services for configuring key activities, resources, and partnerships. Tools such as Total Quality Management (TQM), SERVQUAL, and LibQUAL+ present opportunities to assess the quality of services and decisions, improve services, and achieve a better quality (Reddy, 2017). Academic libraries need to redesign key activities and rethink resources and partnerships to deliver value propositions for research, teaching, and digital learning. However, offering all values necessitates different activities and resources, demanding working with various partners, as noted by Rasuli *et al.* (2018). For example, critical activities in an HEI digital library may include providing the literature needed by researchers, managing research output, providing research-related information related to funding, research data, and publications, organising training workshops to improve researchers' research capabilities and extending literacy assistance (Maryati et al., 2022). In addition, key activities may encompass negotiation and cooperation agreements with digital resource owners, information dissemination, software and database development and maintenance and deploying digital or physical preservation (Rasuli et al., 2018). Rasuli et al., (2018) further identified vital activities, including developing standards such as metadata ensuring regulatory and policy compliance and staff in-service training.

A review of some of the South African HEIs digital libraries offers chat to enhance service delivery channels as digital libraries' key activities may consist of mobile communication channels and online ordering and chat features to advance the business processes (Maryati et al., 2022). Essential resources are one of the main elements of HEIs' digital libraries. Maryati *et al.* (2022) state that a library platform is also a vital resource required to run the business model. Resource management in digital libraries calls for professional library human resources trained in managing literature. In addition, Jadhav and Altur (2021) suggest that librarians may be an indispensable resource that plays a distinctive and dynamic role in providing easy access to authoritative information at the right time and disseminating to the user in appropriate formats based on local users and possess a high level of security to prevent hackers from users' details and the type of information they accessed. In addition, human resources in terms of search specialists and reference desk specialists may be of the essence in the provision of digital library services (Rasuli et al., 2018). Some partners are required to optimise their business model. For example, academic libraries may cooperate with research libraries to access and manage research data (Maryati et al., 2022) and other resource software and hardware resource owners such as cloud computing service providers. Furthermore, partnerships and collaborations with research units may optimise research support services; with this collaboration, the research output resources managed by the research unit may be served by the library directly or only the bibliography (Maryati et al., 2022). South African HEI digital libraries function within highly professionally connected environments in and beyond their institutions and membership in international professional associations and regional consortia (Chelsa, 2021). At the Institutional level of South African HEI digital libraries many libraries have concertedly worked at developing strategic institutional partnerships with Student Affairs, the Physically Challenged Unit, Information Communication Technology, Research, Alumni and Development Offices, and most importantly, faculties (Chelsa, 2021).

Digital Libraries Higher Education Institutions Financial "How Much"

The "how much" element is critical for HEI digital library success. In a South African context, Council-approved institutional funding remains the primary source of financial support for higher education institutions. Depending on the type of institution, the library budget is part of either the academic support research and internationalisation or support student affairs budgets (Chelsa, 2021). Furthermore, educational library allocations primarily cover capital expenditure, operating costs, infrastructure and information resources budgets, with human resources and Information Communication Technology forming part of central institutional funds (Chelsa, 2021). Moreover, most libraries receive less than 2% of the total institutional budget allocation, with funds supplemented by donations, sponsorships, and other grant allocations (Chelsa, 2021). In addition, some academic libraries have embarked on initiatives to generate additional income, especially in the area of digitisation, with the majority of third stream funding flows either from grants or select government funds, bequests or donor funding to assist with library facility upgrades or to contribute to the resource collections to support teaching, learning and research goals (Chelsa, 2021).

Thus, using the business model canvas to analyse the existing business model's financial aspects may be essential to HEI digital libraries. Analysing business models requires attention to revenue streams and cost structures (Tidhar, 2020) and pricing. As Maryati (2022) stated, libraries, as non-profit organisations, do not aim to get revenue directly from their users. Instead, the experts argue that revenue increase may be obtained from the emergence of trust, good feedback, and an improved library reputation due to improved services. Furthermore, in academic digital libraries, Piennar (2016) identified four revenue model types: earned revenues, embedded institutional support, third party subsidies, and consortia income models. These revenue models are depicted below.

In addition to revenue models, financial aspects need to address the cost structure for providing value propositions. Some of the critical cost structures for digital libraries include staff, hardware, software and subscription costs (Rasuli et al., 2018). In providing research support services, Maryati (2022) indicates that academic libraries have a limited budget for system development and other operations highest cost is allocated to subscribing to journals. Therefore, testing research support services with the available platform can generate value that can convince policymakers to give optimal budgets for developing information systems of research support services (Maryati et al., 2022). Pricing is key to the economic viability of digital libraries' business models. However, digital libraries may find determining the reasonable cost of services challenging (Gouda, 2004). Moreover, price increases and inconvenient hours are often the cause of pain (Prosser, 2011; Pokorna, 2015) and may result in the loss of patrons.

Digital Libraries Higher Education Institutions Target Customers

A South HEI's target customers may be undergraduate and postgraduate students, faculty members, administrative staff, and external stakeholders. The target customer component provides answers about

Table 1. Revenue model categories

Revenue Models	
Earned revenue models	By using these models, publishers conduct activities, provide services, or sell items for which they charge a fee to generate revenue.
Embedded institutional support	The subsidy originates from its parent company, e.g. university, university library, research centre or institute, or association.
Third-party subsidies	Grants are provided by external stakeholders (commercial and non-profit organisations);
Consortia models	Many stakeholders provide the funding of many presses without direct service provision.

(Piennar,2016)

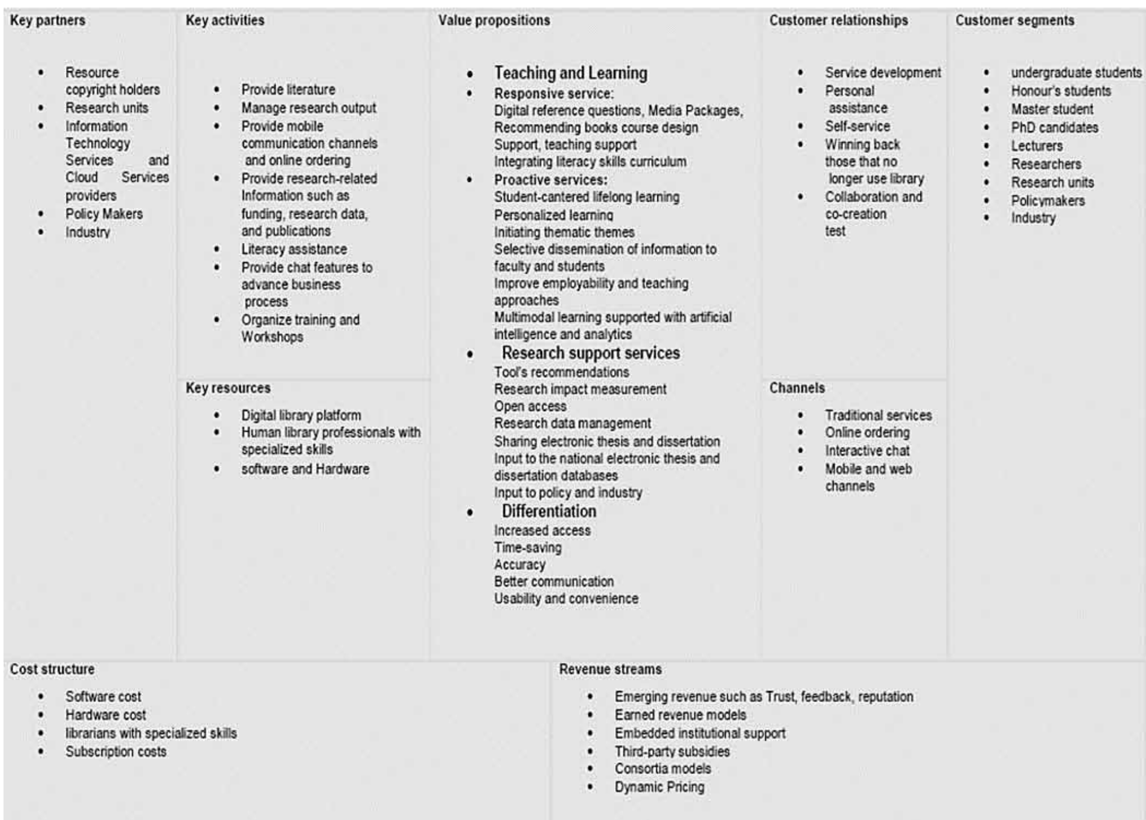
the target customer or patrons to whom the company wants to offer value, specifying customer segments (Osterwalder et al., 2005, Pateli & Giaglis, 2004). Target customer segmentation is an essential aspect of the business model. Osterwalder and Pigneur (2010) noted that customers are at the heart of the business model, as the company will not survive without profitable customers. As Kansen and Mantykangas (2014) suggested, as a starting point, one should not always focus on existing users and analyse their contexts but instead, use a multi-disciplinary team familiar with users to identify customer segments. In addition, segmenting users into specific categories with the same characteristics will help programs create good value propositions (Rasuli et al., 2018). For example, some potential customers for digital libraries may generally include students, lecturers and researchers (Kansanen & Mantykangas, 2014). Furthermore, target customers' research support services may be highly literate users, including master's and PhD students and lecturers (Maryati et al., 2022). Target customers for electronic thesis and dissertations may be segmented into academics such as faculties, students, researchers, policymakers and industry as policymakers and industry may be interested in the research conducted in HEIs (Rasuli et al., 2018).

The customer relationship is one key element that digital libraries need to redesign. As in the transformation from physical libraries to digital libraries, library management and libraries' relationships with patrons are transforming (Kansanen & Mantykangas, 2014). Moreover, according to Maryati et al. (2022), customer relationships and business processes need to be improved to maintain the libraries' relationships with users, win back people who no longer use the library for information search, keep the current library users from leaving the library and switching to other sources of information. In addition, Sharifabadi (2006) highlights that in the context of digital libraries, relationship management needs to focus on collaboration, sharing knowledge and information among library staff, researchers, faculty, students, and other departments within the institution, encouraging teamwork, developing skills, and building solid and trusting relationships.

CONCLUSION, RECOMMENDATIONS AND LIMITATIONS

The business model canvas potential for designing and mapping academic digital libraries in South African HEIs has been discussed. Academic library teams may use a business model canvas to design and deliver innovative digital services to address challenges faced by HEIs. In particular integrating digital libraries to support both postgraduate and undergraduate throughput targets. Inclusive of providing support for teaching and learning to improve graduation rates for undergraduate studies is one of the main challenges. Moreover, digital research support services may be explicitly targeted at faculty, academics, students, research departments, policymakers and industry. The figure below illustrates a potential business model canvas for South African HEIs digital libraries, including value propositions that may be adopted for teaching and learning and research support services as drawn from the review.

Figure 1. Proposed roadmap for the implementation of a business model canvas HEIs digital libraries



The chapter seeks to examine the business model canvas from the perspectives of HEIs digital libraries in South Africa. The fundamental limitation is that the paper, whilst attempting to explore the value of the business model canvas in research, teaching, and learning, has not investigated the business model canvas's potential to enhance community engagement. As such future research may look at the possibility of business model canvas for innovative design of services to support community engagement. Moreover, empirical insights from HEIs in South Africa may share new insights on how the business model canvas may be adapted in HEIs academic libraries.

REFERENCES

Adebayo, O., Iwu-james, J., Olawoyin, O., Fagbohun, M., Esse, U., Yusuf, F., Segun-adeniran, C., Izuagbe, R., & Owolabi, S. (2019). Blended learning in higher education: implication and strategies for academic library support. *13th International Technology, Education and Development Conference*.

Alt, R., & Zimmerman, H. (2001). Preface: Introduction to special section business models. *Electronic Markets*, *11*, 3–9.

Bekele, T. A., & Ofoyuru, D. T. (2021). Emerging university-society engagements in Africa: An analysis of strategic plans. *Journal of Comparative & International Higher Education*, *13*(1), 151–180. doi:10.32674/jcihe.v13i1.1690

Belleflamme, P., & Neyse, N. (2020). *A multisided value proposition canvas for digital platforms*. Available:https://alfresco.uclouvain.be/alfresco/service/guest/streamDownload/workspace/SpacesStore/.pdf

Boamah, E., & Liew, C. L. (2017). Conceptualising the digitisation and preservation of indigenous knowledge: The importance of attitudes. *International Conference on Asian Digital Libraries*. 10.1007/978-3-319-70232-2_6

Chelsa. (2021). *State of South African academic libraries report embracing new frontiers*. Available: https://chelsa.ac.za/wp-content/uploads/2021/08/StateOfSouthAfricanLibrariesReport.pdf

Chesbrough, H., & Rosenbloom, R. S. (2002). The role of the business model in capturing value from innovation: Evidence from Xerox Corporation's technology spin-off companies. *Industrial and Corporate Change*, *11*(3), 529–555. doi:10.1093/icc/11.3.529

Chowdhury, G. (2014). Sustainability of digital libraries: A conceptual model and a research framework. *International Journal on Digital Libraries*, *14*(3-4), 181–195. doi:10.100700799-014-0116-0

Corbin, J., & Strauss, A. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. Sage Publications. doi:10.4135/9781452230153

Du preez, P., Verhoef, A. H., & Simmonds, S. (2016). Rethinking and researching transformation in higher education: A meta-study of South African trends. *Transformation in Higher Education, 1*, 1-7.

Fox, E. A., Akscyn, R. M., Furuta, R. K., & Leggett, J. J. (1995). Digital libraries. *Communications of the ACM*, *38*(4), 22–28. doi:10.1145/205323.205325

Gonçalves, M. A., Moreira, B. L., Fox, E. A., & Watson, L. T. (2007). What is a good digital library?" A quality model for digital libraries. *Information Processing & Management*, *43*(5), 1416–1437. doi:10.1016/j.ipm.2006.11.010

Gordijin, J., & Akkermans, H. (2006). *Early requirement determination for networked value constellations: A business model ontology approach*. Free University Amsterdam VUA.

Hastut, I. K., Muslih, M., Syarif, A. M., & Mulyana, A. R. (2021). A Conceptual Digital Library Model for Validated Content-based Preservation of Traditional Javanese Songs. In *4th International Seminar on Research of Information Technology and Intelligent Systems (ISRITI)*. IEEE.

Hedman, J., & Kalling, T. (2003). The business model concept: Theoretical underpinnings and empirical illustrations. *European Journal of Information Systems*, *12*(1), 49–59. doi:10.1057/palgrave.ejis.3000446

Hinterhuber, A., & Liozu, S. (2012). Is it time to rethink your pricing strategy. *MIT Sloan Management Review*, *53*, 69–78.

Iwu, C. G., Musikavanhu, T. B., Ukandu, H., & Dassah, M. (2019). Administering postgraduate education for success: The necessity for postgraduate orientation. *Academia (Caracas)*, *16-17*, 185–210.

Jadhav, U. S., & Alur, S. (2021). Impact of COVID-19 on Academic Library Services. In G. Rathinasabapathy, K. Veeranjaneyulu, & V. Srinivasa (Eds.), *Management of knowledge resource centres in the networked digital environment*. BS Publications.

Jagatap, S. W., & Shaikh, I. (2018). Mapping of Literature on digital library by J-Gate Database. *Knowledge Librarian An International Peer Reviewed Bilingual E-Journal of Library and Information Science*, *5*, 2.

Johnson, W. M., Christensen, M. C., & Kagermann, H. (2008). Reinventing your business model. *Harvard Business Review*, *86*, 59–67.

Kansanen, A. & Mantykangas, A. (2014). The challenge of organizing future libraries. *International Journal of Advanced Statistics and IT&C for Economics and Life Sciences, 4*, 42-48.

Keller, C. M. (2020). *Foreword*. Johns Hopkins University Press.

Khalid, J., Ram, B. R., Soliman, M., Ali, A. J., Khalee, M., & Islam, M. S. (2018). Promising digital university: A pivotal need for higher education transformation. *International Journal of Management Education*, *12*, 264–275.

Lewis, C., Wolff, K., & Bekker, B. (2021). Supporting project-based education through a community of practice: A case of postgraduate renewable energy students. *World Transactions on Engineering and Technology Education*, *19*, 35–40.

Manduca, C. A., Fox, S., & Iverson, E. R. (2006). Digital library as network and community center. *D-Lib Magazine: the Magazine of the Digital Library Forum*, *12*(12), 12. doi:10.1045/december2006-manduca

Marchionini, G., & Maurer, H. (1995). The roles of digital libraries in teaching and learning. *Communications of the ACM*, *38*(4), 67–75. doi:10.1145/205323.205345

Marginea, E., & Kifor, C. V. (2021). Academic Libraries as user-centered organizations. Case study: Quality of services provided by LBUS Library. In *MATEC Web of Conferences.* EDP Sciences.

Maryati, I., Purwandari, B., Santoso, H. B., Budi, I., Solichah, I., & Gani, F. (2022). Research Support Services in Indonesian Academic Digital Libraries A Proposed Business Model and Prototype Design. *DESIDOC Journal of Library and Information Technology*, *42*(1), 18–29. doi:10.14429/djlit.42.1.17108

Megwa, C. P. (2022). *The Impact of Technology On Teaching and Learning In Higher Institutions: A Literature*. Available: https://www.researchgate.net/profile/ChukwuemekaMegwa/publication/357824376

Morris, M., Schindehutte, M., & Allen, J. (2005). The entrepreneur's business model: Towards a unified perspective. *Journal of Business Research*, *58*(6), 726–735. doi:10.1016/j.jbusres.2003.11.001

Ngulube, P. (2018). Overcoming the difficulties associated with using conceptual and theoretical frameworks in heritage studies. In P. Ngulube (Ed.), *Handbook of research on heritage management and preservation*. IGI Global. doi:10.4018/978-1-5225-3137-1.ch001

Ntshuntshe-matshaya, P. P. (2019). Investigating the Relevance of Quality Measurement Indicators for South African Higher Education Libraries [Doctor of Philosophy]. University of the Western Cape.

Osterwalder, A. (2004). *The business model ontology a proposition in a design science approach* [PhD]. Lausanne.

Osterwalder, A., & Pigneur, Y. (2010). *Business model generation*. John Wiley & Sons.

Osterwalder, A., Pigneur, Y., & Tucc, I. L. C. (2005). Clarifying business models: Origins, present, and future of the concept. *Communications of the Association for Information Systems*, *16*, 1–25. doi:10.17705/1CAIS.01601

Pateli, A., & Giaglis, G. M. (2004). A research framework for analysing e-business models. *European Journal of Information Systems*, *13*(4), 302–314. doi:10.1057/palgrave.ejis.3000513

Petrovic, O., Kittl, C., & Teksen, R. D. (2001). Developing business models for ebusiness. *International Conference of Electronic Commerce*.

Rasuli, B., Alipour-hafezi, M., & Solaimani, H. (2018). Analyzing national electronic theses and dissertations programs from business model perspective: Cross-case analysis. *Online Information Review*, *42*(2), 250–267. doi:10.1108/OIR-08-2016-0223

Reddy, P. R. (2017). Measuring of quality services in the libraries. *International Journal of Library and Information Studies*, *7*, 144–149.

Richardson, J. (2008). The business model: An integrative framework for strategy execution. *Strategic Change*, *17*(5-6), 133–144. doi:10.1002/jsc.821

Rof, A., Bikfalvi, A., & Marques, P. (2022). Pandemic-accelerated digital transformation of a born digital Higher Education Institution: Towards a customized multimode Learning strategy. *Journal of Educational Technology & Society*, 25.

Roller, M. R., & Lavrakas, P. J. (2015). *Applied qualitative research design: A total quality framework approach*. Guilford Press.

Rose, J., Holgersson, J., & Soderstrom, E. (2019). Designing innovative digital services for government: A business model canvas adaptation. In *27th European Conference on Information Systems (ECIS)*. Association for Information Systems.

Sharifabadi, S. R. (2006). How digital libraries can support e-learning. *The Electronic Library*.

Si, L., Zeng, Y., Guo, S., & Zhuang, X. (2019). Investigation and analysis of research support services in academic libraries. *The Electronic Library*, *37*(2), 281–301. doi:10.1108/EL-06-2018-0125

South Africa. (2021). Statistics on Post-School Education and Training in South Africa: 2019. Pretoria, South Africa: Department of Higher Education and Training.

Swan, A. (2008). *The business of digital repositories*. Available: http://citeseerx.ist.psu.edu/viewdoc/download?doi:10.1.1.170.1389&rep=rep1&type=pdf

Town, J. S. (2011). Value, impact, and the transcendent library: Progress and pressures in performance measurement and evaluation. *The Library Quarterly*, *81*(1), 111–125. doi:10.1086/657445

Tran, Y., Rene, C. G., & Boer, H. (2015). Managing business model innovation risks - lessons for theory and practice. *16th International CINet conference on Pursuing Innovation Leadership*.

Tunga, S. K. (2021). Library services in digital environment: Challenges and strategies in Covid-19 pandemic situation. *Journal of Advances in Library and Information Science*, *10*, 94–101.

Wheatley, A., & Hervieux, S. (2019). Artificial intelligence in academic libraries: An environmental scan. *Information Services & Use*, 347–356.

ADDITIONAL READING

Gonçalves, M. A., Moreira, B. L., Fox, E. A., & Watson, L. T. (2007). What is a good digital library? A quality model for digital libraries. *Information Processing & Management*, *43*(5), 1416–1437. doi:10.1016/j.ipm.2006.11.010

Markscheffel, B., Fischer, D., & Stelzer, D. (2008). Classification of Digital Libraries - An e-Business Model-Based Approach. *Journal of Digital Information Management*, *6*(1), 71–79.

Ming, Y. (2020). Digital services in academic libraries: Present and future. *Public Services Quarterly*, *16*(1), 59–64. doi:10.1080/15228959.2019.1706692

Noh, Y. (2015). Imagining library 4.0: Creating a model for future libraries. *Journal of Academic Librarianship*, *41*(6), 786–797. doi:10.1016/j.acalib.2015.08.020

Sun, M. (2014). The research on the development of smart library. *Applied Mechanics and Materials*, *571*, 1184–1188. doi:10.4028/www.scientific.net/AMM.571-572.1184

Witten, I. H., Bainbridge, D., & Nichols, D. M. (2010). *How to Build a Digital Library* (2nd ed.). Morgan Kaufmann Publishers.

Zirra, P. B., Ibrahim, A. J., & Abdulganiyyi, N. (2019). A review of digital libraries and their impact in Africa. American. *Journal of Computer Science and Technology*, *2*(4), 60–67.

KEY TERMS AND DEFINITIONS

Academic Library: An academic library is a big repository of information and knowledge from all fields of learning to disseminate and store information for the users and it serves to support the school's curriculum and to support the research of the university faculty and students.

Business Model Canvas: The business model canvas is a strategic management tool that lets organization visualize and assess it business idea or concept. It essentially describes the business logic of a firm and how it creates, delivers, and captures value.

Digital Library: A digital library, also called a virtual library, provides technology-based information and services to enable learners to access relevant information and services anywhere anytime. It can include text, still images, audio, video, digital documents, or other digital media formats or a library accessible through the internet.

Digital Transformation: Digital transformation is the process of using digital technologies to transform existing traditional and non-digital business processes and services or creating new ones, to meet with the evolving market and customer expectations, fundamentally changing how they operate and deliver value to customers.

Higher Education Institutions: Higher education institutions are universities, colleges and further education institutions offering and delivering higher education.

Chapter 3

Contemporary Trends and Technologies in Research Libraries:
An Overview

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ABSTRACT

This chapter discusses some of the contemporary trends and emerging technologies in research libraries. The chapter begins by explaining the concept of a research library and differentiating between the services offered in traditional versus digital research libraries. The contemporary trends and technologies discussed in this study include big data, blockchain technology, podcast, vodcast, data everywhere, drones, robotics and artificial intelligence (AI) technology, unplugged, makerspace, and the internet of things (IoT). The chapter is important to library users, librarians, and the general public interested in library practices.

INTRODUCTION

A research library is owned by institutions seeking to promote access to scholarly materials and support research. A typical research library contains extensive print and non-printed materials on a broad spectrum of subjects. Therefore, primary and secondary literature can be accessed from a research library. We can refer to libraries in universities and research institutions as research libraries since they contain specialised branches attending to different disciplines. There are two types of research libraries – refer-

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ence and lending libraries. In practice, reference research libraries do not allow external users to borrow/lend from their collections, whereas lending research libraries render lending services to interested users. Research libraries are designed to satisfy the demands of researchers and are, therefore, filled with authentic and high-quality materials. Traditionally, the worth of a research library is determined by its size. Collection size, budget, expenditures, and staff are other input measures representing the library's effort and potential to meet users' demands (Nitecki & Franklin, 1999). These input metrics do not account for how users' requirements and expectations are successfully met.

The impact of research libraries is quantified somehow, especially in terms of users' interaction with materials and services. Users' expectations are set before the interaction, and their impression of the library services provided is assessed. Part of the impact is quantified by querying the gap between expected standards and users' perceptions. Therefore, the user is a critical evaluator of the library's influence. Through digitisation programmes and agreements for licences that allow subscription collections, research libraries can make computational use of collections easier. As the knowledge of the public regarding data visualisation and analytics develops, so does the number of new users (including librarians) who wish to experiment with computational tools. Many of these users are only at the beginning of their learning curve. Internally, research libraries have many opportunities to apply data-centric techniques like machine learning to augment descriptive information and produce text corpora (Calvert, 2020). This chapter discusses the library services offered in the digital age and the contemporary trends and technologies in research libraries. Following completion of this chapter, the reader should be able to:

- Understand and explain the meaning of a research library.
- Differentiate between library services offered traditionally and digitally.
- Identify and comprehend trends and technologies used in research libraries.

LIBRARY SERVICES IN THE DIGITAL AGE

We live in the digital age, and in many situations, the central role of information in this era is digital (Mayega, 2008). There is increased Internet usage for information spread and retrieval in today's world, which has affected the way knowledge is gathered and used (Owan et al., 2021; Owan & Asuquo, 2021). The shift toward electronic research libraries has dramatically altered the public's views towards considering conventional libraries. The digital network is the principal mechanism for sharing information. Information across different file formats (such as audio, text, video and audio-visuals) is now easily created, managed, stored and accessed in ways that were only imaginable some decades back. Emerging technologies enable library professionals to identify, gather, organise, customise, and distribute information products and services to the user community in various forms and kinds, both on-demand and in advance, in physical and virtual locations, in real-time (Ayo-Olafare, 2020). Consequently, many libraries are spending to buy digital library materials to satisfy modern-day expectations.

There are several ways in which a research library can utilise the Internet, ranging from setting up a library website to allowing consumers to browse existing catalogues electronically. Scholarly materials such as published research papers may be found using specialised search engines. People may do research on the Internet using the computers and Internet connectivity available in public libraries (Mostapha, 2005). Users under the age of 30 are especially drawn to the convenience and accessibility of online library resources (Corradini, 2006; Snowball, 2008). Most libraries are significant partners for google search engines because of their extensive collection of relevant information and have gained corresponding advantages in circumstances in which they have brokered (Darnton, 2009). Digital research libraries have shifted their focus from primarily offering print materials to delivering more internet connectivity. A variety of issues confront research libraries in adjusting to new methods of service delivery (Abram & Luther, 2004). This makes information literacy capabilities less critical. The fall in the use of libraries, especially in reference services, raises doubts about the need for these services. For libraries to thrive with the Internet and avoid losing customers, library researchers have admitted that they must improve their advertising campaigns. In addition, this involves advocating the importance of information training opportunities in the library community.

DIGITAL SKILLS NEEDED IN THE DIGITAL TRANSFORMATION ERA

Many branches of study, including the humanities, have been touched by digital transformation. Digital transformation is a trend that corporations have been aware of for several years and as technology advances at an astounding rate, digital transformation moves businesses forward. It occurs when businesses recognise the value of social learning in the design and delivery of information, problem-solving, knowledge sharing, and user-generated content (Sousa & Rocha, 2018). However, in the twenty-first century, the variety of digital transformation applications is astounding. Speed is no longer the only advantage, as digital technology's ease, power, variety and speed affect everything from interactivity to accessibility (Fonseca & Picoto, 2020). The rise of new digital technologies is compelling businesses to transform their products, services, workflows and business models (Moroz, 2018). Enterprises were the first to recognise the primary benefit of digital technology speed when computers initially made their way into offices. Nowadays, the increasing number of research libraries are also positioning themselves to take advantage of these advancements and acquire a competitive advantage.

However, the number of potential digital service applications and software types and their interaction with users is so vast that experts with the appropriate digital skills are required to use all emerging digital tools in this new digital era. Our lives are more reliant on technology, and as our reliance on the Internet and digital communications grow, our workforce must adapt to meet the changing skill demands. For decades, digital skills have been required in the workplace. Digital skills are defined as using digital devices such as computers and smartphones to search, assess, use, share, and create content. There has always been a demand for digitally inclined individuals, such as IT specialists and staff who can securely eject a floppy disc, as long as computers, servers and electronic communications have existed. All organizations in the digital economy, including academic and research libraries are coming to realise that digital skills are vital for their employees in the digital transformation era. Research libraries want the great majority of their library staff and team, not just a select few, to have solid digital abilities to stay relevant in this digital era. The library staff and team must have the following digital abilities for a successful digital transformation.

- **Data Analytics:** Data and analytics are the primary accelerators of an organisation's digitisation and transformation activities. Any digital transformation effort will generate a large amount of data. As a result, the most in-demand skill sets should be data analytics, market research analytics, and database administration (Saha, 2018).

Figure 1. Digital skills for digital transformation

- **Digital security:** Digital security is the umbrella word for the resources used to safeguard your online identity, data, and other assets. Web services, antivirus software, smartphone SIM cards, biometrics, and encrypted personal gadgets are examples of these tools.
- **Digital marketing:** Digitally aware marketers who understand and capitalise on the degree of involvement provided by digital marketing have the best chance of creating an impression on consumers. Social media, video creation, email marketing, and content marketing are all effective channels of promotion that necessitate a well-rounded skill set.
- **Cloud Computing:** Cloud computing is an excellent tool at their disposal to help them expedite their transformation efforts. Cloud computing empowers businesses to collaborate with cloud service providers and provides intelligent, readily available, adaptive, and flexible digital solutions.
- **Critical thinking:** The ability to assess material logically and make a reasoned decision based on your analysis is known as critical thinking. Critical thinkers refuse to take things at face value and are conscious of their own cognitive biases, allowing them to arrive at objective judgments.
- **Creativity:** Creativity is the capacity to approach a task or problem in a new or unique way or use one's imagination to develop novel ideas. Creativity allows you to solve complex problems or create novel approaches to assignments.
- **Big Data:** The significance of big data in digital transformation stems from an organisation's ability to combine both in its attempts to enable both digitalisation and automation of business activities. This digitalisation and automation drive efficiency, innovation, and the development of new business models.
- **Social media:** Social media skills assist professionals in developing and implementing marketing initiatives to promote a company. To be successful, you must have a unique flair and an awareness of what makes material shareable, and your social media skills description should reflect these attributes.
- **Machine Learning:** Machine learning requires computation on enormous data sets. Therefore, solid foundational abilities in computer architecture, algorithms, data structures, and complexity are required. Getting into the programming books in depth and trying new things will be beneficial.

- **Blockchain:** The Blockchain Platform will be critical in ushering businesses into the digital transformation age. By providing a means to secure data exchange, dynamic apps, and decentralised identification, the Blockchain Platform enables digital transformation use cases. It allows businesses to improve application modernisation by automating business operations, launching new digital products, and monetising essential digital content (Prakash & Ambekar, 2020).

CONTEMPORARY TRENDS AND TECHNOLOGIES IN RESEARCH LIBRARIES

Numerous trends and technologies are implemented by various research libraries worldwide. The prominent trends and technologies in research libraries include Big Data, Blockchain, Podcast, Vodcast, Data Everywhere, Drones, Robotics, Artificial Intelligence Technology, Unplugged, Makerspace, and the Internet of Things. The world is continually evolving, and new technologies are adopted regularly (Shashikumara et al., 2019). Library professionals must identify and comprehend future library trends and technologies to plan and implement new solutions (Axiell Group AB, 2016). Trends and innovations that impact society and research libraries are no exception. This chapter discusses the most important trends and technologies in research libraries below.

Big Data

Big data is large-scale data that continue to grow without decreasing, taking different forms. Every second, a massive quantity of data sets is generated from all over the globe, meaning that the volume of data will never decrease but will instead continue to grow. To acquire, curate, manage, and analyse such datasets reasonably, commonly used software technologies cannot keep up with the growing amount of big data. Based on the developments in research on big data, it has been documented that big data is characterised by 17 V's and one C (Arockia et al., 2017). These attributes include voluntariness, volume, volatility, vocabulary, visualisation, viscosity, virality, versatility, verbosity, veracity, venue, velocity, variety, variability, value, validity, vagueness, and complexity.

Large volumes of data may be collected, stored, manipulated and analysed by research libraries using big data technologies. Books, e-books, online journals, research papers, conference proceedings, seminar papers, institutional repositories, and other materials make up most of the library's collection. Electronic and physical setups are specifically designed for research scholars and clients to meet their data requirements. Large-scale database analysis is required to keep up with the never-ending inflow of data and knowledge. Libraries are great for benefiting from Big Data while also delivering analytic library services to users. Researchers may now use library services such as data management strategy, data collection, data curating, and information archival (Sugimoto et al., 2012).

Today, "Big Data" is mentioned commonly in news headlines and other published content (Wittmann & Reinhalter, 2014). Big data is gaining traction in the data and correspondence period (Ball, 2019). Currently, "Big Data" is a developing topic that poses several IT issues regarding data gathering, storage, search, structure, and visualisation (Garoufallou & Gaitanou, 2021). While we as librarians have a few practical and powerful strategies for managing this type of data, there has not been much research on using metadata to create computerised resources using apparatuses such as big data and distributed computing innovation (Panda, 2021). For research libraries, Big Data analytics faces two main challenges: first, the sheer nature of the data needs an enormous amount of computational power and storage; second, the analytical methods and algorithms themselves are complex, making Big Data analytics a computationally demanding endeavour (Al-Barashdi & Al-Karousi, 2019). Cloud has proven to be the most suitable infrastructure solution for supporting Big Data analytics applications' storage and processing needs.

Blockchain Technology

The blockchain is a distributed, tamper-resistant data storage system (Singh et al., 2022). This is in line with librarians' usual practices of gathering, preserving, and disseminating authoritative information. Blockchain is a relatively new and dependable technology that aids in data protection, preservation, and reliability (Abid, 2021). Libraries are 21st-century change agents, integrating new technologies to deliver maximum information in the shortest time. Blockchain technology may be utilised to address several issues in the library sector, such as securing information in a distributed, tamper-resistant framework. The blockchain ledger may be used for various applications outside financial markets, including tamper-proof publications, distributed ownership records, and academic archives in libraries (Hoy, 2017).

Blockchain technology can also enable the smooth borrowing of research materials among libraries and between libraries and users. Issues of borrowing without proper record-keeping will be forgotten stories with the implementation of blockchain technology in research libraries. For instance, the COVID-19 experience coupled with other social changes occasioned homelessness, statelessness, employment and travel, resulting in groups of individuals who are permanently or temporarily displaced from their homes. Research libraries in the digital era must adapt to accommodate them. Refugees and migrants of all ages need access to information resources that may assist them in developing new skills and finding jobs. Libraries may provide services that these communities cannot get elsewhere, yet they often are unable to obtain a library card or borrow goods. Developing an interoperable blockchain-based system that connects all library systems and a secure, verifiable digital identity that can be used to access information at participating libraries.

The blockchain will allow unlimited access to digital content and print collections for all participants to secure users' privacy and personal identity. The International Federation of Library Associations (IFLA) might prototype a global interlibrary loan system with blockchain technology. Due to the nature of interlibrary loans and the foreign currency transactions involved. Blockchain technology may evaluate the validity (correctness) of data over time. Some scholars successfully showed the feasibility of a low-cost, independently verifiable technique for auditing and certifying the legitimacy of scientific investigations (Irving & Holden, 2016). They accomplished this by generating a new private Bitcoin key from the plaintext of a protocol trial paper. As a result, researchers can instantly verify the blockchain's timestamp. When comparing the original record's hash to the blockchain's, the records have been altered if the two hashes do not match.

Podcast

A podcast is an entertaining method to advertise library collections services to attract new readers (Lee, 2006). Podcasting provides libraries with intriguing opportunities to communicate with their users in a new and well-known way. It can help remove barriers, relieve pressure or anxiety students may have about using the library and put a welcoming face on the library. Libraries can take advantage of the popularity of podcasting and use it to spread information to a larger audience. Clients have another option to receive ready-made knowledge in a compact format using podcasting technology in library services, which develops a mobile learning environment. Due to the importance of many libraries, such as the Los Angeles public library, London library, Library of Congress, the British Library, DC library, free library Philadelphia, Kiama Library, and the New York library, among others, are now using podcasting service to organise and promote otherwise difficult-to-find scholarly and recreational items. It is expected that librarians will walk away with direct marketing and organising ideas and ideas for how to promote and organise this relatively new medium in the years ahead. Libraries can also use podcasts to host authors and well-known citizens for various annual activities. In order to listen to these activities, individuals may either download one of the audio programmes listed or subscribe to the libraries' authors and events podcasts.

Vodcast

Vodcast is derived from the root term "Vod", which is an acronym for "video on demand" (Kolbitsch & Maurer, 2006). Vodcasts, also known as video podcasts, are an extension of the development of podcasts, albeit they differ in that they are not just audio in nature but also visual (Naidu & Constable, 2016). Vodcasts are, by definition, a collection of audio-visual materials that may be downloaded to a personal computer or other video-enabled connected devices through the Internet (Greef, 2012). Vodcasts need more storage space due to the audio and video components. Libraries utilise vodcasts to show their accomplishments and attract the public to check out their upcoming events. Videos of library programmes and activities have become a popular way for libraries to demonstrate their successes while also encouraging attendees to future events. Teachers and students can connect effectively outside a classroom in real-time.

Along with increasing lecturer-student interaction, the vodcast reduces the need for face-to-face counselling by extending the relationship beyond classroom time (Sutton-Brady, 2009). The use of vodcast is an effective way of reducing face-to-face interactions, especially now that social distancing is encouraged due to the Covid-19 pandemic. Due to its importance, many scholars are now interested in how students' learning outcomes can be enhanced through vodcasting (Backhaus et al., 2019; Goundar & Kumar, 2021; Yeganeh & Izadpanah, 2021).

Data Everywhere

Data Everywhere was founded by Dan McGee and Dave Bortz in November 2013 and is in Chicago, Illinois. Data Everywhere is an add-in for spreadsheets that enables sharing specific datasets with other spreadsheets, databases, websites, and mobile devices. It connects existing spreadsheets to a cloud-based data management service that provides replication, security, revision control, basic workflow, and search for these applications. Ordinary business users may share their data with co-workers and other parties as raw data rather than as files that have been embalmed, enabling other users to remix the data in novel ways. As opposed to a mere document, Excel as a data source enables Data Everywhere users to create new sorts of applications that would have previously required specialised programming. Data collection and management are critical in today's libraries. New technologies provide excellent opportunities to collect, store, and analyse accurate user data and personal information. Data can be accessed using mobile phones, iPads, and other internet-connected devices. Data can be used to produce products and services, boost marketing, and promote information in the news. Data services have evolved into essential information services for libraries, allowing researchers to link with research from other studies (Library of the Future, 2018).

Organisations of all sizes, from large corporations to start-ups, will need to be adept at capturing, storing and consuming data. This must be a never-ending data cycle in a feedback loop. This data cycle can be addressed with a slew of tools and technologies, but their effectiveness is contingent on the direction and governance provided by the organisation. Work on your data strategy always, as this will help your company improve its overall performance, empower employees, and provide more control over their data and data-driven decisions. There are several tools available for businesses to use after having enough data. Organisations may encounter several obstacles when implementing and managing their data strategy (e.g., issues might arise from architecture, data infrastructure, competencies, operational expenses, business user expectations, people, etc.) as they go down the data analytics journey lane. These issues must be addressed and resolved as soon as possible.

Drones

Drones, also known as unmanned aerial vehicles (UAVs), are becoming more popular in various industries, including leisure, security, military, agriculture, energy, insurance, and hydrology. Robots that fly in the air, called drones, perform many tasks such as taking pictures, recording films, and gathering data in various formats from their surroundings. Fixed-wing and multirotor drones are the two main categories. Multirotor drones can operate in places where people cannot, gather data in several formats, and even intervene when necessary due to their portability and size (Natarajan et al., 2018). In addition, multirotor drones with protective hulls are very durable in collisions, making them even more helpful for exploring unexplored territory. Parcel delivery services and other organisations use flying robots (Gatteschi et al., 2015). Though several well-known drone variants have been in use for over two decades, the public's attention has been drawn to newer models and technologies that have not been around as long. Applications of drones have experienced a significant paradigm shift. Even while drones have become an essential part of contemporary warfare, their use for non-military purposes has increased significantly. Consequently, drones are now used in other areas such as aerial photography and filming, shipping, search and rescue, geographic mapping, wildlife monitoring, law enforcement, crop inspections, pollution inspections, and meteorological services.

Drones may be used at the library because of their wide range of non-military applications. It's difficult for folks in today's fast-paced world to visit the library at their convenience. The fact that you are in the wrong place at a bad moment further compounds the problem. People who live near a library or have access to a time-saving route away from regular heavy traffic may use these advantages, but this is not the case for everyone. Drones may be used for a variety of purposes. Using drones to deliver books and other library resources to users might be a game-changing feature of this new technology (Nath, 2018). The first and most important prerequisite for a library to provide a drone delivery service is a library mobile app or a mobile-friendly library website (Saloi, 2021). Drones are helpful for library organisations (Nath, 2018). Modern flying robots outfitted with technology can transport books, furniture, and other items from one location to another. Using the app or website, library patrons may borrow items from the collection; however, this needs a user login and the ability to reveal their current location and delivery address. It may also be used as a security measure both inside and outside the library and is significantly superior to fixed cameras because it moves and covers the entire area, providing 24-hour observation. The preponderance of national and district libraries is in metropolitan regions. Many people no longer find it easy to visit the library as cities develop, despite its central location, which was meant to promote exposure and accessibility. Population expansion in the city has increased the number of library customers who travel far to visit. Persons who can only attend the library after work, people who can't visit for personal or professional reasons, traffic congestion, or the absence of public transit or direct routes to the library may need many taxis or buses to reach the library (Nath, 2018). This limitation may be overcome by sending books to a specified location, generating new potential for libraries and users. The procedure begins with a patron requesting a book through a specific library app, which is then received and processed by the library's concerned section. The ordered book is carried to the drone department, where a skilled pilot attaches the book to the drone and allows it to fly to the patron's hand. It automatically returns to the origin after delivery, with all essential operations and advancements updated for both sender and receiver.

Robotics and Artificial Intelligence (AI) Technology

Libraries are progressively adopting robotics and AI technology (Harada, 2017). AI and robotics are powerful for automating activities within and outside industrial facilities. In recent years, AI has become more prevalent in robotic solutions, bringing adaptability and learning capabilities to previously inflexible applications (Vysakh & Rajendra, 2019). This highlights how libraries can combine robotics with other AI technologies, such as using a drone controlled by a robot to keep the library under constant observation. As a user help and guide, talking robots can be put throughout the library.

The application of AI in libraries is to construct computers or robots that can think, act and, in some situations, surpass human intellect. This has been shown to have obvious implications for librarianship (Omame & Alex-Nmecha, 2020). Consequently, many public and research libraries are now using artificial intelligence for different purposes. Some options include expert systems for reference services, robots that can read books and shelves, and virtual reality for immersive learning. Cataloguing and topic indexing, reference services, technical support, and shelf-reading are all instances of artificial intelligence in library systems.

Unplugged

Unplugging can mean various things, but it always implies a break from the fast-paced, overstimulating, and sometimes frenetic world of technology that propels so many of us through our days. Unplugging, then, implies taking a break from a typical routine and creating a quieter zone to engage in undistracted action, engagement, or inaction. Libraries will continue to be significant sources of technological access. At the same time, libraries are all about making connections (ALA Libraries Transform, 2018). People often need to unplug to create those connections, and libraries have developed creative ways to assist users. Unplugged gives students access to high-quality reference materials to help them study. This brings the library into the classroom and the house, always making it available in e-books on any device.

Makerspace

The Makerspace, a combination of two notions ('Maker' and 'Space'), is an offspring of the technology era's innovativeness, symbolising a blending of two worlds (Omosebi & Bakare, 2022). Makerspaces, also known as Hackerspaces or FabLabs, are self-contained spaces where people may create, develop, and study. 3D printers, software, electronics, supplies and hardware, craft equipment, and other goods are regularly found in libraries (Public Library News, 2012). Makerspaces are becoming more frequent in public, academic, and research libraries as a creative method to engage users and provide value to traditional library services.

Internet of Things (IoT)

IoT is a new technical change that library and library personnel should be familiar with since it will help libraries improve their facilities, tools, and experience. Libraries will be able to add more value to their services and deliver a better library experience to their clients. Because items are individually identifiable, the Internet of Things is about digitally connecting them. Radio Frequency Identity (RFID), which does the same thing by communicating with computers, marks and updates library management systems with entries to books given to a customer, is still familiar to librarians. However, the difference with IoT is that the Internet interacts with a thing or entity, such as a book. The Internet of Things (IoT) can assist address some of the most common library concerns, such as object misplacement and use, by connecting books, articles, CDs/DVDs, theses, and other physical items (Singh et al., 2022).

The IoT may be used in libraries to provide patrons with easy access to both traditional and online collections and data and directories. For example, librarians and library users may find it easier to discover actual artefacts and explore virtual resources with this technology. Contextual recommendations and information about resources relevant to the current user's interests might likewise be sent using this method. Other aspects of library service, such as consultation and training, might benefit from the IoT. Users' moods, daily habits, and other similar details gleaned from their mobile devices through the IoT might be utilised to create personalised training programmes (Qin, 2018). The IoT may also alert users to the lack of space in the reading room or the absence of workstations. Other commercial IoT applications exhibited more exciting prospects when compared to various library activities. Although the IoT has the potential to be utilised often in marketing and promotion, its value does not seem to be limited to this area. Other uses include process optimisation, library workflow structuring, and the development of unique economic models that make libraries more fun for users and other stakeholders. For a library to be seen as a contemporary institution, it is essential to use IoT-based marketing tactics to promote its operations. Internal libraries might benefit from this technique as well. For example, resource collection, description, analysis, intelligent construction, and suitable resource storage are functional areas of IoT in research libraries.

FACTORS MILITATING AGAINST THE ADOPTION OF THESE TECHNOLOGIES

Almost every organisation faces difficulties with technology adoption. Indeed, presenting new technology to an organisation might be more complicated than the technical installation for most professional services firms (Kieth, 2019). Although technology has made our lives easier, the ease with which we may access shared information has legal implications for businesses. The following are some of the obstacles to new technology adoption:

- **Adopting new technology solely for novelty:** While many new technologies are beneficial, some of it is purely commercial. Even if the technology is helpful, it may only be valuable for specific businesses. Before purchasing any new technology, properly research it and make sure you can use it. Otherwise, you risk having yet another costly paperweight or squandering disc space on applications that you never use.

- **New Technology's disruptive impact:** New technology is disruptive in the near term. Only by integrating with legacy enterprise systems can it reach its full potential. Existing policy and processes will need to be upgraded, causing substantial disruptions. When exposed to real-time situations, the new implementation may generate bugs. It takes some time for it to settle.
- **Resource scarcity:** Emerging trends and technologies are not inexpensive. Even with open-source software, the initial development expense might be costly. The costs of training, inconvenience, and downtime are all indirect costs. During the challenging changeover period, customer dissatisfaction is also dangerous. Such costs overwhelm businesses, causing them to delay technology adoption.
- **Skill challenges:** Emerging technologies, such as Artificial Intelligence, face significant skill shortages. New technology adoption is further hampered by a lack of thought leadership and risk-taking at the highest levels.
- **High cost:** Adopting new technology has numerous advantages. Many businesses want to embrace digital transformation, but they do not believe they have the resources to purchase and integrate new technologies. Successful technology adoption necessitates some initial expenditure for onboarding and deployment.
- **Integration and training:** It takes time and money to train users on new technology and software. Lack of adequate and specialised training on the technology to be adopted is another major factor slowing down the process (Calibraint, 2021). Employees must be trained even if a new technology purports to be "user-friendly". Because not everyone can simply adapt to new technologies, assistance is required to ensure everyone is on board (Scalzo, 2019). It also aids in the prevention of costly mistakes made by first-time users.
- **Onboarding:** Many people mistake focusing solely on the initial implementation of new software or technology, but their training needs do not end there (Altadonna, 2021). You will need to develop a good strategy for introducing new consumers to your technology.
- **Time:** Adapting to new technologies is a lengthy and often demanding process. It can be disappointing not to see the results of your efforts right away.

CONCLUSION

Libraries are an essential aspect of the society in which they exist. Libraries have boosted their services by embracing various technological tools or aids because of the enormous advances in ICT. This period has seen massive information communication and technology changes, and many fields are attempting to adapt to this new environment by implementing various technologies (Saloi, 2021). Libraries are not far behind, either, as they are constantly contending with the changing environment. If scholars are increasingly familiar with the tools offered to them and their involvement is more formalised, research libraries might play a more significant role in the future. Research libraries can utilise their expertise to assist researchers in improving the quality of their grant applications and increasing the institution's success in attracting research funding. Big Data is also one of the most rapidly developing technologies today. Research has documented that the application of Big Data in libraries can assist in information generation, and productivity is higher in libraries that have implemented big data than those that have not. To summarise, Big Data tools and analysis tools necessitate specialised talents and enable more outstanding performance in today's competitive market (Kamupunga & Chunting, 2019). Academic and research libraries are anticipated to become more attractive, relevant, and acceptable because of these new offerings and ongoing improvements. However, libraries' approaches, applications and concepts will continue to evolve.

REFERENCES

Abid, H. (2021). Uses of blockchain technologies in library services. *Library Hi Tech News*, *38*(8), 9–11. doi:10.1108/LHTN-08-2020-0079

Abram, S., & Luther, J. (2004). Born with the chip: The next generation will profoundly impact both library service and the culture within the profession. *Library Journal*, *129*(8), 34–45.

ALA Libraries Transform. (2022). *Unplugged*. https://bit.ly/354x0mm

Al-Barashdi, H., & Al-Karousi, R. (2019). Big Data in academic libraries: Literature review and future research directions. *Journal of Information Studies & Technology*, *2*(2), 13. Advance online publication. doi:10.5339/jist.2018.13

Altadonna, N. (2021). *Digital adoption challenges and solutions to overcome them*. Apty. https://www.apty.io/blog/digital-adoption-challenges

Arockia, P. S., Varnekha, S. S., & Veneshia, K. A. (2017). The 17 V's of Big data. *International Research Journal of Engineering and Technology*, *4*(9), 329–333.

Axiell Group AB. (2016). *Top 7 digital trends for libraries to follow in 2016.* https://www.axiell.co.uk/top-digital-trends-for-libraries-to-follow-in-2016

Ayo-Olafare, F. R. (2020). Global trends and emerging technologies in libraries and information science. *Library Philosophy and Practice (e-journal),* Article 3835. https://digitalcommons.unl.edu/libphilprac/3835

Backhaus, J., Huth, K., Entwistle, A., Homayounfar, K., & Koenig, S. (2019). Digital affinity in medical students influences learning outcome: A cluster analytical design comparing vodcast with traditional lecture. *Journal of Surgical Education*, *76*(3), 711–719. doi:10.1016/j.jsurg.2018.12.001 PMID:30833205

Ball, R. (2019). Big data and its impact on libraries. *American Journal of Information Science and Technology*, *3*(1), 1–9. doi:10.11648/j.ajist.20190301.11

Bell, S. (2005). Commentary-backtalk: Don't surrender library values. *Library Journal*, *130*(9), 79–79.

Calibraint. (2021). *Technology Adoption Challenges – More Attention to Digital Tech*. Calibraint. https://www.calibraint.com/blog/technology-adoption-challenges

Calvert, S. (2020). Research libraries, emerging technologies-and a pandemic. *EDUCAUSE Review*, *2*, 74–75. https://digitalcommons.unl.edu/libraryscience

Corradini, E. (2006). Teenagers analyse their public library. *New Library World*, *107*(11/12), 481–498. Advance online publication. doi:10.1108/03074800610713307

Darnton, R. (2009). Google & the future of books. *The New York Review of Books*, *55*(2), 27–3. https://bit.ly/3vccUBf4

Fonseca, P., & Picoto, W. N. (2020). The competencies needed for digital transformation. *Online Journal of Applied Knowledge Management*, *8*(2), 53–70. doi:10.36965/OJAKM.2020.8(2)53-70

Garoufallou, E., & Gaitanou, P. (2021). Big data: Opportunities and challenges in libraries, a systematic literature review. *College & Research Libraries*, *82*(3), 410. Advance online publication. doi:10.5860/crl.82.3.410

Gatteschi, V., Lamberti, F., Paravati, G., Sanna, A., Demartini, C., Lisanti, A., & Venezia, G. (2015). New frontiers of delivery services using drones: A prototype system exploiting a quadcopter for autonomous drug shipments. In *2015 IEEE 39th Annual Computer Software and Applications Conference* (Vol. 2, pp. 920-927). IEEE. 10.1109/COMPSAC.2015.52

Goundar, M. S., & Kumar, B. A. (2021). The use of mobile learning applications in higher education institutes. *Education and Information Technologies*, 1–24. doi:10.100710639-021-10611-2

Greeff, W. J., & Barker, R. (2012). Exploring vodcasts as a supportive learning tool. *Progressio*, *34*(1), 170–185.

Harada, T. (2017). *Robotics and artificial intelligence technology in Japanese libraries*. Paper presented at IFLA WLIC 2019 - Athens, Greece - Libraries: dialogue for change in Session S08 - Information Technology. In: Robots in libraries: challenge or opportunity? Wildau, Germany. http://library.ifla.org/id/eprint/2695

Hoy, M. B. (2017). An introduction to the blockchain and its implications for libraries and medicine. *Medical Reference Services Quarterly*, *36*(3), 273–279. doi:10.1080/02763869.2017.1332261 PMID:28714815

Irving, G., & Holden, J. (2016). How blockchain-timestamped protocols could improve the trustworthiness of medical science. *F1000Research*, *5*, Article 222. doi:10.12688/f1000research.8114.2

Kamupunga, W., & Chunting, Y. (2019). Application of big data in libraries. *International Journal of Computers and Applications*, *178*(16), 34–38. doi:10.5120/ijca2019918955

Kieth, T. (2019). *Technology adoption challenges: 3 hurdles and how to get over them*. Introhive. https://www.introhive.com/blog/technology-adoption-challenges

Kolbitsch, J., & Maurer, H. A. (2006). The transformation of the Web: How emerging communities shape the information we consume. *Journal of Universal Computer Science*, *12*(2), 187–213.

Lee, D. (2006). iPod, you-pod, we-pod: Podcasting and marketing library services. *Library Administrator and Management, 20*, 206-208. https://bit.ly/33MloDZ

Library of the Future. (2018). *Data everywhere*. https://www.ala.org/tools/future/trends/data

Maker Spaces in Libraries. (n.d.). *An expert takes us through the how, why and why not*. https://bit.ly/3LTVVtn

Mayega, S. (2008). *Library information services in the digital age.* In Fourth Shanghai International Library Forum (SILF 2008), Shanghai, China. http://eprints.rclis.org/12567

Moroz, M. (2018). Acceleration of digital transformation as a result of launching programs financed from public funds: Assessment of the implementation of the operational program digital Poland. *Foundations of Management*, *10*(1), 59–74. doi:10.2478/fman-2018-0006

Mostafa, J. (2005). Seeking better web searches. *Scientific American*, *292*(2), 51–57. doi:10.1038cient ificamerican0205-66 PMID:15715393

Naidu, Y., & Constable, T. (2016, April). Use of vodcasts by the UNISA Library for teaching and learning: Challenges, opportunities and lessons learned about this emerging technology. In *22nd Standing Conference of Eastern, Central and Southern Africa Library and Information Associations (SCECSAL XXII)* (pp. 125-131). Academic Press.

Natarajan, K., Nguyen, T.-H. D., & Mete, M. (2018). Hand Gesture Controlled Drones: An open-source library. *2018 1st International Conference on Data Intelligence and Security (ICDIS)*, 168–175. 10.1109/ICDIS.2018.00035

Nath, F. (2018). Library drone delivery programme: A Study. *DESIDOC Journal of Library and Information Technology*, *38*(5), 349–353. doi:10.14429/djlit.38.5.12892

Nitecki, D. A., Franklin, B., Nitecki, D. A., & Franklin, B. (1999). New measures for research libraries. *Journal of Academic Librarianship*, *25*(6), 484–487. doi:10.1016/S0099-1333(99)00084-1

Omame, I. M., & Alex-Nmecha, J. C. (2020). Artificial intelligence in libraries. In N. E. Osuigwe (Ed.), *Managing and adapting library information services for future users* (pp. 120–144). IGI Global. doi:10.4018/978-1-7998-1116-9.ch008

Omosebi, F. E., & Bakare, O. D. (2022). Makerspace: An innovative inclusion in Nigerian libraries. In I. I. Ekoja, E. F. Ogbomo, & O. Okuonghae (Eds.), *Handbook of research on emerging trends and technologies in librarianship* (pp. 143–158). IGI Global. doi:10.4018/978-1-7998-9094-2.ch010

Owan, V. J., & Asuquo, M. E. (2021). Assessment of socio-demographic factors and students' satisfaction with the study of ICT in secondary schools. *Pedagogical Research*, *6*(3), em0101. Advance online publication. doi:10.29333/pr/11087

Owan, V. J., Asuquo, M. E., Ekaette, S. O., Aslam, S., Obla, M. E., & Owan, M. V. (2021). Gender, age and staff preparedness to adopt Internet tools for research sharing during Covid-19 in African varsities. *Library Philosophy and Practice (e-Journal),* Article 6133. https://digitalcommons.unl.edu/libphilprac/6133

Panda, S. (2021). Usefulness and impact of big data in libraries: An opportunity to implement embedded librarianship. *Technological Innovations & Environmental Changes in Modern Libraries*, 45-60. 10.31235/ doi:osf.io/fsau9

Prakash, A., & Ambekar, S. (2020). Digital transformation using blockchain technology in the construction industry. *Journal of Information Technology Case and Application Research*, *22*(4), 256–278. doi:10.1080/15228053.2021.1880245

Qin, J. (2018, May). The research of the library services based on the Internet of things. In *4th International Symposium on Social Science*. Atlantis Press. 10.2991/isss-18.2018.83

Saha, P. (2018). *Top skills required for digital transformation*. HRKatha. https://www.hrkatha.com/special/learn-engage-transform/top-skills-required-for-digitaltransformation

Saloi, A. (2021). Drone in libraries for document delivery: Flying documents. *Library Philosophy and Practice (e-journal),* Article 4599. https://digitalcommons.unl.edu/libphilprac/4599

Saloi, A. (2021). Drone in libraries for document Delivery: Flying documents. *Library Philosophy and Practice (e-journal),* Article 4599. https://digitalcommons.unl.edu/libphilprac/4599

Scalzo, C. (2019). *Challenges of implementing new technology and how to address them*. Online Computers. https://www.onlinecomputers.com/2019/01/challenges-of-implementing-new-technology-and-how-to-address-them

Shashikumara, A. A., Manu, T. R., & Panna Chaudhary, V. A. (2019). Emerging technology trends for libraries and library professionals. *Librarianship Development Through the Internet of Things and Customer Service (LDITCS),* 75. https://www.librarianshipstudies.com/2019/08/emerging-trends-technologies-in-library.html

Singh, M. P., Lata, N., & Sonkar, S. K. (2022). *Transformative technologies for libraries*. Ess Ess Publication.

Snowball, C. (2008). Enticing teenagers into the library. *Library Review*, *57*(1), 25–35. doi:10.1108/00242530810845035

Sousa, M. J., & Rocha, Á. (2018). Digital learning: Developing skills for the digital transformation of organisations. *Future Generation Computer Systems*, *91*, 327–334. doi:10.1016/j.future.2018.08.048

Sugimoto, C. R., Ding, Y., & Thelwall, M. (2012). Library and information science in the Big Data era: Funding, projects, and future. *Proceedings of the American Society for Information Science and Technology*, *49*(1), 1–3. doi:10.1002/meet.14504901187

Sutton-Brady, C., Scott, K. M., Taylor, L., Carabetta, G., & Clark, S. (2009). The value of using short-format podcasts to enhance learning and teaching. *ALT-J*, *17*(3), 219–232. doi:10.1080/09687760903247609

Vysakh, C., & Rajendra, B. H. (2019). Reshaping of librarianship, innovations, and transformation. *International Conference on Reshaping Librarianship: Innovations and Transformations. ICRLIT - 2019: e-Proceedings*, 59-63. https://bit.ly/3shxZIO

Wittmann, R. J., & Reinhalter, L. (2014). The Library: Big Data's Boomtown. *The Serials Librarian: From the Printed Page to the Digital Age*, *67*(4), 363–372. doi:10.1080/0361526X.2014.915605

Yeganeh, S., & Izadpanah, S. (2021). The Effect of Podcasts and Vodcasts Among Motivated Iranian Learners of English: Different Listening Proficiency Levels. *Journal of Language Horizons*, *5*(1), 51–75.

ADDITIONAL READING

Boateng, F., & Quan Liu, Y. (2014). Web 2.0 applications' usage and trends in top US academic libraries. *Library Hi Tech*, *32*(1), 120–138. doi:10.1108/LHT-07-2013-0093

Chiu, W. Y., Meng, W., & Li, W. (2021, December). LibBlock-Towards Decentralized Library System based on Blockchain and IPFS. In *2021 18th International Conference on Privacy, Security and Trust (PST)* (pp. 1-9). IEEE. 10.1109/PST52912.2021.9647821

Hasan, N. (2020). Blockchain technology and its application in libraries. *Library Herald*, *58*(4), 118–125. doi:10.5958/0976-2469.2020.00030.10

Hennig, N. (2017). Podcast literacy: Educational, accessible, and diverse podcasts for library users. *Library Technology Reports*, *53*(2), 1–42. doi:10.5860/ltr.53n2

Hirsh, S., & Alman, S. W. (2019). *Blockchain (Library Futures Series, Book 3)*. ALA Neal-Schuman. https://scholarworks.sjsu.edu/faculty_books/255

Jessy, A., & Rao, M. (2016). Marketing of resources and services with emerging technologies in modern libraries: An overview. *International Journal of Information Dissemination and Technology*, *6*(1), 15–20. https://eprints.manipal.edu/146157

Li, S., Jiao, F., Zhang, Y., & Xu, X. (2019). Problems and changes in digital libraries in the age of big data from the perspective of user services. *Journal of Academic Librarianship*, *45*(1), 22–30. doi:10.1016/j.acalib.2018.11.012

Patel, S. S., & Bhatt, A. (2019). The Application of Web 2.0 Tools in university libraries of India. *Library Philosophy and Practice (e-Journal),* Article 2984. https://digitalcommons.unl.edu/libphilprac/2984

Simović, A. (2018). A Big Data smart library recommender system for an educational institution. *Library Hi Tech*, *36*(3), 498–523. doi:10.1108/LHT-06-2017-0131

Tripathi, M., & Kumar, S. (2010). Use of Web 2.0 tools in academic libraries: A reconnaissance of the international landscape. *The International Information & Library Review*, *42*(3), 195–207. doi:10.1080/10572317.2010.10762864

Zeadally, S., & Abdo, J. B. (2019). Blockchain: Trends and future opportunities. *Internet Technology Letters*, *2*(6), e130. doi:10.1002/itl2.130

Zhan, M., & Widén, G. (2018). Public libraries: Roles in Big Data. *The Electronic Library*, *36*(1), 133–145. doi:10.1108/EL-06-2016-0134

Zhan, M., & Widén, G. (2019). Understanding big data in librarianship. *Journal of Librarianship and Information Science*, *51*(2), 561–576. doi:10.1177/0961000617742451

Zhang, L. (2019). Blockchain: The new technology and its applications for libraries. *Journal of Electronic Resources Librarianship*, *31*(4), 278–280. doi:10.1080/1941126X.2019.1670488

KEY TERMS AND DEFINITIONS

Artificial Intelligence: AI is the capacity of a system or a robot computer-controlled to do activities usually performed by humans.

Big Data: A big data set is one that is too large or complicated for standard data processing techniques.

Blockchain: A blockchain is an electronic database shared by computer network nodes.

Digital Age: This is when advances in computer technology have made enormous amounts of data freely available to practically anybody.

Internet of Things: This is a network of physical things connecting and exchanging data over the Internet or other communication networks.

Library Services: These are services provided to increase the use of library items, connect library users with library resources, and meet their information needs.

Research Library: A research library contains diverse scholarly materials produced from research and for the furtherance of other studies in each discipline.

Trends: Trends refer to new ways in which an event, occurrence, phenomena, construct, or technology evolves in newer ways than was previously conceived.

Chapter 4

Infusion of Digital Technologies in the Sustainability of Academic Libraries: Opportunities and Threats

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ABSTRACT

Digital technologies are now incorporated into organizations for effective and efficient operations of their job performance. Many African countries are yet to advance into the technology phase whereas other parts of the world are already adopting digital technologies in their operations and service delivery. The qualitative research approach was applied in this study using a literature review to harvest different articles in online databases of Scopus and Web of Science. Findings indicate that digital technologies could be used in the sustainability of academic libraries through accessing, processing, gathering, manipulating, presenting, and communicating information in different format such that library users' information needs are met. Digital technologies such as smartphones, ebooks, blogs, social media, digital computers, scan machines, digital cameras, robotics, drones, etc. were used to support library and information services. The study recommends proactive steps by parent bodies to provide libraries with financial support to acquire necessary digital facilities.

INTRODUCTION

Two decades ago, an academic library served merely as a quiet study space and a huge repository of tangible materials such as books, journals, and reports, among other things, that could be collected, issued,

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returned or studied (Kadli, 2020). Due to the changes brought by digital technologies into the library space, individual users have infused it into their work routines for effective and efficient operations on daily basis in their activities. Librarians now use technology to acquire, catalogue, preserve, diffuse, and provide reference services and other services. Libraries have extended, rethought, and reinvented themselves, and now offer a wide range of information services utilizing cutting-edge technology, as well as reaching out to its users through social networking and digital media in ways they never had before. The world has advanced into the information age, which is characterized by technical developments, expanded access to digital information resources, cloud storage, and social media. These technologies have an impact on libraries, and the usage of information and communication technology (ICT) has a dynamic impact on modern library services. Similarly, digital technologies have changed not just how information is packed, processed, saved, and broadcast, but also how users may access the information they need from anywhere, at any time, and in a personalized fashion (Prasad, 2017).

The scholarly information environment has changed drastically as a result of the digital age. Teachers and students now rely on its utilization coupled with libraries. Library users have a wide range of information needs, and libraries around the world are adapting to the digital age's challenges by rethinking library infrastructure, services, and collections (Anuradha, 2018). New and emerging technology has played an important role in influencing the various library services. These technologies not only benefit users by providing speedy, high-quality, and efficient services but allow library and information workers to be innovative in order to improve the effectiveness and responsiveness of their services (Kadli, 2020). Students are using digital technology for learning in higher education, exposing a collection of tools chosen to combine formal learning contexts (Pinto & Leite, 2020). Digital technology, according to Selwyn et al. (2016), can include but is not limited to, computers, tablets, smartphones, Facebook, Moodle, online library services, Google, YouTube, and composing essays on Microsoft Word. People may now access the Internet from anywhere using portable devices thanks to digital technology. Libraries may utilize such technology to promote library services, improve information access, redecorate libraries with new facilities, encourage cooperation, share and establish communities, solicit user input, communicate with one another, and publicize events, services, and news (Prasad, 2017).

Digital technology has broken into our daily lives and has become an unavoidable and normal part of our life. However, the dramatic changes generated by their arrival continue to be a matter of heated dispute in the literature in a variety of professions (Mierzecka, 2018). Universities and university libraries have been impacted by massive technological change in recent years. The impact of technology advancements on all aspects of the academic library activity, including systems, services, collections, the physical library environment, marketing, and support for university teaching, learning, research, and administration, has become highly significant (Atkinson, 2020). With the current COVID-19 pandemic and its mitigating effects resulting in diminished human contact and remote engagement, academic libraries can ride the wave of new norms like virtual and open distance learning by, employing digital technologies to turn a difficult circumstance into an opportunity.

RESEARCH OBJECTIVES

This study is anchored on the following research objectives:

- Examine the infusion of digital technologies in the sustainability of academic libraries.

Figure 1. Technology and the academic library (Atkinson, 2020)

- Determine the types of digital technologies used to sustain academic libraries.
- Analyze the perceived usefulness of digital technologies to sustain academic libraries.
- Determine the challenges to effective uses of digital technologies to sustain academic libraries.
- Establish factors that could enhance the infusion of digital technologies in the sustainability in academic libraries.

METHODOLOGY

This study employed interpretive content analysis of literature harvested from different online databases of Web of Science and Google Scholar. The literature was harvested using the following sub-themes of digital technologies, and academic libraries. These were the sub-themes through which the book chapter was developed. The research investigation which was developed for this study was carried out within three to four months intervals. First, both authors conceptualized the title and abstract before it was sent for evaluation by the editor and team members organizing the book chapter. Thereafter, the responsibility regarding the entire book chapter was shared among the authors of this piece. In order to strengthen the discussion surrounding the infusion of digital technologies to sustain academic library activities, the authors consulted over forty-four research papers/articles in this study. There were a lot of commonalities and differences in what was found in the study through the internalization of the interpretive content analysis used in the study. Kumar (2005) was of the view that interpretive content analysis is another important strategy used in most research investigations because it unveils hidden understanding that would have been difficult to find out ordinarily. Many researches today now prefer to internalize the outcome of research based on the phenomenon under discussion in the study.

LITERATURE REVIEW

The literature review developed in this study was carried out using systematic literature where the literature of different articles was critiqued in relation to the chosen topic of this study. The literature review covers the following different sub-headings/areas and they are the infusion of digital technologies in the sustainability of academic libraries, types of digital technologies used to sustain academic libraries, perceived usefulness of digital technologies to sustain academic libraries, and establish factors that could enhance the infusion of digital technologies in the sustainability in academic libraries.

Infusion of Digital Technologies in the Sustainability of Academic Libraries

Academic libraries have transformed significantly as a result of the extensive use of digital technology, although these changes and the methods for carrying out library functions have evolved the jobs themselves, as well as the aim of an academic library (Mierzecka, 2018). Academic libraries have shown tremendous adaptability in meeting the needs of a larger and more diverse student body (including developments in the distance and blended learning), and services are now much more user-driven and tailored in response to the needs of 24-7 access to resources across a variety of platforms, thanks to the introduction of technology. Academic libraries have also played an important role in the implementation and regulation of open access mandates, allowing researchers to expand the reach of their research by managing institutional repositories and data management (Anuradha, 2018; Chisita & Chiparausha, 2019). Technological innovations, such as computers, portable devices, and the Internet, have had a significant impact on institutions and people's lives, affecting their relationships with information, knowledge, and working methods (Selwyn, 2016). In a quickly changing educational environment, providing students with cutting-edge education on all fronts is critical to staying competitive. However, it is not always simple, especially when technology advances at an ever-increasing rate (Anuradha, 2018). Digital technology equality is identified as a critical concern in the 2019 EDUCAUSE Horizon Report for higher education, highlighting not only equal access to information but also equal opportunity to generate content and cooperate in a remote setting (Alexander et al., 2019). Academic libraries may play an important role in addressing these concerns by offering digital literacy programs that focus on the development of skills for material creation and sharing, open access to publications, data, and other research outputs, which libraries have long advocated for.

Types of Digital Technologies used to Sustain Academic Libraries

Many materials, ranging from reference volumes to e-books, are now available in digital format and are handled through integrated library systems, digital libraries, and web-based online public access catalogues, discovery tools, and library portals. In addition, librarians now have new means to engage with other professionals and their users through social networking sites such as Facebook, Twitter, SMS (Short Message Service), and online chat services (Prasad, 2017). Online forums, library mobile apps, FAQs, online databases, institutional repositories, remote logins, online test paper archives, library websites, and social media are now emphasized by library professionals to let users access library resources and services beyond the four walls of the library (Shastri & Chudasma, 2021). Most libraries in South Africa and around the world have access to and use a number of social media platforms. Social media platforms are used to market library services, announce library news and improve service delivery. The information shared through these platforms such as Academic Edu, ResearchGate, and others that are examples of Academic Social Networking Sites with the users includes; user information, library events, and new services (Rabatseta, Maluleka & Onyancha, 2021).

Tella (2020), emphasizes that advanced technologies that are building the technological transformation comprise Internet-connected household appliances (the Internet of things), driverless cars, big data, robotics, artificial intelligence, blockchain, addictive technology, nanomaterial, neurotechnology, synthetic biology, energy storage, and cloud computing. Because lower-impact, behind-the-scenes work can be outsourced or exported, the advent of cloud computing provides new freedom to move up the value chain in the institution (Cox, 2019). On the application of robots, Gaham (2019) stated that libraries are currently using four different types of robots. They are shelf reading, telepresence, humanoid, and chatbot robots.

Libraries all around the world have been attempting to use affordable smartphones to improve their services since their introduction. One of the technologies that can be employed with smartphones is the QR code. QR codes and smartphones were slow to catch on in India, but they are now a vital part of people's daily lives, speeding up technology adoption (Kadli, 2020). Mobile technologies and QR codes, according to Singh and Nikandia (2017), are new communication tools that are revolutionizing how individuals search for information, get information and interact with it on a daily basis (2021). Furthermore, adoption is stuttering in the face of 18 new technologies, with relatively few people prepared and aware of the cybrary, library website, WebOPAC, institutional repository, and social media. Learning environments' utility and character have been incorporated into technologies such as the Integrated Library Management System, the Library Guide app, RFID, and the Internet of Things. According to Chingath (2020), all library technologies, such as the establishment of an encrypted database, speaking robots, flying books, and so on, are viable. The implementation of these technologies will aid in the enhancement of library services. According to Moruf and Dangani (2020), emerging library technologies such as instructional system design software, electrical copyright management systems, and bibliographic citation software, as well as integrated search software, library automation software, electronic resource management, and classroom management software, will have a significant impact on the development of digital content in academic libraries. Acharya, Hiremath, and Lalasangi (2019) discussed breakthrough technologies such as the bleeding edge which shows that with the current COVID-19 epidemic, another sort of digital technology used for teaching and research in Africa, as well as the rest of the world, is the use of learning management systems (LMS), such as Moodle, Blackboard Learn, Canvas, Edmodo, and Schoology. The library is now considered an essential component of any learning management system. To encourage lecturers to guide their students to information sources supplied by the library, it is critical that the library's digital platform is included in any adopted LMS in the institution right from the start (Adetunji & Oladokun, 2020).

The Perceived Usefulness of Digital Technologies in the Maintenance of Academic Libraries

Digital technology solutions are seen to offer the potential to increase educational access, lower prices, and improve quality (Bolu & Egbo, 2014). According to Moya et al. (2011), the employment of digital technologies improves teaching and learning quality, efficacy, and accessibility. Libraries' digital resources compete with resources that are widely available on the Internet, which is especially true for students. Despite their admiration for the quality of materials acquired in libraries, students prefer the convenience and accessibility of Google Scholar and others applications (Wu & Chen, 2014). The importance of digital technology in enhancing mixed, online, and mobile learning in East Africa cannot be understated (Mtebe, 2014). Local attitudes, on the other hand, remain limited, with serious implications for libraries. Local government stakeholders in Ethiopia, Ghana, Kenya, Tanzania, Uganda, and Zimbabwe saw libraries as "lenders of books" with limited access to technology, rather than "agents for development and innovation," according to Elbert et al. (2012). A "lack of recognition of the relevance of libraries," according to Baada et al. (2020), is a significant barrier to obtaining adequate library resources in Ghana. The lack of a clear role for libraries in national development plans impairs the problem by forcing many libraries to rely on sporadic and short-term funding (Benson et al., 2016; Moahi, 2019).

According to Lynch et al. (2020), perceptions of libraries within development organizations are still low and constrained, with books and literacy being connected with them, and a lack of capacity to engage actively in development. However, there is evidence that these perceptions can and have changed over time, and many development practitioners are willing to see the potential of libraries as players in development. A study carried out in Nigeria on data obtained during a period spanning from 2005 to 2014 showed a pronounced reduction in the use of printed books and periodicals after the introduction of digital resources (Asogwa, Ugwu, & Idoko, 2016). Saibakumo (2021) pointed out that there was a strong level of awareness among Nigerian librarians towards many developing technologies for effective service delivery. Chukwusa (2019) noted that in collection development services in academic libraries, acquisition librarians are aware of the usefulness of information and communication technologies.

Challenges to Effective uses of Digital Technologies to Sustain Academic Libraries

Academic libraries are clearly under significant pressure, and the importance of a library to a university's strategy and its priority in budget allocation can no longer be assumed. Academic libraries must justify their value as university administrators make difficult judgments about where to invest scarce resources (Ateka & Kwanya, 2019). In relation to higher education and libraries, a report from the United Kingdom identifies "intensified contextual pressures – a myriad of political, economic, and other pressures" (Pinfield et al., 2017), including funding challenges, increased competition, and government evaluation of teaching and research. Inadequate financing, lack of power supply, and poor maintenance, according to Saibakumo (2021), are the biggest impediments to new technology adoption. Starting a refurbishment without knowing how much money is available, how much the project will cost, and where the money will come from (donors, government funds, or loans) severely hinders or inhibits genuine development. Another potential limiting element comes when financial resources are related to donor expectations that may or may not be in line with the academic institutions' core principles and mission (Anuradha, 2018). As a result of these issues, African libraries are naturally looking for other options outside of Africa in financing technologies in libraries. According to the Organisation for Economic Co-operation and Development (OECD, 2019), Africa got about $52 billion in official development assistance in 2017. These figures exclude support for development from so-called "emerging donors," such as non-OECD nations, which are estimated to be worth between $11 billion and $41.7 billion per year. Private investment is acknowledged to "dwarf" established types of development support, despite its notoriously difficult monitoring (Ingram & Lord, 2019). US-based foundations provided $1.5 billion to Africa in 2012. This opens up a plethora of opportunities for African libraries to link their work to the larger goals of development-oriented organizations and agendas in order to gain access to more funding (Lawrence et al., 2015). Ukachi (2015) found that users' limited digital competence has a direct impact on their low use of electronic resources. Tang and Tseng (2013) found the same in terms of a user's limited belief in his effectiveness in information retrieval. While Anaraki and Babalhavaeji (2013) got a link between a lack of knowledge about library resources and low usage of electronic resources. Despite this, guidelines for using library resources frequently fail to adequately address the subject of using digital resources. This is demonstrated, for example, by a study conducted on a sample of 250 students by Aderibigbe and Ajiboye (2013), which discovered that library training is insufficient to meet their needs, with too much emphasis on traditional library resource use and insufficient time devoted to developing students' digital skills related to the use of electronic resources.

Tulinayo, Ssentume, and Najjuma (2018) used a structured questionnaire with both closed-ended and open-ended questions to investigate the factors that influence students' digital technology use and acceptance at two of Uganda's top public higher education institutions (Makerere & Kyambogo). The results revealed a variety of problems that learners confront while employing digital technology tools in their limited environments. Low bandwidth leads to slow Internet; insufficient cable network terminals; limited time to access university digital technologies; lack of training on how to use various digital technology tools; lack of exposure to various digital technologies; insufficient digital technologies at the university in comparison to student numbers (small number of computer laboratories and competition for digital technologies); unstable electricity power; lack of training on how to use various digital technology tools; lack of exposure to various digital technologies; insufficient digital technologies at the university in comparison to student numbers. It was similar to a study conducted by Idika, et al. (2021) at the University of Nigeria, Nsukka, Enugu State, which looked into the availability and use of Digital Technologies (DT) in Economics teaching and learning. The high cost of Internet data and software, as well as the lack of Internet bandwidth and epileptic power supply, were identified to be significant obstacles.

Factors that could Enhance the Infusion of Digital Technologies in the Sustainability of Academic Libraries

The academic library has been forced to reimagine and reinvent the delivery of its programs and services as technology advances. "While the academic library's principal aim has always been to serve the curriculum, the notion has been significantly enhanced in light of today's students' technological requirements and expectations" (Anuradha, 2018). The topic of training came up at the same time as the topic of utilizing electronic resources. Digital technology, on the other hand, has significantly increased the possibilities for offering many types of instruction at the library, from new student orientation to specialized training (Mierzecka, 2018). The construction of a Media Commons, where staff and students would be given numerous opportunities to learn how to use multimedia as tools for staff and as part of courses for students, is of particular concern. Knowing how to use technology is the first step in creating situations where people and robots can collaborate. As Artificial Intelligence and robotics make their way into libraries, librarians should set aside their conservatism, because these technologies may eventually replace the slothful and conservative librarians/information professionals. As a result, training, and retraining to improve skills should be prioritized (Tella, 2020).

Academic librarians should also adapt to new technologies by receiving proper training and enhancing their technical abilities in order to provide the greatest possible service to users that new technologies may provide (Anuradha, 2017). Tella et al. (2020) emphasized that librarians and other information professionals' ability to create, manage, and make information available to information users, as well as the demonstration of unique skills rarely possessed by others, will ensure the information professionals'' place in this new era. Discipline knowledge, generic (transferable) abilities, personal competencies such as constant learning, the ability to work autonomously, adaptability, enabling change, and more are required in the digital academic library scenario, as well as a greater demand for technology skills (Raju, 2014). Management skills, information retrieval, technological communication, negotiation, resource organization, discovery services, use of OSS (Open-Source Software) to manage information resources and provide effective library services, international research collaboration, and collection forecasting skills are just a few of the skills listed as essential for LIS professionals (Jalal, 2019). While technology trends are rapidly evolving, it is clear that librarians will not be able to incorporate all of them into their collections. As a result, they must select technologies that will benefit them in the long run while also considering their users' information needs (Bharti & Verma, 2021). The library must be fully accessible, adaptive, entrepreneurial, digitally smart, and focused on supplying the blend of places and services expected by its ever-changing customers in order to be a vital element of the academic experience (Anuradha, 2018). Academic institutions must have adequate information infrastructure in order to enable access to education, learning, information, and knowledge resources via digital technologies such as the Internet of Things, mobile computer systems, and social media platforms (YouTube, Twitter, WhatsApp, and Facebook). E-learning, e-resources, e-information, and electronic archives must all be provided in a digital environment that can be expanded by utilizing modern technology resources and facilities like social cloud computing and the Internet (Makori & Mauti, 2016).

RECOMMENDATIONS

Based on the findings obtained from this study, the following recommendations were made:

- That digital technologies should be infused into academic libraries for their sustainability in the operations of library services
- The need to acquire more recent sophisticated digital technologies in the sustainability of academic libraries become essential due to the multifarious and complex tasks they faced with
- Since of digital technologies were perceived usefulness to sustain academic libraries, it is imperative librarians should become acquainted with their use \
- Due to the continuous use of digital technologies, it has proven to be effective in academic libraries hence the need not to restrain form its use
- To enhance the infusion of digital technologies in academic libraries the study recommends the need to reimagine and reinvent programs for quality service delivery to meet future users' information needs.

CONCLUSION

It is important to note that, without digital technologies, no library across the world would be able to survive especially in this era where users do not need to visit the physical building of the library. Many years ago, several academic libraries have served merely as a quiet study space where tangible materials of books, journals, and reports, are kept, but as changes begin to evolve in the library space, digital technologies were known to have the potential to transform the library activities. Some of the activities surround accessing, processing, gathering, manipulating, presenting, and communicating information in a different format to users of libraries, to meet users' information needs. The transformation resulted in the adaptation of a myriad of digital technologies smartphones, digital television, video streaming, eBooks, digital music, blogs, social media, digital computers, printers, scan machines, digital cameras, clocks, robotics, and drones among others. It can be established that the infusion of digital technologies cannot be overemphasized because it has assisted library professionals with opportunities on how to use the tools to improve service delivery, source for materials online, and manage digital documents. Amidst the opportunities found to exist using digital technologies to sustain academic libraries, certain threats of scarce skills and knowledge required to operate and pilot within the online platform among information professionals were absent. Most of the digital technologies proven to be available were old and have outlived their usefulness with regard to the enhanced provision of library services including operations. The budgetary allocation remains minimal in the acquisition of required technologies even though there were qualified staff in most academic libraries. Recommendation made surrounds active step by step institutional policy in academic libraries on how parent bodies could support them with finance to purchase required digital facilities in the library.

REFERENCES

Acharya, S., Hiremath, S., & Lalasangi, S. (2019). Technological trends in modern libraries. *Indian Journal of Library Science and Information Technology*, *4*(2), 63–65. doi:10.18231/j.ijlsit.2019.018

Aderibigbe, N. A., & Ajiboye, B. A. (2013). User Education Program as Determinant of Electronic Information Resources Usage in Nimbe Adedipe University Library, Nigeria. *The Electronic Library*, *31*(2), 244–255. doi:10.1108/02640471311312410

Adetunji, O. A., & Oladokun, T. A. (2020). Effective Strategies for Sustainable Library Automation in Nigerian Academic Libraries: Preparing for 'The New Normal' Caused by the COVID-19 Pandemic. *Nigerian Library Association (NLA) Scholarly Conference on Library and Information Services during and after COVID-19 Pandemic*.

Akparobore, D., Omosekejimi, A. F., & Nweke, A. C. (2020). Librarians' Awareness, Positive Attitude and ICT Skills: A Panacea for Effective Services Delivery in the Fourth Industrial Revolution (4th IR) Era in Academic Libraries in Southern Nigeria. *Library Progress (International)*, *40*(2), 184–194. doi:10.5958/2320-317X.2020.00021.5

Alexander, B., Ashford-Rowe, K., Barajas-Murphy, N., Dobbin, G., Knott, J., McCormack, M., & Weber, N. (2019). EDUCAUSE horizon report: 2019 higher education edition. *EDUCAUSE*. https://library.educause.edu/resources/2019/4/2019-horizon-report

Anaraki, N. L., & Babalhavaeji, F. (2013). Investigating the Awareness and Ability of Medical Students in Using Electronic Resources of the Integrated Digital Library Portal of Iran. *The Electronic Library*, *31*(1), 70–83. doi:10.1108/02640471311299146

Anuradha, P. (2017). *The impact of digital technologies on academic libraries: Challenges and opportunities*. https://www.ipinnovative.com/journal-article-file/5255

Anuradha, P. (2018). Digital transformation of academic libraries: Opportunities and challenges. *IP Indian Journal of Library Science and Information Technology*, *3*(1), 8–10. doi:10.18231/2456-9623.2018.0002

Asogwa, B. E., Ugwu, C. I., & Idoko, A. N. (2016). Internet Services in Academic Libraries. *The Electronic Library*, *34*(5), 757–771. doi:10.1108/EL-04-2015-0066

Ateka, A., & Kwanya, T. (2019). Using QR codes to Promote Information Services and Products in Academic Libraries in Kenya. *Digital Technologies for Information and Knowledge Management*. http://repository.tukenya.ac.ke:8080/bitstream/handle/123456789/1767/Using%20QR%20codes%20to%20Promote%20Information%20Services%20and%20Products%20in%20Academic%20Libraries%20in%20Kenya.pdf?sequence=1&isAllowed=y

Atkinson, J. (2020). *Technology, Change and the Academic Library Case Studies, Trends and Reflections*. https://www.elsevier.com/books/technology-change-and-the-academic-library/atkinson/978-0-12-822807-4

Baada, F. N. A., Ayoung, A. D., Bekoe, S., & Azindow, F. B. (2020). Resource constraints and quality public library service delivery in Ghana. *The International Information & Library Review*, *52*(1), 10–31. doi:10.1080/10572317.2019.1607697

Benson, O. V., Anyanwu, E. U., Co, O., & Nwauwa, E. B. (2016). Priorities and challenges of actualizing sustainable development goals: Perspectives of library and information professionals in Owerri, Nigeria. *Journal of Applied Information Science and Technology*, *9*(2), 40–46.

Bharti, K. L., & Verma, S. (2021). Use of Emerging Technologies in the University Libraries: A study of Review of Literature. *Library Philosophy and Practice (e-journal),* 6134. https://digitalcommons.unl.edu/libphilprac/6134

Bolu, C. A., & Egbo, K. (2014). The Role of Higher Education Institutions in the Development of ICT Professionals for Innovation in Nigeria. *International Journal of Engineering Innovations and Research*, *3*(1), 1.

Chingath, V. (2020). *Technology Trends in Libraries. Transforming libraries: Smart users, smart services and smart resources*. https://www.researchgate.net/publication/346975783

Chisita, C. T., & Chiparausha, B. (2019). Open Access initiatives in Zimbabwe: Case of academic libraries. *Journal of Academic Librarianship*, *45*(5), 102047. doi:10.1016/j.acalib.2019.102047

Chukwusa, J. (2019). Awareness of the Usefulness of ICTs as Correlate of Attitude towards Use in collection development by Librarians. *Library Philosophy and Practice (e-journal),* 2930. https://digitalcommons.unl.edu/libphilprac/2930

Cox, J. (2019). Technology and the Positioning of the Library on Campus: Challenges and Opportunities. *Proceedings of the IATUL Conferences*, Paper 1. https://docs.lib.purdue.edu/iatul/2019/strategic/

Elbert, M., Fuegi, D., & Lipeikaite, U. (2012). Public libraries in Africa – agents for development and innovation? Current perceptions of local stakeholders. *IFLA Journal*, *38*(2), 148–165. doi:10.1177/0340035212444512

Graham, M. (2019). *Robots in the libraries*. www.soutron.com/robots-libraries/

Hu, J., & Zhang, Y. (2016). Chinese Students' Behavior Intention to Use Mobile Library Apps and Effects of Education Level and Discipline. *Library Hi Tech*, *34*(4), 639–656. doi:10.1108/LHT-06-2016-0061

Idika, E. O., Eneogu, N. D., Ede, M. O., Obiorah, N. J., Nji, I. A., Okolie, O. M., & Tom, B. (2021). Availability and Utilization of Digital Technologies in the Teaching and Learning of Economics at the University of Nigeria, Nsukka. *Journal of Critical Reviews*, *8*(2). https://www.bibliomed.org/fulltextpdf.php?mno=73239

Ingram, J., & Lord, K. M. (2019). *Global development disrupted: Findings from a survey of 93 leaders*. Brookings Institution. https://www.brookings.edu/wp-content/ uploads/2019/03/Global-Development-Disrupted.pdf

Jalal, S. K. (2019). Emerging roles of librarians in academic libraries: A great leap forward. *Library Herald*, *57*(2), 183–194. doi:10.5958/0976-2469.2019.00010.1

Kadli, J. H. (2020). QR Codes: Academic Library Perspective in Digital Age. *Library Philosophy and Practice (e-journal)*, 3916. https://digitalcommons.unl.edu/libphilprac/3916

Lawrence, S., Koob, A., & Mutima, N. (2015). *U.S. foundation funding for Africa*. Foundation Centre. https://grantcraft.org/content/curated-content/u-s-foundation-funding-for-africa-2015-edition/

Lynch, R., Young, J. C., Jowaisas, C., Boakye-Achampong, S., & Sam, J. (2020). African Libraries in Development: Perceptions and Possibilities. *The International Information & Library Review*. Advance online publication. doi:10.1080/10572317.2020.1840002

Makori, E. O., & Mauti, N. O. (2016). Digital Technology Acceptance in Transformation of University Libraries and Higher Education Institutions in Kenya. *Library Philosophy and Practice (e-journal),* 1379. https://digitalcommons.unl.edu/libphilprac/1379

Mierzecka, A. (2018). Students' information needs and digital technologies in the academic libraries. *Przegląd Biblioteczny*, *86*(4), 509–530. doi:10.36702/pb.440

Moruf, H. A., & Dangani, B. U. (2020). Emerging Library Technology Trends in Academic Environment - An Updated Review. *TheScientificWorldJournal*, *15*(3). Advance online publication. doi:10.47514wj/15.03.2020.002

Moya, M., Musumba, I., & Akodo, R. (2011). Management attitude, support and integration of information communication technologies in higher education in Uganda. *Journal of Modern Accounting and Auditing*. http://ahero.uwc.ac.za/ index.php?module=cshe&action=downloadfile&fileid=1840

Mtebe, J. (2014). *Acceptance and Use of eLearning Solutions in Higher Education in East Africa*. University of Tampere.

Organisation for Economic Co-operation and Development (OECD). (2019). *Development aid statistics at a glance, Statistics by region, Africa*. https://www.oecd.org/dac/ financing-sustainable-development/development-financedata/Africa-Development-Aid-at-a-Glance-2019.pdf

Pinto, M., & Leite, C. (2020). Digital technologies in support of students learning in Higher Education: Literature review. *Digital Education Review*, *37*(37), 343–360. doi:10.1344/der.2020.37.343-360

Prasad, S. (2017). *Modern Technologies for Reshaping Libraries in the Digital Era.* GRIN Verlag. https://www.grin.com/document/367578

Rabatseta, B., Maluleka, J. R., & Onyancha, O. B. (2021). *Adoption and use of social media in academic libraries in South Africa*. https://sajlis.journals.ac.za/pub/article/view/1926/1536

Raju, J. (2014). Knowledge and skills for the digital era academic library. *Journal of Academic Librarianship*, *40*(2), 163–170. doi:10.1016/j.acalib.2014.02.007

Saibakumo, W. T. (2021). Awareness and acceptance of emerging technologies for extended information service delivery in academic libraries in Nigeria. *Library Philosophy and Practice (e-journal),* 5266. https://digitalcommons.unl.edu/libphilprac/5266

Selwyn, N. (2016). *Is technology good for education?* John Wiley & Sons.

Shastri, D. K., & Chudasma, P. (2021). The perception of ICT skills and challenges of usage of technologies among the library professionals of the Gujarat State during the COVID 19: A comprehensive study. *Quality & Quantity*. Advance online publication. doi:10.100711135-021-01167-x PMID:34054149

Singh, K., & Nikandia, P. (2017). Role of Mobile Technology and their Application in Library Services in Digital era. *International Research: Journal of Library & Information Science*, *7*(1), 157–166.

Tang, Y., & Tseng, H. W. (2013). Distance Learners' Self-Efficacy and Information Literacy Skills. *Journal of Academic Librarianship*, *39*(6), 517–521. doi:10.1016/j.acalib.2013.08.008

Tella, A. (2020). Repackaging LIS professionals and libraries for the fourth industrial revolution. *Library Hi Tech News*, *37*(8), 1–6. doi:10.1108/LHTN-02-2020-0016

Tella, A., Bajeh, A. O., Titilola, O. O., & Ayodeji, A. Y. (2020). Librarians and Information Professionals Skills Need for Sustainability at the Advanced Information Technology Era. *Proceedings of the 2nd International Conference on ICT for National Development and Its Sustainability, Faculty of Communication and Information Sciences, University of Ilorin, Ilorin, Nigeria - 2021*. https://www.ijipc.com.ng/index.php/ijipc/article/view/513/281

Tulinayo, F. P., Ssentume, P., & Najjuma, R. (2018). Digital technologies in resource constrained higher institutions of learning: A study on students' acceptance and usability. *International Journal of Educational Technology in Higher Education*, *15*(36), 36. Advance online publication. doi:10.118641239-018-0117-y

Ukachi, N. B. (2015). Information Literacy of Students as a Correlate of Their Use of Electronic Resources in University Libraries in Nigeria. *The Electronic Library*, *33*(3), 486–501. doi:10.1108/EL-05-2013-0085

ADDITIONAL READING

Jankowska, M. A., Smith, B. J., & Buehler, M. A. (2014). Engagement of academic libraries and information science schools in creating curriculum for sustainability: An exploratory study. *Journal of Academic Librarianship*, *40*(1), 45–54. doi:10.1016/j.acalib.2013.10.013

Martin, A., & Madigan, D. (Eds.). (2006). *Digital literacies for learning*. Facet Publishing.

Miller, J. W., Martineau, L. P., & Clark, R. C. (2000). Technology infusion and higher education: Changing teaching and learning. *Innovative Higher Education*, *24*(3), 227–241. doi:10.1023/B:IHIE.0000047412.64840.1c

Nambisan, S. (2017). Digital entrepreneurship: Toward a digital technology perspective of entrepreneurship. *Entrepreneurship Theory and Practice*, *41*(6), 1029–1055. doi:10.1111/etap.12254

KEY TERMS AND DEFINITIONS

Academic Libraries: Academic libraries are libraries established in higher institutions of learning such as Colleges of Education, Polytechnics, university, teacher training Colleges, Institute of Aviation among others too numerous to mention. They are meant to serve the teaching, learning, research, and community development of academic staff and other supporting staff of the institution.

Digital Technologies: Digital technologies have to do with a diverse set of electronic tools, systems, devices, and resources that can be used to harness, create, generate, store and process data and information for the accomplishment of set goals in the organization. There is no organization in present information and knowledge economy that could thrive without the use of digital technologies. Most of all the activities in the organization are carried out through the support of digital technologies.

Infusion: By infusion, we imply an approach of putting something into a bottle or putting fluids or medication into a bloodstream. Therefore, the infusion meant in this study has to do with how digital technologies could be inculcated into academic libraries for enhanced job performance.

Opportunities: By opportunities, we imply some of the benefits associated with the infusion of digital technologies into academic libraries, such as easy accessibility and access to multifarious information resources on the web.

Sustainability: Sustainability has to do with the ability to maintain support for an identified object or project carried out in the organization over a long period of time. This implies that if the digital technologies are judiciously infused into academic libraries, it would help to sustain its longevity.

Threats: The state of having disasters that militate against the performance of the infusion of digital technologies.

Section 2

Knowledge Management and Dissemination/Sharing in Academic Libraries

Chapter 5
Knowledge Organisation in Academic Libraries:
The Linked Data Approach

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ABSTRACT

Linked Data (LD) emerged as an innovation in libraries over a decade ago. It refers to a set of best practices for publishing and linking structured data using existing Semantic Web technologies. Knowledge organisation in academic libraries can use the advantages of LD technologies to increase availability of library resources on the world wide web. Existing methods of descriptive cataloguing are based on describing metadata and constructing unique authorized access points as text strings. However, this strings-based approach works well in the closed environment of a traditional library catalogue and not in an open environment where data are shared and linked. This chapter investigates the introduction of LD in the organization of knowledge in academic libraries, as literature shows that students prefer to search the internet for their information needs. Secondary literature was reviewed and analysed. Findings indicated that libraries that adopted LD increased the visibility of their products on the internet.

INTRODUCTION

Academic libraries should contribute immeasurably to the research, and the teaching and learning activities of the institutions that house them. Generally, library services are social institutions that were established to serve the communities that created them and should prove their value to their stakeholders, especially during this era of advanced and evolving technology where information is available on everyone's reach such as google, social media, social networks etc. (Malapela and De Jager, 2018). According to Malapela and De Jager (2018), the concept of valuing a library service has concerned library and information professionals for decades; however, there has been little consensus on the best approaches to determine and measure the value of library services. Library performance can be measured by accessibility and usability of information sources and services rendered. Advances in information technology such as the

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Internet of Things (IOT), the Fourth Industrial Revolution (4IR) and Linked Data (LD) offer opportunities for improved service delivery in libraries and may transform the roles of library staff.

BACKGROUND TO THE RESEARCH PROBLEM

The principle of Knowledge Organisation (KO) means to arrange library resources in a manner that will facilitate easy access and retrieval when users need those resources (Macgregor & McCulloch, 2006). This could be attained through metadata creation such as cataloguing, classification, authority control, subject analysis and indexing. These bibliographic descriptions have been specified by standards, such as Resource Description and Access (RDA), Machine Readable Catalogue (MARC), subject headings schemes, classification Schemes and other metadata standards used. For instance, RDA is a content standard. The MARC structure is a coding standard and format that originated in the 1960s by Avram (1968) and was developed in pace with the technology of the time. The MARC system is a mathematical code using cataloguing numbers, letters and symbols to denote different elements or fields of bibliographic information. The philosophy behind the MARC system as stated by Avram (1968) was the design of one format structure (the physical representation on a machine readable medium) capable of containing bibliographic information for all forms of materials (books, serials, maps, music and other library information sources). The classification scheme is used for organising knowledge into a systematic order. On the other hand, the subject heading scheme is used to assign subjects for the library materials to increase consistency and easy retrieval (Olson, Boll & Aluri, 2001).

The metadata is then accessed through the library catalogue, Online Public Access Catalogue (OPAC), which is treated as a textual tool for KO (Nahotko, 2020). OPAC is a database of bibliographic records describing the holdings of a library. It allows users to search a document by author, title, subject and keywords, standard number, and more from a terminal, as well as for printing, downloading or exporting of records via different electronic means (Gohain & Siakia, 2013). According to Fabunmi and Asubiojo (2013), OPAC is an interface of an information retrieval system, which assists information searchers to access resources of libraries using several access points. OPAC thus provided users with a means of searching and accessing information; users can see the collections and issue the status of each document in the library, and can reserve and renew a document of their interest when needed (Swaminathan, 2017).

OPAC GENERATIONS AND LD

Nahotko (2020) opines that the OPAC interface has developed over time and with the advancement of technology. For instance, first OPAC generation (I) was created during the 1970s and 1980s and replicated the traditional card catalogue, mainly used to search for previously known items according to a limited number of basic metadata attributes, such as author, title, and call number. Options of search transactions in OPAC generation (I) were limited to entering a strict search phrase, as it required character-by-character matching between user query and the OPAC record.

The second generation (II), which appeared at the end of the 1980s, added the possibility to search by subject heading (with controlled vocabulary) or keywords from the title. Other fields were also added, as well as new mechanisms for request construction, like the use of Boolean expressions. Browsing facilities were also added. Catalogues have become available via Telnet. OPAC was connected to the circulation module, which gave the opportunity for new transactions, as it enabled users to find out if the retrieved documents are available (Nahotko, 2020). Hildreth (1991) specifies the features of OPAC generation (II) as subject access, keyword access, Boolean searching, index term browsing, shelf list review, full standard bibliographic records, multiple display formats, two or more dialog modes, interactive search refinement, search results display or print manipulation, help facility, context-sensitive, informative error messages, search term approximate match routines.

The third generation (III) of OPAC, which surfaced in 1996, added spelling control, ranked searched results by relevance and contained metadata not only about books, but also about other communication genres, like journals, audio-visual and electronic documents. The circulation module was significantly developed for functionalities like orders and loan control, specific data on localisation and a list of copies owned by the library. The user interface was based on menu system leading to data displayed in windows and graphic form. The third (III) generation functionalities were then described as natural language query expressions, automatic term conversion/matching aids, non-Boolean retrieval techniques, ranked retrieval output, relevance feedback methods intelligent navigation aids, integration of keywords, controlled vocabulary, classification-based search approaches, expanded coverage and scope, extended access range via linkages and networks, acceptance of search expressions in ordinary language, with facilities for using a dictionary to provide for abbreviations, synonyms or spelling variants, context-dependent automatic help, using terms from relevant records retrieved to enhance the search strategy (Nahotko, 2020).

The fourth generation of OPAC (IV) that emerged in the 2000 and is called the Web OPAC is characterised by the use of many tools typical for the WWW, such as the graphical user interface, sharing resources using the Z39.50 protocol, integrated search using hypertext links and the ability to process metadata in various formats such as MARC and Dublin Core, imported from various sources (Madhusudhan & Aggarwal, 2011). Links to external databases were used. Cover images, abstracts and tables of contents complemented typical catalogue records. Users had the possibility to use interface options, like simple and complex searches. The design of OPAC interfaces was influenced by more advanced technology and IOT. The features of Web OPAC were described by Babu and O'Brien (2000) as Graphical User Interface (GUI), availability of hypertext links through bibliographic records, emulation of search engines in terms of appearance and search features, availability of full text, one interface to search all electronic information, links to circulation files, reference assistance, and more. After 2000, new functionalities of OPAC were the reason for the next OPAC generation, or the Next Generation Catalogue (NGC) descriptions, or OPAC 2.0, which was emerged in 2005.

OPAC 2.0 is treated as generation (V). It is an extension of Web 2.0 enabling integration of the library OPAC with Content Management System (CMS), which significantly increases the user's interface transaction capabilities; it allows users to add their own tags, scores and opinions on materials in library collections; and it exports records in the selected description style. Jetty, Anbu, Jain and Hopkinson (2011), and Chandrappa and Sunil (2017) state that users prefer OPAC 2.0 developments enabled by Web 2.0 technologies that have emerged, such as extending the usefulness and search features of the catalogue by harnessing more bibliographic MARC and circulation data for searching, and seamlessly incorporating data from other resources, social networking with personalisation and user community tagging and reviewing to provide a richer discovery experience. With an OPAC 2.0, library users may add comments or rating to records of books they borrowed from the library. All this information may help another reader to know if the book they just identified would satisfy their needs. This is merely an amplification of a specific feature of OPAC 2.0. Various other functions of OPAC 2.0 are experimented with, isolated or placed in specific groups of Integrated Library System (ILS) environments (Jetty et al., 2011). In addition, users can customise the interface of the catalogue, save search results, order and prolong items, and pay library fees. During the 21st century, the (VI) OPAC generation emerged through the Web Scale Discovery (WSD) system. The discovery system allows the management of the library resources in a unified way, regardless of the resource format and location, and its architecture is no longer service oriented. It possesses some additional features, like faceted navigation and relevance-ranked search results. Library catalogues began to be treated as identifiable web-based orientation services of search and discovery of electronic library resources (to their metadata and/or full texts) through a single interface and a single, integrated index that resembles those carried out by search engines. New browsing capabilities such as single point of entry for all library resources, state-of-the-art web interface, enriched content, faceted navigation, simple keyword search box with a link to an advanced search on every page, relevancy ranking, spell checking, recommendations/related materials, user contribution (e.g. tagging, ratings and reviews), RSS feeds, integration with social networking sites and persistent links were added. The (VII) OPAC generation is based on the Functional Requirements for Bibliographic Records (FRBR) model and its derivatives, mainly FRBR-LRM and Bibliographic Framework (BIBFRAME).

The most important purpose is a better presentation of bibliographic relations and stronger support for user tasks, mainly accessed by improvement of the user interactions with metadata and simplification of the standard, and its adaptation to the rules prevailing in the global information ecosystem. Adoption of this generation of OPAC will bring about changes to the ILS, its algorithms and user interfaces to ensure users can achieve the goals of their interactions with bibliographic information and ILS as a whole. This means that computer technology brought back the best solutions (interfaces and metadata structures) from previously used communication technologies in libraries. OPAC in cloud computing, especially LD technology also known as Linked Open Data (LOD)/ LD, is treated as the last "next catalogue generation" (VIII) to date.

ADOPTION OF LD

The LD technology includes a set of good practices and rules for interlinking machine-readable data sets using Uniform Resource Identifiers (URIs) and the Resource Description Framework (RDF) metadata schema to display, disseminate and merge data in a web environment (Nahotko, 2020). Nahotko (2020) also opines that although this technology was created for all information-processing applications, it is very interesting for library metadata. LD in library KO uses standards like RDA and BIBFRAME. Such a catalogue allows OPAC to completely move away beyond the closed environment of the library KO and become involved in the activities of KO in an open web environment.

This means that metadata is not only computer processed, but also computer interpreted (Guerrini & Possemato, 2016). Due to the rapidly changing technological environment, there is now the opportunity for the library community to expose the data created by cataloguing LOD – applications, trends and future developments and metadata professionals, and to establish interconnections to related resources across the web (Cervone & Svensson, 2016; Zepounidou, Sfakakis & Papatheodorou, 2017) affirm that technology has improved the delivery of services using structured data from one or more domains. Integration of library data into the semantic web demands a shift in conceptual data models and data format according to the semantic web principles and standards. However, libraries have now adopted LD to increase discovery and accessibility of knowledge. According to Wood, Zaidman, Ruth and Hausenblas (2014), LD is a set of techniques that represents and connects structured data such as catalogue data on the web. LD makes the WWW a global database that is called the Web of Data. The LD technologies hold the potential to evolve the current web of documents such as HTML, SGML, XML, JSON, XUL, SVG files into the Web of Data. The Web of Data consists of structured data located in servers through the existence of links. This data is also called LD because it is data connected through links. The data that exists in the Web of Data is called metadata. The term LD indicates a set of steps to distribute and connect structured data on the web. In the hypertext web, HTML documents are connected to each other using untyped hyperlinks, whereas LD depends on the documents having RDF formats to create typed links that connect things globally, forming the Web of Data (Jacksi, Zeebaree & Dimililer, 2018).

One advantage of LD is the release of bibliographic data from the silos, which could be library catalogues to the web, link to resources from other communities and retrieval of library resources by internet search engines. To manage the influx of available information and the rapid growth of data, libraries and many organisations have adopted LD. Wang and Yang (2018) state that during the last ten years, many companies, small or big, have adopted LD. For instance, Wood et al. (2014) reveal that Google and Facebook use LD to enhance their searching capability and connections and Best Buy uses LD to improve its business. "Jay Myers of Best Buy reports that as many as 100 different criteria could affect the purchase of one product. He expects that the use of semantic data can enhance the Best Buy site, improve the visibility of more than 85% of the products, and help consumers identify more appropriate products" (Wood et al., 2014:71). Varlan (2011) reports that Best Buy had a 30% increase in search traffic after incorporating RDF data in its web pages. In the case of library data, the Library of Congress (LC) has been leading in promoting LD technologies and their potential application in libraries.

The first move made by LC was to convert the Library of Congress Subject Headings (LCSH) name authority file into RDF statements and URIs, and thus made them ready for use by other semantic web applications (Wood et al., 2014). OCLC is another leading force in LD research and projects in libraries. OCLC Program for Cooperative Cataloguing (PCC) carried out a project to transform the library metadata, which was based on the MARC record to LD, to increase accessibility of information sources to the global community (Godly & Smith-Yoshimura, 2017). Other OCLC and LD projects revolve around Worldcat.org. According to OCLC (2017b), OCLC implemented Worldcat.org Works (all manifestations of the same work are linked and displayed in a cluster using the OCLC FRBR work set algorithm). The algorithm collects bibliographic records into groups based on author and title information from bibliographic and authority records. Gathering all formats of a work under its title increases availability of the work on the internet. In July 2017, about 215 million work entities were available in Worldcat.org (OCLC, 2017a).

Szeto (2017) also explored how LD can transform and enhance the search and discovery of music resources. "With linked open data, we are free to refine the "alternative" property to a "derivative of" property. Or, refining to show various degrees and styles of derivativeness, such as "part adapted for" (another instrument), "orchestration of," "reduced orchestra version of," "piano reduction of," "re-orchestration of," "adapted for" (a different instrumentation), or even "reconstruction of," "re-creation of," "inspired by," "restyling of." While for a human user using "alternative" will suffice for all these scenarios, more precise properties allow machines to acquire more nuanced under- standing, especially for complex concepts and the many degrees of equivalence and similarity" (Szeto, 2017:21).

PROBLEM STATEMENT

Several studies revealed that students in the institutions of higher learning, mainly universities, preferred internet web engines to OPAC when searching for information for their academic and personal use (Msagadi, 2016; Fati & Adetimirin, 2015; Monyela, 2014; Kumar & Vohra, 2013; Eserada & Okolo, 2019; Jiang, Chi & Gao, 2017; Ferdinand, 2020; Lalnunpuii, Nurtinkhuma & Verma, 2018; Warraich & Rorissa, 2018; Aju & Foti, 2020; Igbudu & Ver, 2020). Moreover, studies that revealed the use of OPAC by students indicated that OPAC was not used satisfactorily, due to its challenges or limitations such as a lack of awareness, a lack of interest, a lack of training, OPAC interface, bibliographic information, a lack of fuzzy search, search functionality, misleading results, data duplication and metadata inconsistency (Monyela, 2019; Akanbi, Adekanbi & Bankole, 2021; Ndumbaro & Kassim, 2021; Cabonero, Austria, Bayang & Bumanghat, 2020; Yeboah, 2018; Rout & Panigrahi, 2018). Researchers such as Gross and Sheridan (2011) and Lown et al. (2013) suggest that users prefer a single search box that accepts any keywords and querying tools such as spell checking and query suggestions. Library users are no longer satisfied with being able to find and identify material held only in their local collection. They are also less satisfied with the linear approaches to information retrieval left over from the paper-based card and book catalogues, including complex functional features of online catalogues, which are still embedded in the libraries' cataloguing systems worldwide (Dorner, 2000; Fabunmi and Asubiojo, 2013).

Exposure of library data in the semantic web and the internet will lead to more accessibility and, ultimately, more usage of library resources and better services to users. Alemu, Stevens, Ross and Chandler (2012) are of the view that the adoption of LD can provide an open interactive system, with external links and the ability to make information easily accessible and re-usable, and with the possibility to discover other related resources. Thus, the library OPAC should be upgraded to LD technology. This technology goes far beyond what OPAC has allowed before (Nahotko, 2020). Gonzales (2014) and Warraich and Rorissa (2018) further opine that since the internet is often the first-place users turn to for information, libraries should take advantage of the concepts behind LD to put their resources out on the web where they can be found by users and, in turn, bring those users back to the library through the lure of authoritative, high-quality resources. Furthermore, if libraries want to stay alive in this modern information technology world, they would have to adopt LD initiatives. Warraich and Rorissa (2018) state that, in this digital environment, academic library users have high expectations, and information professionals design different strategies to make relevant information readily available. LD is a potential technology to be used in these libraries to provide better accessibility for researchers of all backgrounds. The following objectives guided the study:

- To explore the conceptual models for LD
- To establish the framework for LD

METHODOLOGY

The chapter reviews the secondary literature drawn from books, journals, conference proceedings, databases, discusses some of conceptual models and framework for LD and their approaches thereof. This was done to have a better understanding of LD technologies and the conceptual models in the organisation of knowledge.

LITERATURE REVIEW

Literature review includes conceptual models and framework for LD

CONCEPTUAL MODELS FOR LD

The conceptual models for the implementation of LD includes RDF, Resource Description Framework Schema (RDFS), Web Ontology Language (OWL), SPARQL Protocol and RDF Query Language (SPARQL), SPARQL for Continuous Querying (C- SPARQL) and URI. RDF is a standard model for data interchange on the web, using simple Subject-Predicate-Object (also called triple) statements. This is a data model aimed at web scale rather than being limited to a specific domain or applications (Hendler, Gandon & Allemang, 2020). RDF has features that facilitate data merging, even if the underlying schemas differ, and it specifically supports the evolution of schemas over time without requiring all the data consumers to be changed. RDF, a core part of the semantic web, uses URIs to uniquely identify resources and provides a framework to describe a resource in terms of its properties and its relationship with other resources.

In the RDF environment, the system will provide more links to the user query. For example, if the user is searching for the term *"Artificial intelligence"* on the OPAC of their library, information will be retrieved from the OPAC and all the databases, repositories and sites beyond the library OPAC. RDF uses a graph of nodes and arcs representing the resources, and their properties and values. Its ability to exchange information between different applications means that the information may be made available to applications other than those for which it was originally created for; like in the case of the library OPAC where the cataloguers create metadata such as author, title and subject for the library OPAC. The grammar of RDF triples was designed to help merge data from multiple sources by leveraging shared URIs to align layers of information in a unified whole (Baker, Coyle & Petiya, 2014). When the user searches the OPAC that adopted the RDF model, the links will harness information from other sites and present to the user query. Libraries like University of Arizona libraries in the United States of America (USA) adopted the RDF model on their library system (Han, 2006).

The system is composed of a storage layer that is standards based, content neutral and metadata extensible using RDF and RDFS, a metadata management and semantics layer that can be used for metadata management (e.g. support multiple descriptive metadata formats and other types of metadata), ontologies and taxonomy. Knowledge management such as transferring of meaning across domains is addressed in this layer, a common services layer that is standards based and allows application-specific and heterogeneous access such as metadata services like OAI-PMH, linking services such as Open URL and search service, an application layer on top of common service layer that allows different applications to fulfil diverse needs of communities (Han, 2006). Han (2006) also revealed that the RDF-based digital library system at the University of Arizona Libraries provides an easy way for digital resource management by integrating other applications, regardless of metadata formats and web presence. RDFS is a language with vocabularies and constructs intended to structure RDF resources. In order for the RDF model to function, it requires defined vocabularies such as Class, Sub-Class Of, Domain, Range, Label, and Comment that are offered by RDFS ((W3C, 2004c).

OWL, on the other hand, extends RDFS with additional vocabularies such as equivalency (e.g. equivalent Class, equivalent Property, sameAs, and different From), inverse (inverse Of), cardinality relations and data value constraints (Allemang & Hendler, 2008; W3C, 2004a; b). All these semantic web languages support the RDF functionality. SPARQL is the standard language for querying RDF data. It is a graph-matching query language comprised of three parts. The pattern-matching part includes several interesting features of pattern matching of graphs, like optional parts, union of patterns, nesting, filtering values of possible matchings, and the possibility of choosing the data source to be matched by a pattern. Once the output of the pattern has been computed (in the form of a table of values of variables), the solution modifiers allow the modification of these values applying classical operators like projection, distinct, order and limit.

Finally, the output of a SPARQL query can be of different types: yes/no queries, selections of values of the variables that match the patterns, construction of new RDF data from these values, and descriptions of resources (Pérez, Arenas & Gutierrez, 2009). C-SPARQL "is an extension of SPARQL to support continuous queries over RDF data streams. Supporting streams in RDF format guarantees interoperability and opens up important applications, in which reasoners can deal with knowledge that evolves over time" (Barbieri, Braga, Ceri, Della Valle & Grossniklaus, 2009:1061). For example, the user can save their queries on the system such as "artificial intelligence" – whenever new information on artificial intelligence is added on the web, the query runs and adds it on the cache and produce the output faster without executing commands again from the database. Moreover, URIs provide a simple and extensible means for identifying a resource. This specification of URI syntax and semantics is derived from concepts introduced by the WWW global information initiative, whose use of such objects dates back to 1990 and is described in "Universal Resource Identifiers in WWW" [RFC1630]. The specification of URI is designed to meet the recommendations laid out in "Functional Recommendations for Internet Resource Locators" [RFC1736] and "Functional Requirements for Uniform Resource Names" [RFC1737]. URI helps to avoid naming and identification conflicts in the use of elements (Berners-Lee, Fielding & Masinter, 1998). Alemu et al., 2012) opine that one of the defining features of the RDF model is its ability to identify resources and metadata attributes (relations) uniquely and globally using URIs. The use of URIs for metadata element names, labels and relations, according to Nilsson (2010), helps to avoid naming and identification conflicts in the use of elements. A URI is a globally unique identifier that forms a fundamental part of LD.

FRAMEWORKS FOR LD

Frameworks for LD, exist for the representation and publication of library data in the semantic Web. Thus, the library community may use existing frameworks, such as the FRBR and FRBR Object-Oriented (FRBRoo), Functional Requirements for Authority Data (FRAD), Functional Requirements for Subject Authority Data (FRSAD), RDA or develop new models such as BIBFRAME to represent bibliographic information according to the user's needs. The FRBR is a conceptual entity relationship model developed by the International Federation of Library Associations and Institutions (IFLA) (IFLA, 1998). The model presents the relationship between the user tasks of retrieval of and access to online library catalogues and bibliographic databases from users' perspectives. It represents a more holistic approach to retrieval and access, as the relationships between the entities provide links to navigate through the hierarchy of relationships. The purpose of the FRBR model is to identify the functional requirements of information in bibliographic records and to facilitate the specified user tasks. The basic entities of the FRBR model are the result of a logical analysis of the data typically represented in bibliographic records. The model consists of three elements: entities, attributes and relation between entities. It is a theoretical model that can be used to cluster bibliographic records retrieved on the OPAC search into a more meaningful display, thus assisting users in selecting items from bibliographic collections (Hyun & Yong, 2008).

The FRBR model provides a structure within which data requirements can be analysed in a systematic way. The structure provided by the model serves as a framework for analysing the uses that are made of bibliographic data, with specific reference to the entity that is the object of the user's interest and to the attributes and relationships that are relevant to the task being performed by the user (Riva & Žumer, 2018). In harmony with the International Committee on Documentation (CIDOC) and the Conceptual Reference Model (CRM), FRBRoo is a formal ontology that captures and represents the underlying semantics of bibliographic information and, therefore, facilitates the integration, mediation and interchange of bibliographic and museum information. Such a common view is necessary for the development of interoperable information systems serving users interested in accessing common or related content. Beyond that, it results in a formalisation which is more suited to the implementation of concepts from the FRBR family of conceptual models with object-oriented tools, and which facilitates the testing and adoption of these concepts in implementations with different functional specifications and beyond the library domain. It applies empirical analysis and ontological structure to the entities and processes associated with the bibliographic universe, to their properties and to the relationships among them. It thereby reveals a web of interrelationships, which are also applicable to information objects in non-bibliographic arenas (Riva & Žumer, 2015).

The purpose of FRBRoo is to achieve interoperability between libraries and museum collection. Depending on the nature of their research, academic library users may need information held by museums for their cultural, historical and heritage research areas and may need to access information held in museums. The CIDOC CRM has been developed in a manner that is intended to promote a shared understanding of cultural heritage information by providing a common and extensible semantic framework for evidence-based cultural heritage information integration. It is intended to be a common language for domain experts and implementers to formulate requirements for information systems and to serve as a guide for good practice of conceptual modelling. In this way, it can provide the "semantic glue" needed to mediate between different sources of cultural heritage information, such as that published by museums, libraries and archives (Murano, Beretta, Niccoluci & Bruseker, 2021). The FRAD was established by IFLA (2009) as an extension of the FRBR. The primary purpose of this conceptual model is to provide a framework for the analysis of functional requirements for the kind of authority data that are required to support authority control and for the international sharing of authority data. The model focuses on data, regardless of how it may be packaged in authority records. More specifically, the conceptual model has been designed to provide a clearly defined structured frame of reference for relating the data that are recorded by authority record creators to the needs of the users of that data, assist in an assessment of the potential for international sharing and to use of authority data in the library sector, museums and archives. In the context of the model, authority data are described as the aggregate of information about a person, family, corporate body, or work whose name is used as the basis for a controlled access point for bibliographic citations or records in a library catalogue or bibliographic file and authority file (IFLA, 2009). Moreover, the FRSAD is the continuation of the FRAD.

The IFLA Working Group on the Functional Requirements for Subject Authority Records (FRSAR) was formed to address subject authority data issues and to investigate the direct and indirect uses of subject authority data by a wide range of users. The role of the FRSAR working group was to build a conceptual model of group 3 entities within the FRBR framework as they relate to the aboutness of works; to provide a clearly defined, structured frame of reference for relating the data that are recorded in subject authority records to the needs of the users of that data; to assist in an assessment of the potential for international sharing and use of subject authority data both within the library sector and beyond (IFLA, 2010:6).

Although the FRBR and the FRAD models cover subject entities, the FRSAD model extends the entities to 'thema' and 'nomen' and it emphasises the relationships among the subject terms. The cataloguer should assign the subject terms and their relationships on the catalogue to improve access on the OPAC. For example, if the information source is about "Goats", the thema or subject heading of that source in the catalogue is "Goats". The broader subject "Animals" should also be assigned as another subject heading of that information source, which is in a hierarchical relationship with the two themas "Goats" and "Animals". Subject access to information has been a significant approach of users to satisfy their information needs. Research results have demonstrated that the integration of controlled vocabulary information with an information retrieval system helps users perform more effective subject searches (Joudrey, Taylor & Miller, 2015). This integration becomes possible when subject authority data (information on subjects from authority files) are linked to bibliographic files and made available to users (IFLA, 2010). On the other hand, RDA is a cataloguing standard that produces well-formed, interconnected metadata for the digital environment, offering a way to keep libraries relevant on the WWW (Tillett, 2011).

RDA provides a comprehensive set of guidelines and instructions on resource description and access, covering all types of content and media in libraries, archives and information centres (IFLA, 1998). It is based on the functional requirements for bibliographic records in order to relate the user task of retrieval and access in an online library catalogue and biographic database from a user's perspective (IFLA, 1998). It provides a set of guidelines and instructions on recording data to support resource discovery, and it is a flexible and extensible framework for the description of all types of resources, including digital resources and those with multiple characteristics. With system support, RDA allows library bibliographic records to be integrated with those produced by other metadata communities and to move into the digital environment beyond library catalogues (RDA toolkit). RDA support LD (Wang & Yang, 2018). Van Rensburg (2017) notes that the availability of the RDA toolkit, which is an online resource, provides hypertext links to navigate from one instruction to the next. Furthermore, the BIBFRAME model is designed with a high degree of flexibility in that it can accommodate any number of existing models as well as models that are developed in the web environment. The model's flexibility is intended to foster extensibility. It can be a viable and extensible framework for bibliographic description and exchange in the web environment, not only for the benefit of users looking for library resources, but also for reuse in contexts outside of the library community. Finally, it appears that BIBFRAME will permit the full description of relationships between and among resources, enhancing and enriching the user experience of library information (Park, Brenza & Richards, 2020). The BIBFRAME initiative provides the possible framework that will link library resources to the web, bringing them out of their information silos and making them accessible to all users (Gonzales, 2014).

In order to adopt LD, libraries should implement these models. However, since the BIBFRAME initiative has positioned the model to be the replacement of MARC as the primary method of bibliographic description and data exchange between libraries, the initiative is doing more than simply ensuring the openness of the model to accommodate RDA and other content standards (Park et al., 2020). The MARC format, although dominant, is considered to be a record and document-centric metadata structure, rather than being an actionable data-centric format (Coyle, 2010) In the LD environment, data will always be around and valid; even if the library does not have the information source, LD will still harvest, harness and analyse relevant information from other links for the user query. When searching for information, the user may start with OPAC, LD technologies, and models and frameworks implemented on the OPAC will then link the query to the web and retrieve relevant results.

Zepounidou et al. (2017), Gonzales (2014), Raza, Mahmood and Warraich (2019), Haslhofer and Isaac (2011) and Niu (2020) state that other libraries that are applying these models and publishing bibliographic data in LD format, among others, are the British National Bibliography, the National Library of Spain Catalogue, the British Library, George Washington University, Princeton University, University of Oregon, Oregon State University Libraries, University of Florida, North Carolina State University (NCSU), Texas A&M University Libraries, University of California, University of Nevada, Las Vegas, University of Illinois, Prince Town University, University of Utah Libraries, University of Nevada, Reno Libraries, University of North Texas (UNT) Deutsche National Bibliothek, National Library of Medicine, OCLC, Digital Public Library of Americana, National Library of France, German National Library, Swedish National Library, Hungarian National Library, European Digital Library. Therefore, academic libraries should adopt the BIBFRAME model in order to publish their catalogue data on the web and improve access and the use of library sources. They should also spearhead the initiative and assist other libraries to share their information on the web. Library catalogues should not exist in silos, isolated from one another, and from the wider ecosystem of the web (Bermes, 2011). However, the library community should strengthen their quality control on the catalogue records to avoid errors on the data or content drift, dead links or non-active links to the user's queries. Dead links in the catalogue could apply when the information source was removed and no longer available on the web, in that case the catalogue record should be completely removed from the site.

FUTURE RESEARCH DIRECTIONS

The findings from this study has the potential to be used as an allusion to empirical studies on LD in libraries. Studies on the perceptions of librarians, library managers and library users regarding LD should be carried out. The data could be used to formulate policies and guidelines of LD adoption in libraries to enhance retrieval and use of information sources.

CONCLUSION

The adoption of LD technologies will increase retrieval of information sources, eliminate and solve problems of inaccuracies in the catalogue data retrieved from the bibliographic utilities. LD will provide links to other sources beyond the library metadata, which will be useful to the user query and save user time. Gonzales (2014:12) is of the view that "in the world of LD, the relationships between data, not just the documents in which they are contained, are made explicit and readable by both humans and machines. With the ability to "understand" and interpret these semantically explicit connections, computers will have the power to lead users to a web of related data based on a single information search". This makes information searching more stress-free. Raza et al. (2019) are of the view that the complex technologies of LD need experts who can apply them in libraries. LD courses should be included in the Library and Information Science School (LIS) curriculum, conferences and seminars, and workshops should be organised to enhance the skills of the library professionals so that they could be capable to implement LD technologies in the libraries. IFLA and professional bodies in each country should play their role for the availability of data in open licence on the web. Vendors should work with libraries to deal with the copyright and legal issues, as open licence is the basic requirement for LD on the semantic web. Vendors should also create LD vocabularies, host knowledge-sharing forums and provide training to librarians. For example, the OCLC published VIAF in LD format, which is very widely used by the library community. Zepheira helped LC in creating the BIBFRAME model and vocabulary and collaborated with University of California (UC), Davis, to create the roadmap for transitioning to LD-based workflows (Niu, 2020). Zepheira also provides an LD training programme or information specialists (Coyle et al., 2017). Other academic libraries could learn from the above libraries that publish bibliographic data on LD and involve their vendors in adopting LD.

REFERENCES

W3C. (2004a). *OWL web ontology language overview*. Available at: www.w3.org/TR/owl-features/

W3C. (2004b). *RDF primer. W3C recommendation*. Available at: www.w3.org/TR/2004/REC-rdf-primer-20040210/#basicconcepts

W3C. (2004c). *RDF vocabulary description language 1.0: RDF schema*. Available at: www.w3.org/TR/rdf-schema/

Aju, D. T., & Foti, S. T. (2020). Undergraduates' awareness, utilization and satisfaction with online public access catalogue (OPAC) in public university libraries in Nasarawa State, Nigeria. *Library and Information Perspectives and Research*, *2*(1), 18–29. doi:10.47524/liprv2i1.2

Akanbi, M. L., Adekanbi, R. O., & Bankole, Q. A. (2021). Perception and use of OPAC by users in academic libraries in Kwara State, Nigeria. *Record and Library Journal*, *7*(2), 228–233. doi:10.20473/rlj.v7i2.205

Alemu, G., Stevens, B., Ross, P., & Chandler, J. (2012). Linked data for libraries: Benefits of a conceptual shift from library-specific record structures to RDF-based data models. *New Library World*, *113*(11/12), 549–570. doi:10.1108/03074801211282920

Allemang, D., & Hendler, J. (2008). *Semantic Web for the Working Ontologist: Modeling in RDF, RDFS and OWL*. Morgan Kaufmann Publishers.

Avram, H. D. (1968). *The MARC pilot project: final report on a project sponsored by the Council on Library Resources, Inc.* Library of Congress. Available at https://babel.hathitrust.org/cgi/pt:id=uiug.3011201862679

Babu, R., & O'Brien, A. (2000). Web OPAC interfaces: An overview. *The Electronic Library*, *18*(5), 316–327. doi:10.1108/02640470010354572

Baker, T., Coyle, K., & Petiya, S. (2014). Multi-entity models of resource description in the semantic web: A comparison of FRBR, RDA and BIBFRAME. *Library Hi Tech*, *32*(4), 562–582. doi:10.1108/LHT-08-2014-0081

Barbieri, D. F., Braga, D., Ceri, S., Della Valle, E., & Grossniklaus, M. (2009). C-SPARQL: SPARQL for continuous querying. *Proceedings of the 18th international conference on World Wide Web*, 1061-1062. 10.1145/1526709.1526856

Bermes, E. (2011). Convergence and interoperability: a Linked Data perspective. In *World Library and Information Congress: 77th IFLA General Conference and Assembly* (pp. 13-18). Available at https://www.ifla.org/past-wlic/2011/149-bermes-en.pdf

Berners-Lee, T., Fielding, R., & Masinter, L. (1998). *RFC2396: Uniform resource identifiers (URI): generic syntax.* Available at: https://www.hjp.at/doc/rfc/rfc3986.html

Cabonero, D. A., Austria, R. M., Bayang, J. M. L., & Bumanghat, R. P. (2020). Knowledge, satisfaction and challenges on online public access catalog in an academic library in Northern Philippines. *Library Philosophy and Practice (e-Journal).*

Cervone, H. F., & Svensson, L. G. (2016). Linked Data and User Interaction: The Road Ahead. *Webology*, *13*(2), 54–57.

Chandrappa, C., & Sunil, M. V. (2017). Next generation catalogues: A comparative analysis of OPAC's of university libraries in India. *Journal of Library Development*, *3*(1), 25–37.

Coyle, K. (2010). Library data in the web world. *Library Technology Reports*, *46*(2), 5–11.

Coyle, K., Dyla, J., Han, M. J., Folsom, S., Schreur, P., Thompson, T., & Current, P. C. C. (2017). *Linked data infrastructure models: areas of focus for PCC strategies*. Available at: htps://www.loc.gov/aba/pcc/documents/LinkedDataInfrastructureModels.pdf

Dorner, D. (2000). Cataloguing in the 21st century, part 2: Digitization and information standards. *Library Collections, Acquisitions & Technical Services*, *24*(2), 73–87.

Eserada, R. E., & Okolo, S. E. (2019). Use of Online Public Access Catalogue (OPAC) in selected university libraries in South-South Nigeria. *Library Philosophy and Practice (e-Journal).*

Fabunmi, O. M., & Asubiojo, B. O. (2013). Awareness and use of online public access catalogue by students of ObafemiAwolowo University, Ile-Ife, Nigeria. *Library Philosophy and Practice (e-journal*), 922. Available at: https://digitalcommons.unl.edu/libphilprac/92

Fati, O. I., & Adetimirin, A. (2015). OPAC awareness as a factor affecting OPAC use by undergraduates in two Nigerian libraries. *International Journal of Academic Library and Information Science*, *3*(3), 72–80.

Ferdinand, O. A. (2020). Undergraduates' awareness, ICT skills and use of OPAC in federal universities in South West, Nigeria. Library of Progress-Library Science. *Information Technology & Computer*, *40*(2), 257–269.

Godly, C. J., & Smith-Yoshimura, K. (2017). From records to things: Managing the transition from legacy library metadata to linked data. *Bulletin of the Association for Information Science and Technology*, *43*(2), 18–23. doi:10.1002/bul2.2017.1720430209

Gohain, A., & Saikia, M. (2013). Use and user's satisfaction on Online Public Access Catalogue (OPAC) services among BTech. Students of School of Engineering in Tezpur University: A survey. *Library Philosophy and Practice (e-journal)*.

Gonzales, B. M. (2014). Linking libraries to the web: Linked data and the future of the bibliographic record. *Information Technology and Libraries*, *33*(4), 10–22. doi:10.6017/ital.v33i4.5631

Gross, J., & Sheridan, L. (2011). Web scale discovery: The user experience. *New Library World*, *112*(5/6), 236–247. doi:10.1108/03074801111136275

Guerrini, M., & Possemato, T. (2016). From record management to data management: RDA and new application models BIBFRAME, RIMMF, and OliSuite/WeCat. *Cataloging & Classification Quarterly*, *54*(3), 179–199. doi:10.1080/01639374.2016.1144667

Han, Y. (2006). A RDF-based digital library system. *Library Hi Tech*, *24*(2), 234–240. doi:10.1108/07378830610669600

Haslhofer, B., & Isaac, A. (2011). Data Europeana. EU: The Europeana linked open data pilot. *International Conference on Dublin Core and Metadata Applications*, 94-104.

Hendler, J., Gandon, F., & Allemang, D. (2020). *Semantic web for the working ontologist: effective modeling for linked data, RDFS, and OWL*. Morgan & Claypool.

Hildreth, C. H. (1991). Advancing toward the E3OPAC: the imperative and the path. In *Think tank on the present and future of the online catalog. Proceedings of ALA Midwinter Meeting*. American Library Assoc.

Hyun, H. K., & Yong, H. K. (2008). Usability study of digital institutional repositories. *The Electronic Library*, *26*(6), 863–881. doi:10.1108/02640470810921637

IFLA Study Group. (2010). *Functional requirements for subject authority data (FRSAD) – a conceptual model.* IFLA Working Group on the Functional Requirements for Subject Authority Records (FRSAR).

IFLA Study Group. (1998). *Functional requirements for bibliographic records: final report.* Technical report. IFLA. https://www.ifla.org/VII/s13/frbr/frbr.p

IFLA Study Group. (2009). *Functional requirements for authority data – a conceptual model. Working Group on Functional Requirements and Numbering of Authority Records*. Author.

Igbudu, M. T., & Ver, A. (2020). Undergraduates' awareness, use and satisfaction with online public access catalogue (OPAC) of Benue State University Library, Makurdi, Nigeria. *Journal of Library Services and Technologies*, *2*(1), 58–68.

Jacksi, K., Zeebaree, S. R., & Dimililer, N. (2018). LOD explorer: Presenting the web of data. *(IJACSA). International Journal of Advanced Computer Science and Applications*, *9*(1), 45–51. doi:10.14569/IJACSA.2018.090107

Jetty, S., Anbu, K. J. P., Jain, P. K., & Hopkinson, A. (2011). OPAC 2.0 towards the next generation of online library catalogues. *International Conference of Asian Special Libraries*. units.sla.org/chapter/cas/CoASL%202011.pdf

Jiang, T., Chi, Y., & Gao, H. (2017). A clickstream data analysis of Chinese academic library OPAC users' information behavior. *Library & Information Science Research*, *39*(3), 213–223. doi:10.1016/j.lisr.2017.07.004

Joudrey, D. N., Taylor, A. G., & Miller, D. P. (2015). *Introduction to cataloguing and classification* (11th ed.). Libraries Unlimited.

Kumar, S., & Vohra, R. (2013). User perception and use of OPAC: A comparison of three universities in the Punjab region of India. *The Electronic Library*, *31*(1), 36–54. doi:10.1108/02640471311299128

Lalnunpuii, E., Nurtinkhuma, R. K., & Verma, M. K. (2018). Use and users' satisfaction with on-line public access catalogue (OPAC) services of Mizoram University Library: A survey. *ISST Journal of Advances in Librarianship*, *9*(1), 68–73.

Lown, C., Sierra, T., & Boyer, J. (2013). How users search the library from a single search box. *College & Research Libraries*, *74*(3), 227–241. doi:10.5860/crl-321

Macgregor, G., & McCulloch, E. (2006). Collaborative tagging as a knowledge organisation and resource discovery tool. *Library Review*, *55*(5), 291–300. doi:10.1108/00242530610667558

Madhusudhan, M., & Aggarwal, S. (2011). Web-based online public access catalogues of IIT libraries in India: An evaluative study. *Program*, *45*(4), 415–438. doi:10.1108/00330331111182102

Malapela, T., & De Jager, K. (2018). Theories of value and demonstrating their practical implementation in academic library services. *Journal of Academic Librarianship*, *44*(6), 775–780. doi:10.1016/j.acalib.2018.09.018

Monyela, M. J. (2014). *Information seeking behaviour of postgraduate students: a study of Rhodes University and University of Fort Hare* [Unpublished MLIS thesis]. Department of Library and Information Science, University of Fort Hare, South Africa.

Monyela, M. J. (2019). *Cataloguing practices from creation to use: a study of Cape Town Metropolitan Public Libraries in Western Cape Province, South Africa [Unpublished PhD]*. Department of Information Studies, University of KwaZulu-Natal.

Msagati, N. (2016). Awareness and use of OPAC by distance learners: the case of the Open University of Tanzania. *Library Philosophy and Practice (e-journal)*, 1482.

Murano, F., Beretta, F., Niccoluci, F., & Bruseker, G. (2021). *49th joint meeting of the CIDOC CRM SIG and ISO/TC46/SC4/WG9; 42nd FRBR-CIDOC CRM Harmonization Meeting*. University of Oslo.

Nahotko, M. (2020). OPAC development as the genre transition process, PART 1: OPAC generations historical development. *Annals of Library and Information Studies*, *67*(2), 107–117.

Ndumbaro, F., & Kassim, M. (2021). The use of OPAC query logs to support evidence-informed information literacy (IL) training at The University of Dar es Salaam. *Information Development*. Advance online publication. doi:10.1177/02666669211021619

Nilsson, M. (2010). From interoperability to harmonization in metadata standardization: designing an evolvable framework for metadata harmonization [Unpublished PhD]. School of Computer Science and Communication, KTH, Stockholm.

Niu, J. (2020). Diffusion and adoption of linked data among libraries. *Proceedings of the Association for Information Science and Technology*, *57*(1), 1–9. doi:10.1002/pra2.216

OCLC. (2017a). *OCLC and linked data*. Available at: https://www.oclc.org/content/dam/oclc/services/brochures/215912_WWAE-OCLC-Linked-Data-Report.pdf

OCLC. (2017b). *WorldCat Work Descriptions* [White paper]. Available at: https://www.oclc.org/developer/develop/linked-data/worldcat-entities/worldcat-work-entity.en.html

Olson, H. A., Boll, J. J., & Aluri, R. (2001). *Subject analysis in online catalogs*. Libraries Unlimited.

Park, J. R., Brenza, A., & Richards, L. (2020). BIBFRAME linked data: a conceptual study on the prevailing content standards and data model. In Linked Open Data-Applications, Trends and Future Developments. IntechOpen. doi:10.5772/intechopen.91849

Pérez, J., Arenas, M., & Gutierrez, C. (2009). Semantics and complexity of SPARQL. *ACM Transactions on Database Systems*, *34*(3), 1–45. doi:10.1145/1567274.1567278

Raza, Z., Mahmood, K., & Warraich, N. F. (2019). Application of linked data technologies in digital libraries: A review of literature. *Library Hi Tech News*, *3*(3), 9–12. doi:10.1108/LHTN-10-2018-0067

RDA Toolkit. (2020). *Resource Description and Access*. Available at: https://access.rdatool kit.org

Riva, P., & Žumer, M. (2015). *Introducing the FRBR Library Reference Model*. Paper presented at: IFLA WLIC 2015, Cape Town, South Africa.

Riva, P., & Žumer, M. (2018). *FRBRoo, the IFLA Library Reference Model, and now LRMoo: a circle of development.* Paper presented at IFLA WLIC 2018, Kuala Lumpur, Malaysia.

Rout, R., & Panigrahi, P. (2018). Online Public Access Catalogue (OPAC) usage patterns among the library users of Odisha: A study. *International Journal of Library and Information Science*, *7*(1), 28–34. doi:10.34218/IJLIS.7.1.2018.005

Swaminathan, K. S. M. (2017). Use and awareness of Online Public Access Catalogue (OPAC) by students and faculty members of Anna University Regional Campus, Coimbatore, Tamil Nadu-A Case Study. *International Journal of Scientific Research and Management*, *5*(05), 5345–5349. doi:10.18535/ijsrm/v5i5.11

Szeto, K. (2017). The Mistry of the Schurbet Song: The linked data promise. *Notes*, *74*(1), 9–23. doi:10.1353/not.2017.0071

Tillet, B. B. (2011). *Keeping libraries relevant with RDA*. Available at: http://web.ebscohost.con/ehost/pdfviewe/pdfviewer

Van Rensburg, R. J. (2017). *Resource Description and Access (RDA): continuity in an ever-fluxing information age with reference to tertiary institutions in the Western Cape* [Unpublished MLIS thesis]. University of Western Cape.

Varlan, S. E. (2011). Using Semantic Web technologies for knowledge management in e-commerce applications. *Proceedings of the 11th WSEAS international conference on applied computer science*, 194-197.

Wang, Y., & Yang, S. Q. (2018). Linked data technologies and what libraries have accomplished so far. *International Journal of Librarianship*, *3*(1), 3–20. doi:10.23974/ijol.2018.vol3.1.62

Warraich, N. F., & Rorissa, A. (2018). Adoption of linked data technologies among university librarians in Pakistan: Challenges and prospects. *Malaysian Journal of Library and Information Science*, *23*(3), 1–13. doi:10.22452/mjlis.vol23no3.1

Wood, D., Zaidman, M., & Ruth, L. (2014). *Linked data: Structured data on the web*. Manning Publications Co.

Yeboah, E. B. (2018). *Assessing the role and position of the online public access catalogue at Sam Jonah library, University of Cape Coast*. Available at: http://hdl.handle.net/123456789/3947

Zepounidou, S., Sfakakis, M., & Papatheodorou, C. (2017). Representing and integrating bibliographic information into the semantic web: A comparison of four conceptual models. *Journal of Information Science*, *43*(4), 525–553. doi:10.1177/0165551516650410

ADDITIONAL READINGS

Amusan, B. B., & Odumade, A. O. (2022). Data Mining, Linked Data, and Library Service Delivery. In Handbook of Research on Emerging Trends and Technologies in Librarianship (pp. 60-72). IGI Global.

Hidalgo-Delgado, Y., Xu, B., Mariño-Molerio, A. J., Febles-Rodríguez, J. P., & Leiva-Mederos, A. A. (2019). A linked data-based semantic interoperability framework for digital libraries. *Revista Cubana de Ciencias Informáticas*, *13*(1), 14–30.

McKenna, L. (2020). *NAISC-L: A Linked Data Interlinking Framework for Libraries, Archives and Museums* (Doctoral dissertation). Trinity College Dublin Ireland.

McKenna, L., Debruyne, C., & O'Sullivan, D. (2022). Using linked data to create provenance-rich metadata interlinks: The design and evaluation of the NAISC-L interlinking framework for libraries, archives and museums. *AI & Society*, 1–27. doi:10.100700146-021-01373-z

Page, K. R., Lewis, D., & Weigl, D. M. (2019). MELD: a linked data framework for multimedia access to music digital libraries. In *2019 ACM/IEEE Joint Conference on Digital Libraries (JCDL)* (pp. 434-435). IEEE. 10.1109/JCDL.2019.00106

Saleem, Q. U. A., Butt, N., & Warriach, N. F. (2018). Applications of linked data technologies in libraries: Technical and ethical considerations. In *2018 International Conference on Information Management and Processing (ICIMP)* (pp. 11-15). IEEE. 10.1109/ICIMP1.2018.8325833

Warraich, N. F., & Rorissa, A. (2018). Readiness for and barriers to implementation of linked data by Pakistani libraries. *Proceedings of the Association for Information Science and Technology*, *55*(1), 924–926. doi:10.1002/pra2.2018.14505501178

KEY TERMS AND DEFINITIONS

BIBFRAME (Bibliographic Framework): A data model for bibliographic description. It was designed to replace the MARC standards, and to use linked data principles to make bibliographic data more useful both within and outside the library community by linking library resources to the web.

Knowledge Organisation: The process of arranging library resources in a manner that will facilitate easy access and retrieval of information.

Linked Data: A set of techniques that represents and connects structured data such as catalogue data using links that connects on the web

MARC: A communication format, computer code that consistently handles and disseminate the catalogue data recorded on the cataloguing system.

OPAC: An online catalogue that enables users to locate library materials from a remote area if connected to the internet.

RDA: A cataloguing standard that produces well-formed, interconnected metadata for the digital environment.

RDF: A standard model for data interchange on the web, using simple Subject-Predicate-Object (also called triple) statements.

Semantic Web: An extension of the existing World Wide Web, which provides software programs with machine-interpretable metadata of the published information and data. Semantic Web technologies enable people to create data stores on the Web, build vocabularies, and write rules for handling data.

Uniform Resource Identifier (URI): A unique sequence of characters that identifies a logical or physical resource used by web technologies.

Chapter 6
A Digital Library for Researchers, Scientists, and Scholars:
Mendeley Desktop Application

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ABSTRACT

This chapter discusses the application of Mendeley desktop in academic and research libraries. The features of Mendeley were used to justify it as a digital library for researchers, scientists, and scholars. The importance of Mendeley desktop application as a digital library was also compared with a traditional library. This chapter should thus enable anyone without prior knowledge of Mendeley to effectively utilise it as a digital library as it provides an extensive guide on how to work with the Mendeley Application to perform various tasks.

INTRODUCTION

Library remains an avenue for sourcing information and performing other activities such as reading, studying, writing, and researching. Its extensive use by individuals of all categories and fields makes it one of the most critical places knowledge seekers should not overlook. The library can be used across different levels of education. A library is a collection of resources, books, or media readily available. It stores up-to-date information that suits the demands of different users daily. A physical or virtual library gives physical or digital access to available resources in hard copies or electronic form. The collection in a library may comprise printed and non-printed resources stored in a bibliographic database.

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Over the years, development in Information and Communication Technology, especially the Internet, has brought various electronic tools and databases that changed how information is collected, processed, stored, and retrieved. Consequently, attention is gradually shifting from traditional to electronic libraries for speedy and accurate access to information. One of such innovations shaping the way scholarly materials are organised, classified and retrieved is the Mendeley Desktop Application (hereafter MDA). This chapter discusses the Mendeley application as a digital and portable library for researchers, scientists and scholars. The chapter describes the application's features and aims to guide readers to use the application effectively. The authors ensured that this chapter was presented to promote understanding among young and experienced readers.

Therefore, at the end of reading this chapter, readers should be able to: describe the MDA; identify/mention the various features of the MDA; electronically catalogue books and research articles using the MDA; use it for citing and referencing articles in Microsoft word; highlight the importance of MDA to scholars, researchers and scientists.

OVERVIEW OF A DIGITAL LIBRARY

As days pass, innovations keep emerging in all fields of man's endeavours. Thus, Library and Information Science as a discipline is not left out due to the high demand for quick and easy access to books, journal articles and other information sources. In time past, researchers, scholars and scientists relied on the physical/traditional library to source relevant knowledge and information. Along the line, many scholars faced the challenge of travelling distance locations in search of scholarly literature. Fortunately, this challenge was bridged through the advent of the Internet and electronic/digital databases. The Internet is a platform that allows individuals to communicate/disseminate research ideas and findings electronically without having to meet themselves or travel across a long distance. Although the Internet made the storing and retrieval of information accessible, not many people have benefited from the wealth of the Internet. This is because many people lack Internet access, especially in Africa and developing nations (Abdulqadir & Asongu, 2022; Mojapelo, 2020; Owan et al., 2021, 2022; Oyedemi, 2015; Sambuli, 2016). Without internet access, there will be difficulty gathering scholarly materials, especially at the convenience of one's location.

Over two decades ago, accessing digital information was only possible by saving the materials/books on a computer disk or removable disks such as CD-ROM, floppy disks, etc. However, there is poor maximisation of cataloguing skills/tools when accessing files from such storage devices. Thus, these media do not constitute a digital library. A digital library should contain appropriately arranged materials (catalogue) to optimise easy access to information. Cataloguing is a demanding task performed by librarians to ensure that materials are not mixed up. Cataloguing aims to make sure that materials are timely and quickly sourced. The arrangement of materials (including books, journal articles, magazines, etc.) uses several classification indicators. For instance, books can be classified based on, but not limited to, the field, author(s), publisher(s) and year of publication. This means that anywhere materials are saved without appropriate arrangement and classification, such media cannot be referred to as a library. For a platform to be considered a library, it must possess many features (such as proper management of materials, easy accessibility, location of indexed materials, etc.), just like traditional libraries.

Digital libraries, therefore, are electronic databases devoted to producing and maintaining e-collections without requiring end-users to buy the contents they wish to retrieve (Cordón-García et al., 2013). The term "digital library" refers to electronic information collections that include vast and diversified digital content repositories that many geographically dispersed users may retrieve (Khiste et al., 2018). Using computer networks and the Internet, anybody with access to a network or a digital library may easily access a wide variety of electronic information resources stored inside the system (Omotayo & Haliru, 2020). Cordón-García and his colleagues also added that these libraries are primarily filled with reposited knowledge that is freely accessible over the Web. They are notable for the simplicity with which collections may be accessed, the networking opportunities they provide, and the worldwide availability of their contents.

Digital libraries are also referred to as a new kind of library that leverages current information technology to digitalise materials and services (Li et al., 2019). It is common for the functionality of a digital library platform to vary depending on what step of processing is taking place at that time (Zhang et al., 2015). This means that library information technology may be separated into system support, content organisation and user service technologies (Anuradha, 2015). In this chapter, we define a digital library as a collection of books, journal articles, audio, and videos available on the Internet and accessible through computers and smartphones. Digital databases such as Google Scholar and Scopus possess features like a digital library; they are not digital libraries because they are not flexible. For instance, one cannot influence the arrangement of books or materials based on his preferences. Those databases have been customised and can only be modified by the programme developers. Besides, one cannot access the database without Internet and institutional access. Examples of digital libraries include Project Gutenberg, World Digital Library, European digital library, Universal Digital Library, Open Library, Internet Archive, etc. Although the sites have been termed digital libraries, they can only be accessed when there is internet access. Information retrieval would always be a challenge in places with poor internet access.

Evolution and Trends in Digital Libraries

The notion of a digital library may be traced back to the early stages of the electronic library. Christian (1975) was the first to suggest an electronic library, which was further described in 1984 as an institution that gives access to knowledge and uses electronic technology to expand and manage information resources (Dowlin, 1984). Digital libraries first appeared in the early 1990s, although they were preceded by the inspirational concepts of creative thinkers and many decades of active progress in information technology (Xie & Matusiak, 2016). For decades, academic research libraries have been digitising and maintaining online collections to make collections more accessible. While online discovery and access to archive information have improved, academics have mainly utilised digital collections in the same way: scrolling through pages of text, photos, maps, and historical documents (Wittmann et al., 2019).

Digital libraries are a by-product of advances in information technology, particularly the Internet. Some academics believe that information technology has pushed the library beyond its conventional stage into library automation. The digital library will continue to emerge more innovatively in the future due to the rapid development of information civilisation (Wang, 2021). Researchers are increasingly using the notion of "collections as data" to understand better our digital collections and the data they include (Padilla, 2018).

Despite their numerous challenges and constraints, digital libraries have kept up with the speed of technological advancement. All the buzzwords in IT are pursued by today's libraries, from cloud computing, resource finding, Big Data, and the Internet of things to Blockchain Technology (Wei & Deming, 2015). Data resources are multiplying exponentially in the current age of Big Data, but so is the difficulty of extracting the valuable information consumers want. Data processing is becoming much more complicated. Resource service for digital libraries is now required since conventional data processing technology has evident flaws (Dongxing et al., 2011). A better way of building and managing electronic libraries is to improve existing methods, such as data analysis, decision-making, semantics, and data management and presentation technologies such as visualisation (Li et al., 2019). This requires that digital libraries constantly improve their use of new technologies and adjust to current trends and innovations.

Digital Library Software

Different types of digital library software enable users to access information speedily. Examples include Ampletrails Library, BiblioteQ, CONTENTdm, DigiTool, DSpace, EPrints, Greenstone, Invenio, KOHA, Marvel Soft Library Management System, Mintbook, Mnesys, My Library by Solver Software, Omeka, OPALS, ORI-OAI, PMB and Yoolib (Andro et al., 2012). These programmes manage collections of documents, permanent archiving, document identification through unique URLs, metadata structure management and digital reconstruction of documents. Other functions of these programmes include access control based on the IP address, user registration, and granting different rights to administrators, metadata producers, digital documents producers and users. Furthermore, digital library software can be used for collaborative indexing, digital document annotation, commenting on documents and building libraries by users.

Working with digital library software has several advantages since they offer quick and broad access to information. They can be used for the logical arrangement of literature materials and to produce various reports. They provide timely access to information and make data retrieval easy. They can be used to host a large volume of content and offer a variety of ways for information search. They improve the oversight of bibliographical sources and are not bound by geography or other distance-related limitations. According to Andro et al. (2012), choosing which software to use is dependent on factors such as whether the document is old or new and whether the software is open-source (e.g., DSpace, EPrints, Greenstone, Invenio, Omeka, ORI-OAI, KOHA, BiblioteQ, OPALS and PMB) or proprietary (e.g., Ampletrails Library, CONTENTdm, DigiTool, Marvel Soft Library Management System, Mnesys, Mintbook My Library, Yoolib). For instance, some programmes such as CONTENTdm, DigiTool, Greenstone, Mnesys, Omeka and Yoolib are well-suited for managing old documents. In contrast, others such as DSpace, EPrints, Invenio, and ORI-OAI are better for newer documents.

However, besides the traditional and popularly-discussed digital library programmes, other electronic databases (such as Web of Science, Scopus, ERIC, Proquest etc.) and pre-print servers (such as arXiv, Research Square, AAS Open arXiv, AfricArXiv, bioRxiv, EdArXiv etc.) possess attributes almost qualifiable as digital libraries. Nevertheless, citation/referencing tools such as Zotero, EndNote, and Mendeley possess attributes that qualify them as digital libraries. However, few scholars have conceived and appreciated their use beyond citation and referencing. Other scholars have been attracted to the subject of Mendeley but focused more on its use as a social/networking media (Holt Zaugg et al., 2011; MacMillan, 2012). Some scholars have also been interested in comparing the effectiveness of Mendeley with that of other citation managers such as Zotero, RefWorks and Endnote (Bhardwaj, 2017; Ivey & Crum, 2018; Kratochvíl, 2017). Some scholars have considered the Mendeley citation and read count (Kolahi et al., 2020; Maflahi & Thelwall, 2018; Thelwall, 2017) without focusing on the MDA. The MDA is different from Mendeley social network. Subsequent sections of this chapter discuss MDA as a digital library and offer a practical guide to enable readers to use it in managing library resources.

THE MENDELEY DESKTOP APPLICATION: ALL YOU NEED TO KNOW

Mendeley is a free bibliographic reference management application and an academic social network for scholars and scientists. As a citation manager (like EndNote, RefWorks or Zotero), it allows users to collect and save citations from many sources, extract bibliographic information and create accurate in-text citations and references. As a sophisticated social networking platform, Mendeley allows users to collaborate and discover resources utilising Web 2.0 features (MacMillan, 2012). The programme was named after biologist Grigor Mendel and chemist Dmitri Mendeleyev (Hicks, 2011). It was founded in 2007, and its beta version was later released in 2008 (Mendeley, 2021). Mendeley is now owned by Elsevier, having been purchased in 2013. There are two types of Mendeley citation managers - the Desktop Application and the Reference Manager. Both are often synchronised for cloud backup, making it simple for users to annotate and organise documents with easy accessibility. The application is free and can be downloaded from its website (www.mendeley.com). The capabilities of Mendeley Desktop and Mendeley Web are maximised when employed in conjunction since their characteristics complement one another (Zhang, 2012). MDA has a word processor plugin that allows authors to cite consulted articles with just a button click. The citation styles found in Mendeley's reference management software include the American Medical Association (AMA), Chicago Manual of Style, IEEE (Institute of Electrical and Electronics Engineers), American Political Science Association (APSA), American Psychological Association (APA), National Library of Medicine (NLM), American Sociological Association (ASA), Harvard, Nature, Modern Humanities Research Association (MHRA), Modern Language Association (MLA) and Vancouver (Iskandar & Patak, 2019). Using Mendeley to prepare citations and references saves time and enables scholars to flexibly insert bibliographies (Orhan & Ozkan, 2014).

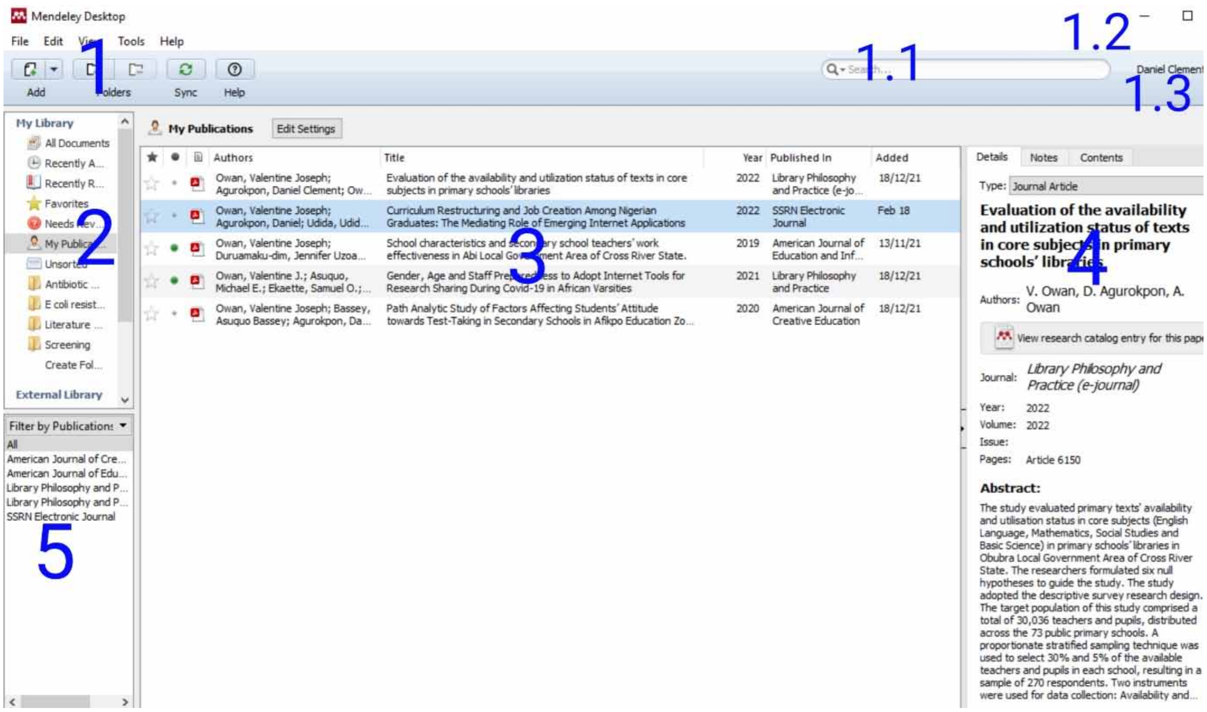
Features of the Mendeley Desktop

The MDA has several features, making it flexible and user friendly. It has a powerful cataloguing feature and work-friendly interface. This means that users do not need to become computer wizards before using the application. The application's main interface is labelled 1-5 in Figure 1. Label 1 represents the *Menu Bar*. All installation plugins can be found in the tools tab under the *Menu bar*. Label number 2 represents the *library's bookshelf*, where all materials such as books and journal articles are uploaded/ imported and accessed. Label 3 simulates a *Desk* in a traditional library where collections from a folder are kept for easy perusal. Clicking on any folder on the bookshelf makes all the documents in that folder appear on the desk (Labelled 3).

To read any document on the desk, the reader must double click on the file. The desk also has cataloguing features that simplify searching for a particular document. Labelled 4 is precisely the place to find all the *Metadata* (i.e., name(s) of the author(s), journal, publication date, abstract, etc.) of a document. Another important menu is the section labelled 5. This section is termed the library *Catalogue* because it is where all the materials on the bookshelf can be quickly sorted based on the author's name, document keywords, publication title or the publishers. Note that the bookshelf and the *Catalogue* work together. It is only the Shelf (folder) you click that the cataloguing filter will apply (except if you click on the "all documents folder").

There is also a powerful *search feature* (labelled 1.1), where keywords are entered to locate documents like search engines and digital databases. The search is folder sensitive, implying that only materials on a working folder can be located during the search. The only exception is when working on the "*all*

Figure 1. The main user interface of Mendeley desktop application



document folder" that the keywords can locate materials from any location, so long as the search string matches the keywords entered. The *tools* (label 1.2) are the control buttons to minimise, maximise or close the application. Label 1.3 shows the user account created at *Mendeley web*. The Mendeley programme is so flexible that a user can easily log into another computer using his login details to automatically retrieve all documents in his library even with a computer change.

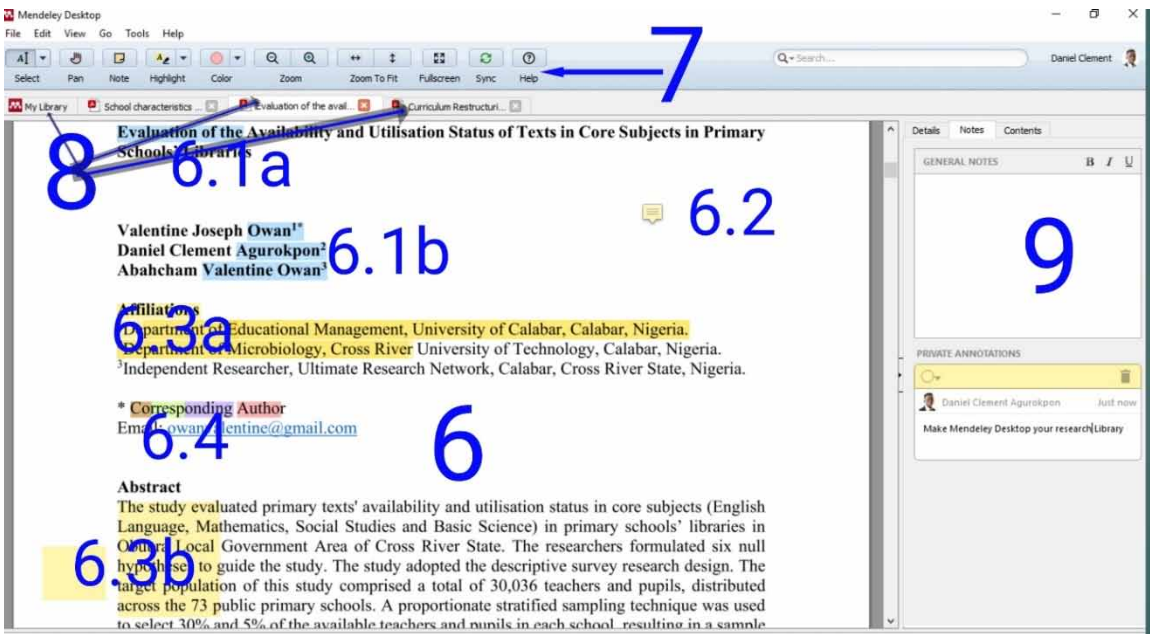
Working with Mendeley Application

To start working with the Mendeley Application, users must add documents to their libraries. This works in the same way as a traditional library, where a collection of library resources is acquired and classified for easy retrieval and use. There are more than three ways to add files to Mendeley Desktop. Adding a specific file, a folder in your computer, importing from the Web as RIS, BibTeX, or EndNote XML file format. Users can also add files manually by imputing the Metadata of the documents. You can use a digital object identifier (DOI) to extract the document's information by adding documents manually. When adding a document to your computer, click on the file or folder. Mendeley will take you to your file explorer; you will select the folder containing the document you wish to add to the library. Once you have located the file, click on the file and click on open (which can be found at the base left corner). The file will automatically be added to the folder on the bookshelf. If you want to add a file from the Web, you can download the file as an *RIS* or a *BibTeX* and then open it with Mendeley Desktop.

You can also add documents using the "*Web Importer*" located in the menu bar. The file metadata will automatically be added. However, the PDF file will not be added; thus, you cannot read the document's main text unless you click on "*view research catalogue entry for this paper*", which can be found in Label 4 (see Fig 1). At the time of writing (version 1.19.8), files in .doc or .docx format cannot be read using the Mendeley Desktop application, but they can be added to Mendeley. These types of files can be opened using the programs designed for them (e.g., Microsoft Word) based on a call from Mendeley. Word documents in Mendeley can automatically be opened using Microsoft Word even though the document is clicked in Mendeley. After adding the file(s) or folder, click on the sync button as shown in Label 1 (see fig. 1). Files with the same Metadata previously added to other authors' libraries are often updated automatically. This means a high chance of having already updated Metadata provided by co-authors or other previous users. A search tool beside the DOI section can track the document's Metadata from the CrossRef database. After importing all documents, you can access them on the bookshelf (labelled 3 in Fig 1). Double-click on the desired file to open the document's content (see label 6 in figure 2). Some tools could be used to perform any operation on the opened text. The menu for these tools has been tagged number 7 with an arrow pointing at the tools. The tools include the *select, pan, note, highlight, colour, zoom, zoom to fit, sync* and *help tools*. These tools are generally valuable for marking a document, identifying essential areas in a document and making comments that can aid in the subsequent studying of the file. The operational outcome of the tools is shown with labels in figure 2. First is the select text tools. The *select text* tool is used for highlighting and copying text. The tool contains two sub-tools; the first is used to highlight text following paragraphs (Labelled 6.1a in Fig2), while the other is used to highlight text in block irrespective of the position of the text, as shown in Label 6.1b. The next is the *pan* (hand tool) which can be termed the "*returning tool*." After activating other tools, they will still function even when you do not want to use them. When using the *pan tool*, you can only scroll through the text without performing any operation.

The *note tool* is used to make notes while reading through the document. They help make critical comments to enable users to remember essential information after reading the document's main text. The note (labelled 6.2) can be kept anywhere in the document interface (Label 6). Interestingly, all notes can be found at the right of the interface labelled 9. In the box (labelled 9), general notes on the document can also be documented. The *highlight tool* is similar to the select text tool on the tools. This is because both can be used to copy text. The unique feature of the *highlight tool* is that all highlighted text remains coloured. Unlike the *select tool*, you need to pin it before it remains in the interface. Another exciting aspect is that the second sub-tool in highlight can mark any part of a document (shapes, blank space, text, etc.) labelled 6.3a and 6.3b for the two sub-tools. While working with both the highlighting and note tools, using the same colour all through may not portray the uniqueness of each text highlighted. Thus, the colour tool is used for colouring text and notes taken (see label 6.4 in Fig. 2). Moreso, the zoom tools increase/decrease the text view. All answers relating to problems encountered while using the MDA may be answered by clicking on the help tool. While working/reading through a document, you can, at any time, switch to other tabs or the main library, as shown in label 8 (with arrows pointing at the tabs). If you want to open a file with an external PDF reader, you will right-click on the document you wish to open. You can scroll through the popup and click on the task (in this case, click on open file externally). These are the features of the Mendeley Desktop application. Other features, such as opening the folder containing the file on your computer, deleting a document, etc.) are understandable while using the application.

Figure 2. The reading interface of Mendeley desktop application



Importance of Mendeley Desktop Application

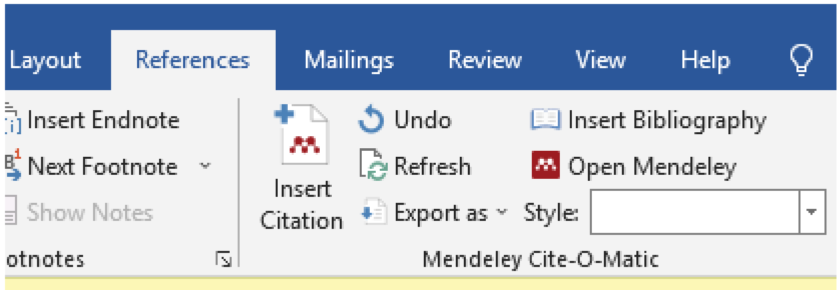
- *Easy Formatting of Citations and References*

Apart from the MDA being used as a digital library, its primary strength is that it can be used to insert citations and references to documents. It has a word processor plugin in the tools tab (see labelled 1 in Fig 1). The plugin is accessible through the word processor itself and is compatible with MS Word and LibreOffice. In this chapter, only the MS-word plugin is described. The plugin can be found in the references tab in Microsoft Word 2013 or higher (Figure 3). The tools in the menu are; insert a citation, insert bibliography, style, refresh, undo, and export as. The insert citation tool is susceptible to every word. Thus, any word you type found in the library (Mendeley Desktop) would be identified. The authors' unique names and titles of documents in the document should be used to save time.

Words in the main body of the document are also tracked. This implies that a journal name, location of the research, or other words can be used. To eliminate errors, ensure that all documents are appropriately formatted with all relevant Metadata provided in Mendeley (using the box tagged number 4 in fig 1). Importantly, author(s) names should be arranged in the order of first to the last name. On the other hand, if the last name comes first, add a comma (,) before other names. The "Insert Bibliography" tool imports references of all the works cited through the Insert Citation tool. A preferred referencing style can be chosen using the "Style" tool.

- *Flexibility in Referencing Style*

Figure 3. Mendeley desktop citations plugin in Microsoft word



Using the MDA and its plugin in a word processor has an advantage for authors. While formatting/preparing a book and research paper, authors often format papers without having a particular journal in mind. Before submission to a journal, the author(s) may be required to follow a formal template and article formatting guidelines requiring the authors to use specific referencing styles. In some cases, recommended styles may differ from those followed while drafting the manuscript. Using manual citation and referencing may require that author(s) begin formatting the citations and references to the new style recommended by the journal. This can be a tiring, time-consuming and herculean task. However, if citations and references were prepared using the Mendeley Desktop Program, a click of the button is all that is required to migrate from one referencing style to another. The Word Processor plugin has been programmed with many referencing styles (e.g., APA, Chicago, MLA etc.). This enables all authors who have used the plugin to cite works to change the referencing style with just a click easily. Another good thing about this application is that it always works with the most recent version of the referencing style. The application enables users to use citation styles not commonly used in a person's discipline, making it highly versatile and flexible to meet various needs. Usually, to use a new/unfamiliar citation or referencing style, one must spend a considerable amount of time learning it. Mendeley addresses all these concerns and makes writing faster.

- *Accessibility of Documents*

The MDA's interface allows its users to access their documents leisurely. Unlike PDF readers, where you will have to open a file before getting to know its Metadata, the MDA allows its users to access the Metadata of a document (e.g., Author(s), publisher, date of publication, abstract and so on) without having to read it. Synchronised documents in MD are stored in the cloud and can be accessed through the web version of Mendeley (Mendeley Web). One core strength of the application is its portability and easy migration of files from one computer to another. It is not easy to lose information indexed in MDA due to its cloud backup. A user can easily access his files on a new computer by simply signing in to his account on a new computer.

- *Staying Organised*

Scholars, researchers, and scientists can quickly note essential points in a document with the highlighting and annotation tools. This would help them draft detailed arguments and discussion points in their articles. Scholars often read documents but miss essential points due to poor organisation. On the contrary, using the MDA can enable scholars to highlight, quickly locate and remember the highlighted text to support their writing. Besides, the Mendeley Application records all downloaded materials related to a research project. Using keywords, authors can quickly locate essential materials against manual opening and closing of files or searching for materials from one folder to another. The Application also organises files by authors, publishers, year of publication, and other parameters. This can enable authors to navigate to their preferred documents with ease.

- *It eliminates the problem of poor citation/referencing*

Usually, well-written and crafted articles are rejected by prestigious journals due to poor referencing and citations. Issues such as citations without corresponding references and vice versa are commonplace among scholars and scientists. However, using the Mendeley application ensures that all works cited are listed in the bibliography or reference list and the other way around. This eliminates the problem of poor citations and references, increasing the chances of acceptance during submission for publication.

- *It is cost-effective*

In time past, many scholars have complained about losing quality materials in their libraries or computers due to different occurrences. These occurrences may include fire outbreaks, damage to a computer, stealing, etc. These materials are precious because huge sums were spent processing them. With the MDA, these issues are no longer common since most files must have been backed to the cloud. Therefore, Mendeley saves cost because authors do not have to spend resources to re-acquire data lost to the factors mentioned earlier. Furthermore, the use of the software is free and open to all interested individuals.

- *It saves time*

It is always very tedious to sit and prepare references to cited works manually. However, the time spent citing and listing references is minimal using the Mendeley application. This is because authors' information and article/document metadata are already stored in the database. Consequently, authors do not need to stress themselves writing down names and publication information. The use of the Mendeley Microsoft word plugin has a handy solution. All authors need to do is go to the references tab in the MS-Word, click on insert citation and enter a few keywords (authors name, or any word in the article title). Then, a list of files with such keywords will pop up for users to select their preferred document. Multiple author citation per idea is also supported.

- *Easy modification of citation/references*

Although the Mendeley application allows users to cite using different citation styles, the default style is the one that is applied when using the MS Word plugin. Nevertheless, authors can easily modify or edit citations to suit their needs. For instance, the Mendeley app, by default, will enter the citation in closed parentheses, such as those used when entering a citation at the end of an idea. It does not prepare citations in a narrative sense (to cite an idea and the cited author's name as part of the sentence). To adjust this, users seeking to use the narrative citation pattern must edit the parenthetical citation (which comes by default) to suit their needs. To achieve the narrative citation form, the users of Mendeley must modify the parenthetical citation. Interestingly, Mendeley allows for modifications without losing track of the metadata or referencing style.

MENDELEY: A DIGITAL LIBRARY FOR RESEARCHERS, SCIENTISTS AND SCHOLARS

The Mendeley can be regarded as a digital library because of its ability to store resources, promote remote access, provide metadata/bibliographic details, personalise suggestions for further reading, and offer selective information services. Like the traditional library, the MDA possess features that account for its library outlook. It has a user interface with high cataloguing capacity, which is one of the strengths of the traditional library. Documents are arranged based on metadata such as authors' names, the document's title, publishers, year of publication, and date added to the library. All documents are appropriately arranged based on file or subject by creating a specific folder and subfolder. All added books/documents can be read because of the PDF technology incorporated in the application. The folders/subfolders serve a similar purpose to a bookshelf in traditional libraries. Unless a document is deleted, all documents are intact in the MDA, like the traditional library where people may hijack documents. The MDA can be termed a "digital library" for scholars, researchers, and scientists with these features. Besides, one of its primary objectives is for the research bibliography. Thus, it is a library that best suits scholars, researchers and scientists. Even though these categories of persons widely use it, other people can also use it as a library since books and other documents can be saved and read through the application. Its portability, cloud linkages, easy sorting, and classification capacity make it more versatile than a traditional library.

Mendeley Versus a Traditional Library Compared

While Mendeley is considered a digital library, it is used to access only pdf and word documents. This implies that printed documents cannot be accessed through it. Of course, the name digital library already tells that only electronic documents (particularly pdf and word) can be accessed. In traditional libraries, documents in all forms of relevant collections are often available. All documents in different formats such as printed documents (e.g., books, journal articles etc.), calendars, pictures and other materials can be housed by the program. Electronic files such as videos and audio-video resources can also be in e-libraries (usually a section in traditional libraries).

An advantage of the Mendeley library to a traditional library is its mobility. The traditional library is often at a specific location unless relocated (which is very rare). Switching to a different document is an easy task in MDA, while the reverse is almost the case in traditional libraries. Unless for personal libraries, highlighting text while reading is usually impossible or not allowed in traditional libraries because what a reader may see as a critical point may not be seen by another reader as necessary. However, in the Mendeley Desktop, the reader can highlight as much as he wishes because the highlight can easily be erased. Furthermore, the Mendeley Desktop library is often owned by a single person by installing the application on a computer. Individuals own traditional libraries, teams, educational sectors, government etc.; traditional libraries can also support many users simultaneously.

CONCLUSION

The MDA is a free bibliography application for scholars, researchers, and scientists because of its essential features. The application saves time and provides standard bibliographies. Aside from scholars, researchers and scientists, the application is also helpful to all individuals capable of reading PDF and unprinted documents. It has a friendly user interface with a high cataloguing capacity. Thus, considered a digital library. This chapter has discussed the Mendeley application richly, along with its features and extensions (plugin). The importance of Mendeley is also discussed as its relationship with a traditional library. This chapter concludes that Mendeley can be used as a digital library in a traditional library but not the other way around. Whatever the strengths, the Mendeley Application can be a subset of a traditional library as both complements each other.

REFERENCES

Abdulqadir, I. A., & Asongu, S. A. (2022). The asymmetric effect of internet access on economic growth in sub-Saharan Africa. *Economic Analysis and Policy*, *73*, 44–61. doi:10.1016/j.eap.2021.10.014

Andro, M., Asselin, E., & Maisonneuve, M. (2012). Digital libraries: Comparison of 10 software. *Library Collections, Acquisitions & Technical Services*, *36*(3), 79–83. doi:10.1016/j.lcats.2012.05.002

Anuradha, J. (2015). A brief introduction on Big Data 5Vs characteristics and Hadoop technology. *Procedia Computer Science*, *48*, 319–324. doi:10.1016/j.procs.2015.04.188

Bhardwaj, R. K. (2017). Academic social networking sites: Comparative analysis of ResearchGate, Academia. edu, Mendeley and Zotero. *Information and Learning Science*, *118*(5/6), 298–316. doi:10.1108/ILS-03-2017-0012

Christian, R. W. (1975). *The Electronic Library: Bibliographic Data Bases 1975-76*. Academic Press.

Cordón-García, J.-A., Alonso-Arévalo, J., Gómez-Díaz, R., & Linder, D. (2013). Open access eBooks. In *Social Reading* (pp. 121–141). Elsevier. doi:10.1016/B978-1-84334-726-2.50004-5

Dongxing, J., Xulei, Y., Qixin, L., Fang, Y., & Xiaolong, F. (2011). Exploration of university information architecture. *Shiyan Jishu Yu Guanli*, *28*(5), 7–11.

Dowlin, K. E. (1984). *The electronic library: The promise and the process*. Neal-Schuman Publishers.

Hicks, A. (2011). "Mendeley": A review. *Collaborative Librarianship*, *3*(2), 10. Advance online publication. doi:10.29087/2011.3.2.10

Iskandar, I., & Patak, A. A. (2019). The significance of Mendeley usage on the accuracy of citation and references. *International Journal of Humanities and Innovation*, *2*(4), 108–114. doi:10.33750/ijhi.v2i4.51

Ivey, C., & Crum, J. (2018). Choosing the right citation management tool: Endnote, Mendeley, RefWorks, or Zotero. *Journal of the Medical Library Association: JMLA*, *106*(3), 399. Advance online publication. doi:10.5195/jmla.2018.468

Khiste, G. P., Avinash, A., & Deshmukh, R. K. (2018). Literature audit of 'digital library': An overview. *Vidyawarta*, (Special Issue), 403–411.

Kolahi, J., Khazaei, S., Dunning, D. G., & Rossomando, E. F. (2020). Do open-access dental articles enjoy higher altmetric attention scores, Twitter, Facebook, news, Wikipedia, blog mentions, Mendeley readers and citations? *Dental Hypotheses*, *11*(1), 1–3. doi:10.4103/denthyp.denthyp_17_20

Kratochvíl, J. (2017). Comparison of the accuracy of bibliographical references generated for medical citation styles by EndNote, Mendeley, RefWorks and Zotero. *Journal of Academic Librarianship*, *43*(1), 57–66. doi:10.1016/j.acalib.2016.09.001

Li, S., Hao, Z., Ding, L., & Xu, X. (2019). Research on the application of information technology of Big Data in Chinese digital library. *Library Management*, *40*(8/9), 518–531. doi:10.1108/LM-04-2019-0021

MacMillan, D. (2012). Mendeley: Teaching scholarly communication and collaboration through social networking. *Library Management*, *33*(8/9), 561–569. doi:10.1108/01435121211279902

Maflahi, N., & Thelwall, M. (2018). How quickly do publications get read? The evolution of Mendeley reader counts for new articles. *Journal of the Association for Information Science and Technology*, *69*(1), 158–167. doi:10.1002/asi.23909

Mendeley. (2021). *Release note for Mendeley Desktop*. https://www.mendeley.com/release-notes/

Mojapelo, S. M. (2020). The internet access and use in public libraries in Limpopo Province, South Africa. *Public Library Quarterly*, *39*(3), 265–282. doi:10.1080/01616846.2019.1622980

Omotayo, F. O., & Haliru, A. (2020). Perception of task-technology fit of digital library among undergraduates in selected universities in Nigeria. *Journal of Academic Librarianship*, *46*(1), 102097. doi:10.1016/j.acalib.2019.102097

Orhan, M. S., & Ozkan, T. S. (2014). Writing references and using citation management software. *Türk Üroloji Dergisi*. *Turkish Journal of Urology*, *39*(1), 25–32. doi:10.5152/tud.2013.050

Owan, V. J., Asuquo, M. E., Makuku, V., & Etudor-Eyo, E. (2021). The extent of online platforms utilization for scholarly research dissemination: A survey of academic staff in African Universities. *Library Philosophy and Practice (e-Journal),* Article 5585. https://digitalcommons.unl.edu/libphilprac/5585

Owan, V. J., Uzoamaka Duruamaku-Dim, J., Nonyelum Odigwe, F., & Owan, M. V. (2022). Dataset of the adoption of digital tools for research sharing among academics in African Varsities during the COVID-19 pandemic in 2020. *F1000Research, 11*, Article 82. doi:10.12688/f1000research.54245.3

Oyedemi, T. (2015). Internet access as citizen's right? Citizenship in the digital age. *Citizenship Studies*, *19*(3-4), 450–464. doi:10.1080/13621025.2014.970441

Padilla, T. G. (2018). Collections as data: Implications for enclosure. *College & Research Libraries News*, *79*(6), 296. doi:10.5860/crln.79.6.296

Sambuli, N. (2016). Challenges and opportunities for advancing Internet access in developing countries while upholding net neutrality. *Journal of Cyber Policy*, *1*(1), 61–74. doi:10.1080/23738871.2016.1165715

Thelwall, M. (2017). Microsoft Academic: A multidisciplinary comparison of citation counts with Scopus and Mendeley for 29 journals. *Journal of Informetrics*, *11*(4), 1201–1212. doi:10.1016/j.joi.2017.10.006

Wang, Z. (2021, September). Research on Intrusion Detection Method and Strategy of Industrial Internet Based on Big Data Environment. In *2021 IEEE International Conference on Computer Science, Electronic Information Engineering and Intelligent Control Technology (CEI)* (pp. 560-569). IEEE. 10.1109/CEI52496.2021.9574516

Wei, L., & Deming, Z. (2015). Forward-looking of the Next Decade Library Technology Trends. *Library Journal*, *34*(1), 4–12. http://www.libraryjournal.com.cn/EN/Y2015/V34/I1/4

Wittmann, R., Neatrour, A., Cummings, R., & Myntti, J. (2019). From Digital Library to Open Datasets. *Information Technology and Libraries*, *38*(4), 49–61. doi:10.6017/ital.v38i4.11101

Xie, I., & Matusiak, K. K. (2016). Introduction to digital libraries. In *Discover Digital Libraries* (pp. 1–35). Elsevier. doi:10.1016/B978-0-12-417112-1.00001-6

Zaugg, H., West, R. E., Tateishi, I., & Randall, D. L. (2011). *Mendeley: Creating communities of scholarly inquiry through research collaboration*. Faculty Publications, Article Number 1633. https://scholarsarchive.byu.edu/facpub/1633

Zhang, F., Gao, Z., & Ye, Q. (2015). Construction of cloud platform for personalised information services in digital library based on cloud computing data processing technology. *Automatic Control and Computer Sciences*, *49*(6), 373–379. doi:10.3103/S0146411615060127

Zhang, Y. (2012). Comparison of Select Reference Management Tools. *Medical Reference Services Quarterly*, *31*(1), 45–60. doi:10.1080/02763869.2012.641841 PMID:22289095

ADDITIONAL READING

Bornmann, L., & Haunschild, R. (2017). Measuring field-normalized impact of papers on specific societal groups: An altmetrics study based on Mendeley Data. *Research Evaluation*, *26*(3), 230–241. doi:10.1093/reseval/rvx005

Elston, D. M. (2019). Mendeley. *Journal of the American Academy of Dermatology*, *81*(5), 1071. Advance online publication. doi:10.1016/j.jaad.2019.06.1291 PMID:31279032

Haunschild, R., & Bornmann, L. (2016). Normalization of Mendeley reader counts for impact assessment. *Journal of Informetrics*, *10*(1), 62–73. doi:10.1016/j.joi.2015.11.003

Hicks, A., & Sinkinson, C. (2015). Examining Mendeley: Designing learning opportunities for digital scholarship. *portal. Portal (Baltimore, Md.)*, *15*(3), 531–549. doi:10.1353/pla.2015.0035

Jeyaprakash, B. (2015). Reference Management Tools for Effective Research: With special reference to Mendeley. *International Journal of Science and Humanities*, *1*, 387–396.

Kousha, K., & Thelwall, M. (2019). Can Google Scholar and Mendeley help to assess the scholarly impacts of dissertations? *Journal of Informetrics*, *13*(2), 467–484. doi:10.1016/j.joi.2019.02.009

Mohammadi, E., Thelwall, M., & Kousha, K. (2016). Can Mendeley bookmarks reflect readership? A survey of user motivations. *Journal of the Association for Information Science and Technology*, *67*(5), 1198–1209. doi:10.1002/asi.23477

Papachristopoulos, L., Tsakonas, G., Boudourides, M., Sfakakis, M., Kleidis, N., Lenis, S., & Papatheodorou, C. (2019). Discovering the structure and impact of the digital library evaluation domain. *International Journal on Digital Libraries*, *20*(2), 125–141. doi:10.100700799-017-0222-x

Parabhoi, L., Seth, A. K., & Pathy, S. K. (2017). Citation management software tools: A comparison with special reference to Zotero and Mendeley. *Journal of Advances in Library and Information Science*, *6*(3), 288–293.

Sau, A., & Bhakta, I. (2018). Mendeley: A free reference management software. *Journal of Comprehensive Health*, *6*(1), 52–53.

Shin, J. (2016). Mendeley Mobile: Powerful Cloud-Based Article and Reference Management in Your Pocket. *Journal of Digital Imaging*, *29*(6), 635–637. doi:10.100710278-016-9907-8 PMID:27678254

Thelwall, M. (2017). Does Mendeley provide evidence of the educational value of journal articles? *Learned Publishing*, *30*(2), 107–113. doi:10.1002/leap.1076

Trout, D. (2016). Mendeley (Version 1.15. 2). *Journal of the Medical Library Association: JMLA*, *104*(2), 183–185. doi:10.5195/jmla.2016.76

Verma, S., & Madhusudhan, M. (2019). An altimetric comparison of highly cited digital library publications of India and China. *Annals of Library and Information Studies*, *66*(2), 71–75.

Zahedi, Z., Costas, R., & Wouters, P. (2017). Mendeley readership as a filtering tool to identify highly cited publications. *Journal of the Association for Information Science and Technology*, *68*(10), 2511–2521. doi:10.1002/asi.23883

KEY TERMS AND DEFINITIONS

Bibliography: A bibliography provides a list of works (such as books and articles) on a subject or by an author.

Catalogue: A catalogue is a list of all the books and other materials located in a particular library or collection of libraries.

Digital Library: This is an online database containing digital items such as text, still images, audio and video clips and other media formats. A digital library and its holdings are supported through Internet.

Documents: A document is a printed, illustrated, projected, or archived expression of ideas, which is often the embodiment of both non-fictional and fictitious material.

Electronic Database: An electronic database is a computer-based accumulation or directory of materials, such as research papers, review articles, theses, books, and chapters in books, among others, that are structured logically with searchable features or sections.

Information: Information are verified or process data about events, observations, things, procedures, people, processes, or phenomena that can lend itself to meaningful conclusions.

Researchers: Researchers are individuals concerned with discovering new knowledge by engaging in the systematic gathering of data, processing them into information using appropriate analytic procedures and making meaning from the evidence for man's improved existence.

Scholars: Scholars are people with a profound knowledge of a subject, an area, or a discipline. Scholars engage in academic or intellectual endeavours and use their intellectual curiosity to become specialists in their professions.

Scientists: Scientists are people that meticulously collect and analyse data and evidence for the generation and testing of hypotheses to gain and share insight and knowledge.

Shelf: A shelf is a rectangular piece of wooden or other hard substance attached to a wall or incorporated into furniture that serves as a platform for storing or displaying library materials.

Chapter 7
Implementation of the SharePoint Platform as a Record Management System in Universities

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ABSTRACT

This chapter assesses the advantages and disadvantages of implementation of the SharePoint platform as a records management system at South African universities. The research found that implementation of SharePoint platform as a records management system requires universities to assemble a records management team with skills and knowledge on archives management and information communication technologies. The National Archives of South Africa should also provide advisory role on universities to select appropriate information communication technology. Development and implementation of the SharePoint platform as a records management system require organisational culture and collaboration of divisions, departments, and units of universities.

INTRODUCTION

Addressing records management systems is a part of the university's strategic objective. University records at risk are students' records where rapidly hardware barriers are setting limits on records' continued growth. This statement is alluded to by Egwunyenga (2009) who states that records are part of university strategic initiatives. Records are central to the administration of the university. SharePoint system can store and preserve records in an organised manner (Pho & Tambo, 2014). The electronic records management system is an integral part of the implementation of the SharePoint management system. This is so because records are a fundamental element of the knowledge capital of any university (Garaba, 2018). The management of records facilitates good governance, accountability, transparency, and access

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to information. This statement is supported by Schina and Wells (2002) who state that universities in the United States and Canada encounter pressure from society to be accountable and transparent.

There are twenty-six public universities in South Africa after the establishment of three public universities, namely the University of Mpumalanga, Sol Plaatjie University, and Sefako Makgatho Health Sciences University after democracy. Twelve traditional universities are offering a combination of theoretical–based training, six comprehensive universities offer a combination of academic and vocational-oriented diplomas and degrees, and eight universities of technology which in the main offer diplomas in vocational–oriented programs (Raju et, 2015). These universities create both paper and electronic records.

STATEMENT OF THE PROBLEM

Post-apartheid South Africa expected the transformation of universities to adopt electronic records management systems to enhance access to information (Nyahodza & Higgs 2017). Records losses and access to records are challenges that led universities to adopt electronic records management systems (Andoh & Attafuah, 2021). Universities create records that are not properly managed. This, therefore, becomes an issue of concern to the university's internal and external stakeholders. Paper-based records systems are easily burned or lost (Egwunyenga, 2009). This chapter is the response to the challenges of loss of records faced by various university communities. The benefit of the SharePoint system includes access to information communication technologies, management support, and infrastructure development.

RESEARCH OBJECTIVES

The study was guided by the following research objectives:

- Investigate implementation of SharePoint platform in South African universities
- Describe the challenges and advantages of the SharePoint platform in South African universities

RESEARCH METHODOLOGY

This study used a qualitative research approach, consisting of a literature review was used to address the research objectives. The decision to use a qualitative approach was based on the nature of the data collected and analyzed by the researcher. A range of literature was synthesized to provide a perspective on the SharePoint development platform, as a means of identifying the implications of the adoption of records management systems. A literature review was used for a systematic analysis of previous studies on the adoption of SharePoint as a records management system. Such a review lead to identifying a gap in the implementation of records management systems by various universities.

The author explored recent studies on electronic records management systems and information security i.e 2005 - 2021. Furthermore, several initiatives and guidelines that address challenges faced by organizations considering the adoption of an electronic content management system were identified. SharePoint plays a role in the management of an organization's electronic records management (Feng & Pan, 2016). This is so because electronic recordkeeping systems are an integral component of organizations in both the private and public sectors. This is alluded to by Ferguson- Boucher and Convery (2011) who indicated that collaboration tools in SharePoint facilitate shared access to information to internal and external stakeholders.

OVERVIEW OF SHAREPOINT

SharePoint platform as a records management system embraced by South African public universities to streamline records management programs. The records management practices lacked uniformity which led to organizations' non-compliance with the Promotion of access to Information Act 2000 and Protection of Personal Information Act No 4 of 2013 and the loss of institutional records (Ajibade & Khayundi, 2017, Katuu, 2016). Furthermore, few studies on the implementation of SharePoint as a records management system were conducted in South Africa. It was against this background that South African universities ran a SharePoint project to assess the project implementation. Universities developed a records management system and investigated the legal, technical, and operational concerns regarding the storage of records in an electronic environment. It was envisaged that the SharePoint project provides an organization with a basis for a structured discussion of the impact of SharePoint on Records management processes.

Currently, South African universities have invested in Information Communication Technology(ICT) (Phiri & Tough, 2018). The investment in ICT assists universities to organise their recorded information in compliance with legislation. For example, Protection of Personal Information Act No 4 of 2013 was enacted to give effect to the constitutional right to privacy, by safeguarding personal information when processed by a responsible party, subject to the justifiable limitation that is aimed at balancing the right to privacy against other rights and protecting important interests such as flow of information. The Promotion of Access to Information Act, 2000 gives effect to the constitutional right of access to any information held by the State and any information that is held by another person and that is required for the exercise or protection of any rights; right. To give effect to the constitutional right of access to any information in a manner that balances the right of access to any information with any other rights, including the rights contained in the Bill of Human Rights in South Africa. Lastly, to promote transparency, accountability, and effective governance of all public and private bodies by empowering and educating everyone to exercise their rights about public and private bodies and effectively scrutinize and participate in decision-making by public bodies that affect their rights. The right of access to university records is a very powerful constitutional right, as it helps people to realize other rights. Investment in Information Communication and Technology assists universities in the long-term preservation of records. SharePoint provides an opportunity for effective records management system. With the development of the university SharePoint system and the increased focus on records, there has developed a need for a robust system to facilitate communication, access to records, and shared responsibility for amending content (Thomas & Underwood, 2015).

The establishment of the SharePoint system is a complicated project to fulfill the future development need of universities (Lu, 2018). A University governance structure or committee is necessary to be put in place to execute the oversight role over Sharepoint compliance. Sharepoint system is identified as one of the risks in the strategic or operational risk register of the university. Universities lack standards to develop electronic records management systems. This implies that universities have procedures in place that allow for data subjects to update the information held by the university. Hence records management standards are necessary to build information systems to manage all forms of records. This means that there is a need for documentation of detailed lists or inventory and types of records each division, department, or unit will collect, for what reason or purpose, from which data subject and how consent was obtained, and if the further processing by third parties as required. The effects of the adoption of the SharePoint platform without forecasting and planning for the consequences of hybrid records systems, digital environments facilitating manipulation of data, media, digital obsolescence, and the proprietary and idiosyncratic nature of applications have already been witnessed in government and other organizations (Duranti 2010). Collaboration between various departments including ICT, records management, risk, and legal departments provided a unique occasion to undertake such initiatives among South African universities. The implementation of a records management system requires the establishment of a governance structure to implement an electronic records management system (ERMS). Governance is the key driver to implementing the electronic records management system.

Implementation Of Sharepoint System At South African Universities

South African universities assembled a records management team composed of records managers, registry officers, archivists, and administrative officers. Records management teams compose of senior records management officers and junior staff is involved in a SharePoint management project. The team assigned to the records management team should be divided according to specific duties and roles for the duration of the project, there should be staff assigned to scanning, indexing, and documentation of records, placing some records in batches to prepare for scanning. Developing countries experience a challenge to organize and manage records in electronic records management. This is so because the staff was not trained in electronic records management. The review of the literature shows that universities in China have limited staff and financial capital to invest in the development of digital archives databases and software (Lu, 2018). The lack of human power has inhibited universities from building a SharePoint system to manage all records. This statement alludes to the study conducted in the Tanzanian Public Service by Kamatula and Kemoni (2018) that argued that insufficient budget, lack of required skills and knowledge and infrastructure for electronic records management systems were a challenge for most organizations.

Electronic Content Management Team Selection And Upskilling

The SharePoint project team composed of the information communication technology department, legal department, and records management unit develops and implements the SharePoint system as the medium of collaboration. This change has an impact on the command of a knowledge management culture. People are assigned records management responsibilities to control the flow of records. Divisions, units, and sections are involved in the control of records. The process of movement of records from one place to another is managed through workflow. This is because of the creation of a central repository for instructional materials that is accessible to all personnel.

The process of SharePoint platform development requires a commitment of the university staff at all levels to the electronic records management system. Without staff support, the electronic records management system runs the risk of becoming redundant. Moreover, such systems will not be user-friendly for staff because they would be lacking feasibility. The organization conducts outreach and training on a records management program. Universities divisions, departments, and units are to be trained on storing records using SharePoint. The institutional approach to employee training and outreach varied differ in records management programs, especially in the United States of America institutions (Schina

& Wells, 2002). The study conducted by Stephen (2014) recommend training needs and program in heritage preservation management and relevant capacity building program to be developed. The training and outreach model for the management of records should be identified. Capacity-building to focus on aspects such as digitization, e -records management, and automation of records.

The assessment included identifying staff members possessing the skills and knowledge of the management of information systems (Phiri & Tough, 2018). However, the staff working in the African institution lack information communication technology skills (Asogwa, 2012). Stakeholders' interests are to be considered to develop institutionary memory to facilitate the collaboration of divisions, departments, and units. The interest of various divisions, departments, and units should be considered (Gilliland, 2014). The author is of the view that universities should embark on capacity development and awareness campaigns. There is a need to train staff on the application of the SharePoint platform system. This statement is alluded to by (Thomas & Underwood, 2017). Records Management training may lead to the development of infrastructure such as classification systems. However, the review of the literature shows lack of expertise or technical skills by people serves as a hindrance to the implementation of the SharePoint platform. Since the process of customization of SharePoint is both technically complex and highly challenging, it requires staff with ICT skills and knowledge.

Integration And Institutionalization Of Tasks

The rearrangement of records management roles for the integration of records management systems recognizes the multiple roles of various divisions, departments, and units. This is dependent on the management structures of the university. Therefore, records management is the discipline that governs processes and controls records of an organization to support business processes (Cheng, 2018). The job description of personnel who worked in Sharepoint should reflect their work plan. This implied that the human resources division is to review the employee job description to include management of records within the SharePoint platform. The new responsibilities should be reflected in the new job description.

End- Users

Organizations are required to identify the applicable legal standards and industry standards to make sure that the university process not only adds business value but follows regulations. Organizations are required to customize file plans on SharePoint. Universities use file plans to classify their records. Each university had a form of classification scheme (Phiri &Tough, 2018). The university file plan is framed by legal and policy requirements (Cheng, 2018). File Plan assists universities to categorise information according to the subject area. The file plan also assists universities to categorizes information according to their level of security. The author recommends users adopt the SharePoint platform to ensure the application of file plans in an electronic environment. However, there is a need for a formal periodic process for verifying the completeness and accuracy of the information collected and place in the Sharepoint system.

Information Communication Technology Changes And Computing Technologies

The advancement of ICT requires universities to adopt the SharePoint system as a platform to manage electronic records systems. The ERMS enhances the record's long-term preservation. It is a global issue, there are constant changes in information communication technology and applications (Asogwa, 2012). This has implications for the long-term preservation of records (Potnis, et al 2016). Organizations are to develop a change management strategy to ensure ICT is adopted by universities aligned to a records management system. The lack of a file plan is an indication that the decision to implement records management systems to manage records were considered without analysis of business process and requirements.

Records Management Policy

Universities develop information or records management policies to drive information communication technologies. Policies provide a guide on records management. Universities lack records management policy to drive changes and transformation as alluded to by Kanyengo (2006). Records management policy is the foundation to develop and implement electronic records management system (Early, 2016). Policies should provide guidelines on how digital records must be managed (Voce, 2014). The policy should state the target audience and ensure that the target audience is well represented. The records management policy should include elements and clauses on access to information; privacy breaches, loss of access to information, management of information, lack of transparency, regarding account management, server locations, data destruction, and data recovery (Bushey, Demoulin & Mclelland, 2015).

The step to develop a policy is to consider the types of records generated and received by a university. The challenge of managing electronic records management needs to be addressed in records management policy. Where the mission of universities, the types of collections generated by the university. After the general scope of the SharePoint was established, areas of the records management policy needed to be determined. The policy should also address aspects of operative agreements, resource sharing, access, and disposal of records. Policies should also stipulate the types of records included in the records management system program. The records management policies should be communicated to the university community.

Universities' records management policies are supported by qualified staff. The qualified staff is employees with an appropriate qualifications in records and archives management. Such staff should possess extensive experience in archives and records management. The review of the literature shows that most of the staff working in universities lack qualifications in records management. Most of the staff employed in universities to head archives and records management programs have general qualifications in management. They were employed outside of the records and archives management program. The challenges of lack of personnel with qualifications in records and archives management are promoted by the lack of institutions offering qualifications in records and archives management. limited institutions of higher learning offer qualifications in archives and records management in South Africa (Ngoepe & Katuu, 2017). For example, the University of South Africa (UNISA) offers a certificate for Doctorate level qualification in records and archives management qualification. The University of Fort Hare offers only a Postgraduate diploma in Archival studies. Other South African universities such as the University of Cape Town and the University of Western Cape offer a combination of library and archives science. Organizations allocate resources to implement records management policy. This is because of poor funding to implement electronic records and archives management systems. This is despite the that most South African universities are under-resourced. It is a high cost to implement a records management system. A records management policy provides a guideline on the use and maintenance of hard drives and file shares. Records management policy provides a guideline on the management of long-term management of records. Compliance with records management policy should be enforced by the policy owners to ensure the effective and accountable management of records.

National Archives Of South Africa Roles And Responsibilities

South African universities as parastatal under the Department of Higher Education and Training generate public records. After the retention schedule expired, these records were transferred to the National Archives of South Africa. Therefore, there is a need for South African universities to adopt effective records management system to ensure completeness of the transfer of records. Archive institutions collaborate with government departments to implement policy and strategy in the United Kingdom (Horton, 2006). This is so because the National archives policy provides advisory roles to manage institutional records. Legislative and regulatory compliance features act as part of the environmental and strategic framework for records management (Okello-Obura, 2009). This statement is alluded to by Chachange and Ngulube (2006), Luyombya and Sennabulya, 2012). who states that legal, technological, and organizational matters require to be considered to manage records. Therefore, organizations are to fulfill legal requirements to manage their records (Cheng, 2018). The National Archives of South Africa publishes guidelines to advise departments to manage electronic records. This is done through enact of the National Archives and Records Service Act 43 of 1996, regulations on the management of electronic records management in the public services in South Africa. These regulations assist organizations to choose electronic records management system to choose appropriate electronic records management systems.

The National Archives lists the electronic records management system to be purchased by organizations. The list of electronic records management system recommended by the National Archives of South Africa incorporates records management requirements. The relations between the National Archives of South Africa and universities determine the success of the records management program. It is the role of the National Archives to provide an advisory role on the type of electronic records management system to be selected by universities. It appears that the National Archives of South Africa work independently from universities. There are no service level agreements between the National Archives of South Africa and universities on the management of electronic records. The lack of relationship between universities and the National Archives of South Africa is the reason for the weak electronic records management system a various South Africa. This is despite the that most university officials are aware of the role of the National Archives and Records Service Act 43 of 1996 in the management of public records.

System Capabilities Versus Actual Configuration

The SharePoint system performance depends on the ICT integration. Therefore, organizations are to integrate information management systems, electronic documents, and records management systems to manage information in a centralized institutional repository. The institutional repository enables the distribution of research output and the restructuring of information (Cho, 2019). It seems that most South African universities' electronic records management systems are in an initial stage. Most of the South African universities' electronic records management systems were installed with the view to documenting university records. Therefore, it is necessary to describe all business processes conducted to ensure that all people are aware of the electronic records management system. The SharePoint system is supposed to facilitate the process of records retrieval, storage, and use at the university level. SharePoint is important for the efficient management of records of universities. The system must be established to integrate with other information management systems of the university. SharePoint platform not only improves the classification of records but creates intellectual capital at the university for sustainable development (Cheng, 2018) South African universities integrate electronic records management systems with the intranet both technologically and operationally to reduce information silos, and data access challenges. SharePoint should be linked with technological choices and the ICT portfolio chosen by a university. Africa's infrastructure is inadequate for handling large preservation of knowledge resources (Stephen, 2014). The development and implementation of relations with ICT service providers are necessary.

INTERDEPARTMENTAL COLLABORATION

Centralized institutional administration is applied to improve the performance of the records management system through the adoption of unified standards and policies (An, Bai, Deng, Sun, Zhong & Dong, 2017). Collaboration enables the digital preservation of records because it has been a driver for digitization and digital preservation initiatives (Boamah, Dorner & Oliver, 2015, P .49). The developed ICT support information flows and collaborative work to allow to support of an information management system. The workflow-based document management system demonstrates the flow of documents and requires the workflow to manage records (Pho & Tambo, 2014). ICT is established to preserve records in a central repository. Information stored in the Share drive is to be migrated to the Sharepoint platform.

Collaboration of divisions, departments, and units enabled the digital preservation of records in Africa. This is an indication that developed countries are advanced concerning the documentation and preservation of digital records. Lack of collaboration was cited as a challenge to implement electronic records management system. This statement is alluded to by a study conducted by Svard (2013) who said that the challenges of long-term preservation were caused by a lack of collaboration with people who had a holistic view of information management and electronic information systems.

Recordkeeping requirements are identified in legislation, regulation, policies, and standards (Bushey, Demoulin & Mclelland, 2014). Legislation and regulatory requirements require organizations to improve records management practices through collaboration with various stakeholders (Sheriff, Bouchlaghem, El-Hamalawi & Yeomans, 2012). Organizations are to ensure compliance with the Protection of Personal Information Act No 4 of 2013 on the security of personal information. Security is a control measure implemented throughout the electronic records system to prevent unauthorized access, destruction, alteration, or removal of records (Bushey, Demoulin & McClelland 2015). The protection of confidentiality of records through access control is essential in an organization. Access to records stored in an electronic environment should be managed through controls on access, use, alteration, and records destruction. Records should be protected from any form of destruction. In the case of an information communication technology system malfunction or security breach, there should be a security of the record.

COMMITMENT FROM SENIOR MANAGEMENT

Leadership is necessary to ensure a culture of openness in terms of the management of electronic records management systems. It is necessary to understand that system implementation requires buy-in from senior management. This statement is alluded to by (Phiri & Tough, 2018, Azmee, Kassim & Abdullah, 2017) who state that establishing senior management support is a key driver to supporting the records management program. Management provided human and financial resources to records and document management programs. Resources for electronic records management systems include Information communication technologies (Boamah, 2015). Staff is to be trained in digital technologies. Senior management provides strategic direction on a SharePoint project. Top management commitment must be in the form of hands-on involvement in all project steps. The commitment of senior management is visible through the allocation of project resources. Senior management supports the SharePoint project by ensuring that the scanner digitizes records preserved in a paper-based system to an electronic environment. The management should champion a SharePoint project from the start until is completed. The champion must be a representative from the middle to top management level (Ambika & Amrik, 2005). The motivation for top management to provide commitment should come from the saving of resources and reduction in costs. Management also plays a role in the maintenance and progress of the system that management of review is held regularly with key personnel representing management from across the organization. Implementation of electronic records management system is dependent on organizational culture. leaders are to institute a filing culture to ensure that all staff use file plans to file in an electronic environment (Wilcox, 2011). Organizational culture is achieved through buy-in from management, successful assessment of status and needs, design of a holistic solution, development of a solution, implementation and evaluation, and refinement. Wilcox (2011) acknowledges that implementation of the SharePoint system can be achieved through the following:

- Produce policy letters that demonstrate the leader's interest in the project and bring on board the whole organization.
- Identify and recognize the champion.
- Build the model knowing that the requirements will change.
- Capacity development and staff awareness.
- Assign tasks, responsibilities, and ownership
- Include everyone in the effort so that good ideas are shared and poor processes are eliminated before they become common.
- Use the feedback mechanisms that are available in every system to identify the refinements that are needed; and.
- Create a tracking system for modifications so that commander has accurate data to use in making decisions

SYSTEM USAGE

Feedback or reporting mechanism was used to assess the adoption of the SharePoint system by various organizations. According to An, Bai, Deng, Sun, Zhong and Dong, (2017), feedback mechanisms are used to improve the quality of archival resources and user satisfaction with the delivery of information services. User feedback is necessary to assess the implementation level of the SharePoint. The author is of the view that the use of User feedback is important to identify any challenges within the electronic records management system. Universities should regularly weed databases of information that is no longer required, such as information relating to former customers or staff. University should have a response and notification policy including a response list detailing the legal requirement, handling, and escalating procedures and notification. Access to the SharePoint platform is controlled and monitored. This implies that the university should develop procedures for identifying people's access requests.

Accessibility

Records must be preserved to ensure accessibility. Moreover, access to information globally improves public confidence and trust in both private and public sectors (Asogwa & Ezema, 2017). Electronic records are supposed to be accessible globally (Majore, Yoo & Shon 2014). However, the challenge experience in the electronic environment is media and file format obsolescence. Masane (1998) says that organizations are to develop processes and procedures to ensure that records are accessible by various stakeholders. Archivists and records managers require to organize and provide effective access to the collected content. There is a need for functional and technical to categorize records to be published. Loss of control over the information stored in SharePoint is not a concern with implications for the ability to manage the information life cycle but also for information security and authenticity (Ferguson-Boucher & Convery, 2011). The availability and retrieval is not only a question of efficiency but a legal issue, as it is closely linked to constitutional rights to have access to certain information (Bushey, Demoulin & McClelland, 2015). Promotion of Access to Information Act No 2 of 2002 promotes South African citizens' access to information. Institutions should develop a strategy to ensure that the right information is available to the users. It is also important to determine or control who can access the records and to protect the records' integrity and confidentiality, which is more of a security issue. In compliance with the Promotion of Access to Information Act, organizations must provide access to the requested records within a period that may vary.

Sharepoint Project Plan

Table 1 shows the Sharepoint preparation plan conducted by records managers and Information Communication technology officers. The records Manager compiles a file plan based on interviews with business units and sections. The Information Communication Technology (ICT) divisio is a key division in the implementation of the Sharepoint system in an academic library. Organizing academic libraries is dependent on Information Communication Technology. This is because academic libraries are organized according to organizational structure. The academic libraries, in this book chapter, is an electronic records management systems created to preserve records according to records lifecycle. The University Management (MANC0) is responsible to support the project by allocating resources.

Table 2 shows the Sharepoint implementation plan. File plan implementation requires a service provider to prepare a business requirement specification. This implies the Business units, divisions and sections to sign project specifications aligned to business processes. The ICT division is responsible for developing a library site for divisions, units and sections on the internet. This implies that each division is enable to access its library site. Both administrator and user of Sharepoint system are trained on how to use a Sharepoint.

Table 1. Sharepoint project planning

Item	Date	Resources
SharePoint preparation and questionnaire document	2020	This document was prepared and sent to the Deputy Director of Information Communication Technology to distribute to the various departmental stakeholders
SharePoint system preparation and questionnaire document	2020	This document was not completed
Requirement gathering meeting	2020	No requirement gathering session was held with the Vice-Chancellor other than within the MANCO meeting
Requirement gathering	2020	A meeting was held with Records and Archives, Information Communication Technology, Project Manager
BRS document	2020	Based on the File Plan and the meeting held, this business requirements specification was compiled
BRS document	2020	Changes were made to align the site to the approved site plan

FINDINGS

This study presents the finding of a study on the implementation of SharePoint at South African universities. The results of the study revealed that the South African universities have taken several initiatives aimed at establishing records management practices. However, the results showed that the universities are faced with challenges in their efforts to develop electronic records management systems. Based on the results of this study, there is a need for proper planning before an organization embarks on electronic records management system. The majority of those required to manage electronic records management systems lacked the skills and competencies to manage digital records. This study proposes a model describing how the set of system characteristics and the moderating factors influence users' perceptions of electronic recordkeeping systems. Given that records management work is no longer the responsibility of Information and records management specialists but rather is increasingly part of every employee's duties at an organization. From the review of literature, it becomes clear that SharePoint was viewed as a platform to save money, improve efficiencies and provide alternatives to traditional paper-based management. SharePoint as a records management system to capture records in underserved areas has also been fraught with problems, which have slowed its adoption. Among these problems are several key challenges such as:

- Shortage of ICT staff
- The challenge of using the software.

Table 2. Sharepoint project management

Step	Item	Description	Responsibility
1	Business Requirement Specification	A Business Requirements Specification (BRS) will be created	Service Provider
2	BRS signoff	Signoff on the BRS must be given to BSI	Universities
3	Development	Development of the site to preserve records will commence	Service Provider
4	Developer testing	The solution will be tested by the service developer to ensure it is bug-free and stable	Service Provider
5	Factory acceptance testing	The solution will be tested by the business Analyst to ensure it meets the business requirements	BSI Service Provider
6	Administrator training	A site administrator must attend SharePoint Administrator training as scheduled by universities and service provider	Universities
7	User training	The site users must attend user training as scheduled by universities and service provider	Universities
8	User testing	The solution is handed over to the appointed resource for user testing	Universities
9	Change request	Any changes will be managed through a formal change request process	Universities
10	Problem resolution	Any problems identified will be resolved and the process will be repeated from step 4	Universities
11	User testing sign off	A signed acceptance that the solution has been satisfactorily user-tested must be given to the service provider	Universities
12	Content cleaning	The assigned resources must clean up the documentation that is to be migrated to the Intranet. This will involve: Identifying content that needs to be retained Identifying content that needs to be manually archived	Universities

- The adoption of SharePoint was often ad hoc and driven in the main by ICT departments in response to changing business needs.
- Most perceived SharePoint as limited to ICT implementations or as initial testbeds for larger projects

Information security and compliance concerns regarding the storage of records in SharePoint became evident during the consultation process. i.e. the handling of records in SharePoint. This research found that South African universities establish governance structures to manage their records. The University governance structure includes the university council. The university council delegates authority to the university management to manage the institutions. The university management established committees such as the Records and Archives management committee responsible for records and archives management. This structure is important to assemble an organizational structure to manage university records.

IMPLICATIONS OF THE SHAREPOINT SYSTEMS

The Sharepoint system development and implementation are dependent on the university's allocation of resources to capacity development and raising awareness (Thomas & Underwood 2015). Understanding the SharePoint system will reduce resistance from the users. It is a challenge to staff with a low level of ICT literacy to implement the system as alluded to by Asogwa (2012) Records managers, information officers, and archivists have to manage digital documents raising issues of privacy, security, preservation, and copyright issues as alluded to by (Khumalo & Masuku, 2018). Sharepoint system cannot be implemented in a university with an ineffective records management system. Universities are required to appoint records managers to drive effective records management systems, develop a proper security system of records, proper records retention and disposition schedule, develop a filing procedure manual, and adequate provision of funds to implement a records management system (Egwunyenga, 2009). Records management systems require a stable environment, workflow, and administrative systems (Jones & Vindes, 2016)

The implication of these is the duplication of electronic record systems by other universities, as some have several electronic records management systems which keep records. Duplications of information systems do not assist the university community as it only adds to the information overload. There is a need for an organization to adhere to a culture of filing electronically to ensure the management of the system. There is a need for managers and all the employees to work together. According to (Ambika & amrik, 2005) to implement various management systems individually need to practice an integrated system. The task and responsibilities of records managers need to be reviewed. Both academic and non-academic staff are to be aware of the system created to store and create records. Digital recordkeeping and archiving capacity building are the safeguard measures that are embedded into the risk control-based enterprise information architecture to support the operations of individual organizations to ensure that digital information is created, captured, and used responsible (An, Bai, Deng, Sun, Zhong & Dong, 2017). Communication is key for any organization to succeed in all projects. There should be effective communication between all parts of an organization. A multi-functional team, composed of various departments or units must be integrated and worked together.

FUTURE RESEARCH DIRECTIONS

It is recommended that studies be conducted in other African universities on the adoption of electronic records management systems. Such studies would supplement existing studies and provide a holistic and integrated approach to contextualizing electronic records management, about the management of university records

CONCLUSION

The implementation of SharePoint requires the support of management and decision-making mechanisms for developing and complying with rules and policies around SharePoint installations. SharePoint governance needs to be part of the overall information governance program. SharePoint requires an appropriate approach to design, deployment, socialization, maintenance, and ongoing decision-making. The records management principle of OAIS requirements should be followed for the successful implementation of a records management system. Through literature review, this study has revealed that it requires skills and knowledge to adopt and implement SharePoint System as electronic records management. It is the view of the author that this study will not only close the gap in the literature on the SharePoint system but also explain the use of the system in archives. The study identified opportunities that could be used to manage information. The overall conclusion from this study, therefore, is that public universities in South Africa are prepared to adopt Sharepoint as a records management system.

RECOMMENDATIONS

The study suggests the following recommendations for the succesful implementation of Sharepoint:

- Universities need to identify information as one of the risks in the strategic or operations risk registers.
- There is a need to coordinate between various stakeholders enterprise-wide approach to the management of information.
- A clear matrix that defines what types of information can be shared between the various business areas within universities must be created.
- Universities should provide necessary measures to protect the confidentiality and integrity of information collected and place into the SharePoint system.
- Mechanisms need to be put in place to ensure that information place on SharePoint is accurate and updated.

REFERENCES

Ajibade, P., & Khayundi, E. F. (2017). The Role of Records Management in Small Micro and Medium Enterprises (SMMEs) in South Africa and Its Implications for Business Sustainability. *African Journal of Library Archives and Information Science*, *27*(2), 175–188.

Ambika, Z., & Amrik, S. (2005). Integrated management system: the experiences of three Australian Organisations. *Journal of Manufacturing Technology Management, 16*(2), 211 – 232.

An, X., Bai, W., Deng, H., Sun, S., Zhng, W., & Dong, Y. (2017). A knowledge management framework for effective integration of national archives resources in China. *The Journal of Documentation*, *73*(1), 18–24. doi:10.1108/JD-04-2016-0040

Andoh, K. P. R., & Attafuah, A. (2021). *Access control of human resource records: case of the University of Cape Coast*. Collection and Curation. doi:10.1108/CC-06-2020-0025

Asogwa, E. B. (2012). The challenge of managing electronic records in developing countries: Implications for records managers in sub-Saharan Africa. *Records Management Journal*, *22*(3), 198–211. doi:10.1108/09565691211283156

Asogwa, E. B., & Ezema, J. I. (2017). Freedom of access to government information in Africa: Trends, status and challenges. *Records Management Journal*, *27*(3), 318–338. doi:10.1108/RMJ-08-2015-0029

Azmee, N. N., Kassim, A. N., & Abdullah, Z. C. (2017). DIensions of Knowledge Management Maturity; Top Management Support and Leadership, People, and Information Technology. *Journal of Information and Knowledge Management*, *7*(2), 1–7.

Boamah, E., Dorner, G. D., & Oliver, G. (2015). Using Theory to understand Digital Preservation Management in Ghana. *PDT&C.*, *44*(2), 46–61. doi:10.1515/pdtc-2015-0011

Bushey, J., Demoulin, M., & Mclelland, R. (2015). Cloud Service Contracts: An Issue of Trust. *Canadian Journal of Information and Library Science*, *39*(2), 128–153. doi:10.1353/ils.2015.0009

Chachage, B., & Ngulube, P. (2006). Management of business records in Tanzania: An exploratory case study of selected companies. *South African Journal of Information Management*, *8*(3). Advance online publication. doi:10.4102ajim.v8i3.227

Cheng, C. K. E. (2018). Managing records and archives in a Hong Kong School: A case study. *Records Management Journal*, *28*(2), 204–215. doi:10.1108/RMJ-02-2017-0004

Cho, J. (2019). *Exploratory analysis of the operation of institutional repositories in Asian countries.* Academic Press.

Duranti, L. (2010). Concepts and principles for the management of electronic records, or records management theory is archival diplomatics. *Records Management Journal*, *20*(1), 78–95. doi:10.1108/09565691011039852

Early, S. (2016). *Getting more from SharePoint-Part 3. Metrics, Content Processes, and Governance policies*. Information Today Inc.

Egwunyenga, J. E. (2009). Record Keeping in Universities: Associated Problems and Management Options in South West Geo-Political Zone of Nigeria. *International Journal of Educational Sciences*, *1*(2), 109–113. doi:10.1080/09751122.2009.11889983

Feng, X., & Pan, W. (2016). Determinants of Acceptance of Electronic Recordkeeping Systems: A User-Focused Empirical Study of System Characteristics. *Canadian Journal of Information and Library Science*, *40*(2), 125–151.

Ferguson-Boucher, K., & Convey, N. (2011). Storing Information in the Cloud- A Research Project. *Journal of the Society of Archivists*, *32*(2), 221–237. doi:10.1080/00379816.2011.619693

Garaba, F. (2018). The neglected fond in university archives: The case of sport club records at the University of Kwazulu-Natal (UKZN), Pietermaritzburg Campus, South Africa. *Records Management Journal*, *28*(2), 143–158. doi:10.1108/RMJ-11-2016-0043

Gilliland, A. J. (2014). *Conceptualizing Twenty-First Century Archives*. Society of American Archivists.

Horton, S. (2006). Social Capital, government policy and public value: Implications for archive service delivery. *Aslib Proceedings*, *58*(6), 502–512. doi:10.1108/00012530610713588

Jones, M., & Vines, R. (2016). Cultivating Capability The Socio-technical challenges of integrating approaches to records and Knowledge Management. *Records Management Journal*, *26*(3), 242–258. doi:10.1108/RMJ-11-2015-0035

Kamatula, G., & Kemoni, H. (2018). A framework for E-Records in Support of E-Government Implementation in the Tanzanian Public Service. *ESARBICA Journal*, *37*, 70–88.

Kanyengo, C. W. (2006). *Managing digital information resources in Africa: Preserving the integrity of scholarship.* Paper presented at the Bridging the North-South Divide in Scholarly Communication on Africa: Threats and Opportunities in the Digital era, Leiden, The Netherlands.

Katuu, S. (2016). Overview of the InterPares Trust Project in Africa: Trusting Records in an Increasingly Networked Environment. *New Review of Information Networking*, *21*(2), 117–128. doi:10.1080/13614576.2016.1247743

Khumalo, B. N., & Masuku, M. (2018). The Self-Worth of Records and Archives Management Students at the National University of Science and Technology, Bulawayo, Zimbabwe. *African Journal of Library Archives and Information Science*, *28*(1), 49–59.

Lu, L. L. (2018). Analysis of the Present Situation and Strategy of the Informatization construction of College Student Archives in China. *International Journal for Research in Educational Studies*, *4*(3), 11–15.

Luyombya, D., & Sennabulya, S. (2012). *An analysis of the public archive's infrastructure in Uganda.* Comma-2012_1_07_luyombya _sennabulya.inddd

Majore, S. A., Yoo, H., & Shon, T. (2014). Secure and Reliable electronic records management system using digital forensic technologies. *Supercomputer*, *70*(1), 149–165. doi:10.100711227-014-1137-6

Masanes, J. (1998). *Web Archiving*. Springer.

Ngoepe, M., & Katuu, S. (2017). Provision of Records Created in Networked Environments in the Curricula of Institutions of Higher Learning in Africa. *New Review of Information Networking*, *22*(1), 1–12. doi:10.1080/13614576.2017.1297731

Nyahodza, L., & Higgs, R. (2017). Towards bridging the digital divide in post-apartheid South Africa: A case of a historically disadvantaged university in Cape Town. *SA JnL Libs & Info Sci*, *83*(1), 39–48. doi:10.7553/83-1-1645

Okello-Obura, C. (2009). Positioning of Records and Archives education in Uganda: An analysis of the trend. *ESARBICA Journal*, *28*, 172–195.

Phiri, J. M., & Tough, G. A. (2018). Managing university records in the world of governance. *Records Management Journal*, *28*(1), 47–61. doi:10.1108/RMJ-11-2016-0042

Pho, T. H., & Tambo, T. (2014). Integrated Management Systems and Workflow- Based Electronic Document Management: An Empirical Study. *Journal of Industrial Engineering and Management*, *7*(1), 194–217. doi:10.3926/jiem.846

Potnis, D., Deosthali, K., Cortez, E., & Allard, S. (2016). Skills and Knowledge Needed to Serve as Mobile Technology Consultants for Information Organizations. *Journal of Education for Library and Information Science*, *57*(2), 187–196.

Raju, R., Raju, J., & Claassen, J. (2015). Open scholarship practices reshaping South Africa's scholarly publishing roadmap. *Publications*, *3*(4), 263–284. doi:10.3390/publications3040263

Schina, B., & Wells, G. (2002). University Archives and Records Programs in the United States and Canada. *Archival Issues*, *27*(1), 35–51.

Sheriff, A., Bouchlaghem, D., El-Hamalawi, A., & Yeomans, S. (2012). Information Management in UK-Based Architecture and Engineering Organisations: Drivers, Constraining Factors and Barriers. *Journal of Management Engineering*, *28*(2), 170–180. doi:10.1061/(ASCE)ME.1943-5479.0000085

Stephen, M. M. (2014). Status of digital heritage preservation management in Eastern Africa. *The Electronic Library*, *32*(3), 363–374. doi:10.1108/EL-01-2013-0003

Svard, P. (2013). Enterprise Content Management and the Records Continuum Model as strategies for long-term preservation of digital information. *Records Management Journal*, *23*(3), 159–176. doi:10.1108/RMJ-12-2012-0035

Thomas, D., & Underwood, P. G. (2015). The use of the intranet of the Durban University of Technology Library as a Knowledge Management tool. *South African Journal of Library and Information Science*, *81*(1), 21–27. doi:10.7553/81-1-1545

Voce, J. (2014). Reviewing institutional policies for electronic management of assessment. *Higher Education*, *69*(6), 915–929. doi:10.100710734-014-9813-2

Wilcox, S. D. (2011). Creating a Knowledge Management Culture at the Army Soldier Support Institute. *Army Sustainment*, *43*(2), 52–53.

ADDITIONAL READING

Khumalo, S., & Mearns, M. (2019). Sharepoint as enabler for collaboration and efficient project knowledge sharing. *South African Journal of Information Management*, *21*(1), 1–19. doi:10.4102ajim.v21i1.1044

Khumalo, S. S., & Mearns, M. (2019). A User's perspective on Implementing Sharepoint for Knowledge-Sharing and Collaboration in Retail. *European Conference on Knowledge Management*.

Matlakala, A., & Pretorius, A. (2016). The use of Sharepoint as a tool for knowledge management in a south African university. *International Conference on Intellectual Capital and Knowledge Management and Organisational Learning*, 199.

Mulyono, A. J., Harisno, H., & Kristianto, N. C. (2013). The development of knowledge Management System model in XYZ corporation. *Proceedings of 2013 IEEE International Conference on Teaching, Assessment and Learning for Engineering (TALE),* 188 – 191. 10.1109/TALE.2013.6654426

Rambe, P., & Mbeu, A. M. (2017). Technology Enhanced Knowledge Management Framework for Retaining Research Knowledge among University Academics. *Journal of Economics and Behavioral Studies*, *9*(1), 189–206. doi:10.22610/jebs.v9i1.1572

KEY TERMS AND DEFINITIONS

Archives: It is a record with enduring value preserved by an organization.

Electronic Records Management System: It is an electronic records management system developed to manage electronic records.

Records: It is recorded information regardless of form or format.

SharePoint: Is a formalized means of organizing and storing an organization's documents, and other content, that relates to the organization's processes. the content management solution that will enable and make it easy for Unisa staff to manage documents and records of all types and formats in a uniform and efficient manner, in terms of the following tasks and activities.

Chapter 8
Social Media and School Libraries in the Wake of the COVID-19 Pandemic:
Overview of Schools in a Selected District in Manicaland, Zimbabwe

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ABSTRACT

The COVID-19 pandemic has presented school libraries with opportunities and challenges that are unprecedented in the history of humankind as evidenced by total shutdowns, lockdown rules and regulations, and adaptation of emerging technologies for supporting teaching and learning in educational institutions. This chapter provides a general overview of the experiences of school libraries in a selected district in Manicaland, Zimbabwe. It highlights how the digital divide disadvantages school libraries that are resource famished. Using a qualitative methodology, the chapter interrogates how the adaptation of social media platforms has helped school libraries to contribute towards learning amidst the complications of the COVID-19 pandemic.

INTRODUCTION

Social media is mostly used in negativity, so much that those born before technology, including old-schoolers accept it with suspicions. This technological phenomenon is so instant that it captures events as they occur and unfiltered information is spread like veld fire to the masses around the world. Social

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media is in real-time captures phenomena instantly, thus, opening eyes just for capturing every detail. Virtually all organizations around the globe have incorporated this technology into their daily routines during Covid 19 lockdowns. School media centers are not an exception, they were also left with no option, since social media remained an innovative alternative source for facilitating the capturing of information and enabler instant shareability, without physical contact as required by Covid 19 regulations. During the pre-Covid 19 pandemic lockdowns, school libraries and other organizations were comfortable with their status regarding the provision of manual library services and gradually embracing new technologies, including, social media. The Covid- 19 pandemic brought about significant and instant changes, mostly requiring virtual access to learning and teaching resources. School media centers had also to adjust to the new normal just as all other organizations around the world were doing, embracing new technologies, such as social media.

Danladi and Soko (2018) heightened that the COVID-19 adversely affected the education sector as evidenced by the closure of universities, colleges, and schools. According to the aforementioned author, this predicament has resulted in the Work from home (WFH) *modus operandi* and online education even though this progressive development is undermined by the digital divide, poor ICT infrastructure, lack of information and digital skills, and non-availability of conducive workspaces at homes, especially in societies that are resource-starved, for example, Africa and other third world countries. The study will be guided by the following research questions**:**

- What is the social media?
- How did social media benefit school media centers with regards to information dissemination and access?
- How much support did school media centers receive from school administrators?
- Who funded virtual access to resources?
- What strategies should be utilized to enhance the effective use of social media by school media centers in Zimbabwe?

This chapter will expound on these questions, using a general approach regarding a selected district in Zimbabwe.

Background of School Libraries in Zimbabwe

This study is based on the adaptation and use of social media in a selected district in Zimbabwe in the wake of the COVID-19 pandemic. Zimbabwe's Ministry of Primary and Secondary Education, (2019) reported that in 2018, there were 6 242 schools with Education and Childhood Development (ECD) programs, 6 288 primary schools, and 2 871 secondary schools. The province where the district X under study is situated has one thousand and seventy-one (1071) registered schools and one hundred and thirty-one (131) satellite schools. Of the 1071 schools, eight hundred and one (801) are primary schools and two hundred and seventy (270) are secondary schools. The District to which this paper is giving the particular reference has 246 schools of which 21 were selected for this chapter. However, it should be noted that having a school library is not a strict requirement, a school may operate without or with a makeshift one. information obtained through a phone interview with the National Library and Documentation Services (NLDS) indicated that there are only eighty-two (82) registered libraries in public primary schools and one hundred and sixty-four for public secondary schools nationally. Surprisingly, some school libraries may be managed by untrained librarians, mostly a general hand seconded to work in a library, that is if the school authorities have a positive view of the library.

Chisita (2013) highlighted the need to engage accountable establishments to address issues of schools without libraries and to resuscitate those that are dysfunctional libraries to serve not only students and staff but the entire community through linkages with public and national libraries. According to the aforestated author, public and private sector partnerships come in handy as key factors in the development of school libraries; for example, formal companies operating in communities should provide support for school libraries as part of their social responsibility rather than just exploiting resources without investing in the development of the communities (Chisita, 2013). The adaptation of social media is dependent upon access to reliable internet connectivity and this is hindered by poor digital infrastructure in developing countries. However, the solution to such a challenge can be alleviated through schools and libraries forging public and private partnerships with reliable internet service providers (ISPs).

NEW KID ON THE BLOCK (NKOTB) SOCIAL MEDIA

Friday, (2020) citing Fang, Hu, Li and Tsai (2014) defined 'social media as computer and mobile-mediated tools that facilitate interaction and sharing of information in text, visual, audio and video forms in an online networking environment. Examples of social media tools include, Facebook, MySpace, Twitter, YouTube, Blogs, Wikis, LinkedIn, WhatsApp, Flickr, and Orkut among others. Hogan and Quan-Haase (2010) noted that most social media assimilate other forms of computer-mediated communication (CMC), for example, Facebook, MySpace, and Twitter do have direct messaging systems similar to e-mail, whereas dating sites embed instant messaging (IM), friend testimonials, and blogging features alongside their core feature of profile searching. These technologies interact in a virtual environment that facilitates information sharing. Lewis (2010) in (Hayes, 2015) noted that social media simply serve as a label for digital technologies that allow people to connect, interact, produce and share content. However, Hayes (2015) argued that the aforementioned definition is not only limited to social media but other technologies like email. Citing Bradley and McDonald (2011), Chukwuyere, Nwanneka, Chukwudebelu and Chidiebere (2020) defined social media as any Internet-based or mobile application that operates for collaboration, which allows participants to connect, create, comment, view, share, rate, discover, profile, and exchange user-generated content. Social media allows anyone to edit or add content even to twist the facts.

With today's sophisticated technologies, facts including images could be reshaped and restructured and a new twisted story can be developed and shared instantly with many people around the world. No wonder why social media is viewed as a suspicious technology. Chukwuyere et al (2020) argued that fake information on social media has dominated the social space with its attendant conspiracy theories. For example, the (WHO) recommended the uptake of jabs for vaccination against Covid-19, on the other hand, there were a myriad of conspiracy theories about these vaccinations and social media was used to disseminate this information the world over, and many people were left in a confusion of what to believe. Allcott, Gentzkow and Yu (2019), in Chukwuyere, et al (2020) highlighted that the more "worrisome aspect of the social media is its potency to be used to spread fake news with its significant negative effects on the society and people's decisions and behaviors" Mutanga, Ureke, and Chani's (2021) study on responses from netizens in South Africa and Zimbabwe confirmed the fear that there were common uncertainties regarding across the two African nations. The findings of the aforementioned study confirmed evidence of social media being used as a tool for the dissemination of doomsday conspiracy theories. It is against this background that the researchers concur with Elmore and Coleman's (2019) proposal for libraries to be innovative in adapting praxis -oriented strategies to counter misinformation and school libraries are no exception.

Elmore and Coleman (2019) highlighted the need to incorporate critical media literacy into the curriculum to counter the viral nature of media and its ability to shape the discourse around people and policy. Johnston (2020) noted the vitality of media literacy instruction as a panacea against information disorder and recommended that schools need to transition from the checklist tactic of teaching how to evaluate information and move to an instructional method that stresses the more critical thinking aspects of assessment such as the foundation of the information, social and political predisposition and authenticating evidence and information through numerous springs. Currently, libraries are adapting metaliteracy because it is an integrated pedagogical approach that brings together all literacies that can be employed to weaponize library users to confront information disorder. Zinyemba, Nhongo and Zinyemba (2021) noted that in Zimbabwe there was a wide discrepancy between learners residing in the urban areas and those who were domiciled in the rural areas as evidenced by the rural learners not experiencing any form of learning during the lockdown period while their urban counterparts were learning. However, school libraries and other organizations were able to focus on the positive side of social media and embrace it to their competitive advantage. School libraries used social media as convenient platforms and trusted sources to virtually disseminate information to users. For example, teachers have been using social media platforms to conduct lessons virtually, librarians were able to do the same and share resources that support student learning and teaching. Krutka and Carpenter (2016) viewed social media platforms as vital tools to leverage for intelligent pedagogical purposes that add value to learning by making it more engaging and also proffering educational experiences that might not otherwise be possible. Danladi and Soko (2018) conducted a study on the use of social media in secondary schools and recommended that librarians should utilize social media by creating social media platforms, such as social media discussion forums where students can discuss books they have read to develop a sustainable reading culture.

The American Library Association (ALA) (2021) reported that "the school library extended itself into the home, providing virtual hours via webcam conferences, email, phone, and instant messaging. Librarians continued to foster reading development with virtual book clubs, storytimes, and read-aloud sessions. Even gaming and makerspace activities evolved as virtual learning programs". ALA added that libraries in America "offered access to tech tools that allowed users to create or access video content, communicate via digital discussion platforms, and stay on top of assignments and class information via texts." On a similar note, African Libraries also embraced social media to reach their users. For example, "Libraries in Johannesburg, South Africa, have reinforced their activities on social media, including new regular 'ask a librarian' session" (International Federation of Library Associations-IFLA, 2021). Binder (2020) noted that distinct geographic, economic, and social gaps in access persist, leaving a significant knowledge gap on the digital realities for the current techno savvy generation. Ong, (2020) added that a "lack of meaningful and full access to a computer or the internet translates into missed lessons, inability to access materials, and difficulties completing assignments". While there are growing calls for the adaptation of social media, it is important to assess the merits and demerits of such platforms for school authorities to find safer, ethical, and beneficial ways of exploiting such technological innovations. The next section briefly outlines selected advantages and disadvantages of social media

Merits of Social Media in School Libraries

- Students can add and annotate resources they locate. Together, the librarian, teacher, and students collect a rich resource that can be used for homework projects." (Young Adult Library Services Association (YALSA) (2011).
- Social media is instant and interactive.
- Involves participation by more participants at once.
- Improved communication with various stakeholders, increased opportunities and contacts, and increased student learning and satisfaction. (Ritesh Chugh, 2021)
- Marketing of the school media centre/ library.
- Social media modernizes school libraries, which are transformed/ adjusted to meet up with new trends.

Demerits of Social Media in Schools

Social media pose a danger for mostly young children and women, as it has been used to share child exploitation information and the transmission of unsolicited sexual messages among other challenges. Binder (2020) noted, "Social media, in particular, is perceived as an unsafe space, with 68% of online abuse of women and girls taking place on social media platforms. There are many risks associated with digital technology, including online harassment from strangers (such as unsolicited messages), cyber-bullying, cyberstalking, unsolicited sexual messages or images, and non-consensual sharing of intimate photos, child sexual exploitation, and abuse, as well as data security and privacy risks". The following are some of the demeris of social media;

- Low quality or lack of reliability of online information is a major limitation of social media. (Gao, 2017).
- Children could end up spending a lot of time on social media, posing health hazards of too much exposure to these gadgets and lack of outdoor activities.

DEVELOPMENT OF SOCIAL MEDIA

Social media has become the trending technology of the twenty-first century as evidenced by its growing influence on all aspects of socio-economic activities and its use by a variety of demographic groups mostly the young people and corporate organizations. Duggan, Ellison, Lampe, Lenhart, and Madden (2015) highlighted that social media has developed from being a frolicsome digression for adolescents to a technology that is integral to the socio-economic and political lives of all demographic's groups. Ritholz, (2010) contends that social media has its roots in technological development during the later years of the eighteenth century when the telegraph was used to transmit and receive messages over long distances. According to Edosomwan, Prakasan, Kouame, Watson, and Seymour, (2011) cite Emile Durkheim (1858-1917) and Ferdinand Tonnies (1855-1936) as the pioneers of social networks. The aforementioned authors' philosophical thoughts highlight the importance of developing and sustaining collective consciousness and this is one attribute of social media as it allows society to build social capital on a wider scale. The foundations of social media are anchored on the development of the telephone when in the 1950s phone phreakers went on a prowl to illegally access the telephone system to make free calls (Edosomwan et al, 2011).

Sajithra and Patil (2013) described Usenet as a globally distributed Internet discussion system that was developed in 1980 from the general-purpose Unix-to-Unix Copy (UUCP) architecture of the identical name. This development marked the inventiveness of the Email concept for the shareability of categorized messages, thus enabling users to decipher and post messages to one or more categories. Kaplan and Haenlein, (2010) note that the other foundations of social media date back to the twentieth century when Usenet, a universal discussion system that permitted Internet users to post public messages was developed. The aforementioned authors contend that the modern social media technologies emerged in the second half of the twentieth century when the "Open Diary" a weblog was created Bruce and Susan Abelson founded connected online diary writers into one community (Kaplan & Haelein, 2010). The other development in the 1980s included the following:

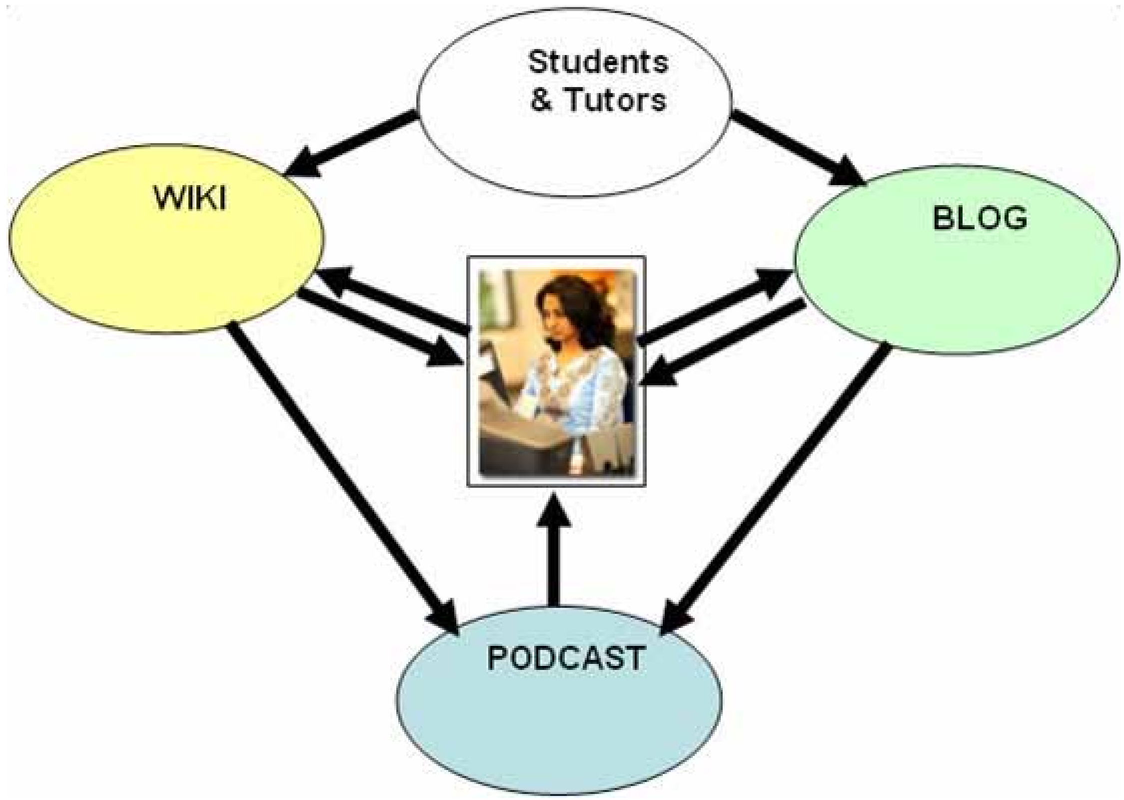
- LISTSERVs-served as an effective way to reach out to a large number of people in an instant.
- Internet Relay Chat (IRC) - a form of online chatting enabling one-to-one communication through private messages including chat and data transfers;
- Personal websites, Discussion groups, and chats democratized internet access and became the primary podium for contemporary deliberations;
- Social Networking Sites - SNSs serve as virtual communities that enable users to generate individual public profiles, interact with real-life friends, and meet other people based on common interests;
- Blogs, podcasts, Wikis - these serve as Web, 2.0 applications useful for learning and collaboration.

The above Figure 1 illustrates the convergence of the three emerging Web 2.0 applications and their unique and cooperative contributions to enhancing student learning. Boulos, Maramba, and Wheeler (2006) recommended further research on how these emerging technologies can be leveraged to enhance and deepen student engagements in the learning process powered by digital technologies. Web Technologies encompass constant technological changes ranging from Web, 1.0, Web, 2.0, and Web 4.0 that are useful in learning, research, and collaboration. The aforementioned technologies have the potential to add value to teaching and learning in the era of technological change. The next section will explore how school media centers responded to the COVID-19 pandemic regarding social media use.

School Media Centers and Social Media use in Response to the COVID 19 Pandemic

Globally, many school libraries that were technologically endowed were able to respond to the COVID -19 pandemic by switching on to virtual services. Santos (2020) noted that children across Texas engaged with their librarians for storytime sessions through computer screens instead of in person, book club members learned how to use Zoom, and librarians worked harder than ever as thousands of readers across the state signed up for virtual subscriptions and learned how to check out books and other materials with such digital platforms including but not limited to Libby, Overdrive, Hoopla and other apps. Kumar (2020) noted that libraries in the USA, "during the lockdown period in the USA, "National Emergency Library" developed web-based archive blogs which have a wide range of collection around 1.4million books on its digital library platform". On a similar note, in India, the response to the Covid-19 pandemic

Figure 1. The convergence of emerging Web 2.0 applications
(Boulos, Maramba & Wheeler, 2006).



restrictions, whereby schools and libraries were closed, Kumar (2020) cited that the National Digital Library of India (NDLI) came up with a user-oriented interface that was specially designed for digital collections of e-resources like eBooks, e-journals among other formats. for specific groups of students and continuously enhancing its services. The researchers, professors, school and college students were able to visit the website of NDLI to access these e-resources free of cost and easily through mobiles, laptops, or computer systems. Updates of any upgrades were communicated using social media platforms. In New Zealand, school libraries proved to be adaptable as they adopted new technologies and social media platforms to engage students and teachers for library services. Bichan (2020) reported that the "COVID-19 lockdown provided us with a grand opportunity to prove our worth, explore new technologies and ensure student access to all they need to succeed". School Librarians in New Zealand used social media such as LiveBinder and Zoom to connect and engage students for various library programs. "In Australia, access to the internet is almost ubiquitous," reported the Connections (2016). Internet access is not a challenge as in developing countries. In Zimbabwe, the Ministry of Primary and Secondary Education in collaboration with UNICEF developed a digital learning passport in its endeavor to respond to Covid 19 restrictions. However only users with the required gargets and infrastructure could only have access. Zimbabwe being a nation with limited internet infrastructure could also be a limitation for the school librarians who might need to introduce social media services. As noted in the background, the number of registered libraries in public schools is only two hundred and forty-six (246) nationwide, against over nine thousand (9000) public schools. The scenario is a clear indication that embracing new technologies such as social media in school libraries is too much to talk about. Worsening the situation is that, according to data gathered from NLDS there is no establishment of librarian posts in schools. Therefore, talking about bringing new technologies such as social media into school libraries is far ahead of the basics that need to be addressed first. Zinn (2021) reported that in Nigeria most of the staff in charge of the library had no librarianship qualification. "Only 7% of schools in South Africa have a functional library while most classrooms do not have books available that learners can read. More than half of learners do not have access to books at home. There is also an acute shortage of relevant content and appropriate level of books in the African languages (Bloch, 2018)

Ayanso (2010) conducted a study on the digital divide that profiled 192-member nations, resulting in cluster profiles showing two groups of nations, which were labeled as "ICT leaders" and "ICT followers". There were only 32 nations identified as ICT leaders and 146 nations as ICT followers (Ayanso, 2010). In the study, an examination of the two clusters showed that none of the nations in the region of Africa were identified in the ICT leaders cluster, whereas Europe had 22 of the 32 nations identified as ICT leaders. This cluster included Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Iceland, Ireland, Italy, Luxembourg, Monaco, The Netherlands, Norway, Portugal, San Marino, Slovenia, Spain, Sweden, Switzerland, and the UK. Sub-Saharan African countries dispose of strictly limited financial and technological resources and are dependent on foreign aid to reduce the digital gap and build an information society in the region (Pantserev, 2016). This confirms the digital divide that exists and how it affects the provision of quality school library services in developing countries.

The afore-mentioned experiences confirm that those countries that are technologically endowed found it easy to adapt to the COVID-19 new normal unlike those that are resource-starved. Jæger and Blaabæk (2020) noted that globally, the Coronavirus pandemic (Covid-19) resulted in the closure of schools and placed the burden on parents to take charge of their children's schooling. However, the greatest challenge of this scenario was that the pandemic exacerbated the existing inequalities in children's learning opportunities because only those parents with resources were able to leverage their children by providing access to modern technology while those of lower socioeconomic could not do the same. Zimbabwe saw a situation whereby elite schools were the front-runners in embracing online learning because of their resource endowed status, while, underprivileged learners remained locked up by the lockdown while they waited for the government and well-wishers to intervene (Silumba & Chibango 2020). The challenges cited for the failure to adjust to online learning relate to lack of access to digital technologies, poor internet connectivity, and high costs of data (Hove & Dube, 2021).

Embracing social media in school library services reflects the ICT leaders or first-world countries, where bread and butter issues are not regarded as challenges. Coming down to the developing countries, the story is different. Poverty and many other hard economic challenges worry even a young school child. There is a division of the 'haves' and 'have not', where mostly the 'haves' are in private schools and 'have not' in public schools, and it worsens in the rural community. In Zimbabwe, for example, some schools operate without a library. There is no establishment of a school librarian in public schools. However, some schools through Schools Development Council (SDC) and the Headmaster, if they have a positive view of the library, appoint a librarian even untrained, to work in the school library. Sithole (2012) commented about school libraries in Zimbabwe. "quite frankly, libraries in schools continue to decline and shelves are empty or full of irrelevant materials. Few schools have libraries and the quality and relevance of information resources in these libraries reveal marked variations from school to school. Government support for school libraries is still elementary". This scenario together with other factors such as the digital divide that already exists worsens the development of school libraries in developing countries, particularly of the espousal of new technologies that allow for virtual access in the wake of Covid 19. A technological divide exists in Zimbabwe between urban and rural schools that put rural-based students at a disadvantage (Gomba, 2016). This experience together with the lack of functional policy to establish school libraries for every operating school in Zimbabwe has already created a lot of limitations on what a school library could do.

There is a "substantial digital divide both across and within countries (African), reflected in uneven access to resources such as electricity and unequal access to and use of smartphones and computers," (Kronke, 2020). Data in developing countries is very expensive, encircled by poverty and other hard economic conditions, thinking about using social media or other technologies, both for library staff and students as well as teachers become very secondary. What they wake up thinking about is how to bring food to the table for their families. Children could also be sent to the markets as vendors. Tokwe (2021) noted that "…the road pavements are not spared either, young girls in trendy jeans spread their wares also calling persuasive voices. This is the state it has reached. Years of economic meltdown punctuated by the closure of industries, factories… driven by this man-made pandemic, mothers, girls, and even the elderly women have trooped out of their domestic homes to seek economic survival in the streets." Could this hard-earned cash be spared to buy data for library social media? The answer is very clear, the digital divide continues to grow because of inequalities that exist.

Social Media and Access to Knowledge Sharing

As noted in the preceding paragraphs, some developed countries navigated and were able to launch social media platforms and started new services which they offered virtually. Some examples were noted from the USA, India, and New Zealand. The situation in Africa is unique because in times of social stability access to the internet is guaranteed as long as one affords the cost of connectivity, while in times of social instability the government access can be blocked as a national security measure. Parker (2021) highlighted that the first internet shutdown in Sub-Saharan Africa was in Guinea in 2007 and in 2020 there were recorded incidences of full or partial shutdowns were recorded in multiple countries including Algeria, Burundi, Chad, Ethiopia, Guinea, Mali, Sudan, Togo, Tanzania, and Zimbabwe. Such unilateral actions have an effect on other critical socio-economic activities including learning, teaching, and research.

However, there is a huge discrepancy among school libraries in developing nations, where issues of poverty are rampant and this undermines democratic access to digital technologies. Tkáčová, Pavlíková, Jenisová, Maturkanič, and Králik, (2021) noted that the varied forms of social media (SM) have become popular among young people because they provide information and entertainment, including a wide range of web technologies such as blogs, wikis, online social networks, and virtual networks. According to the aforementioned authors, social media plays a huge role in the lives of children and teenagers, especially during the COVID-19 pandemic, when the computer becomes not only a means of entertainment or leisure but also a vital and daily means of education and communication with other people. Thus, COVID-19 has brought a radical change, not only in the daily schedule and leisure time of pupils and students but also in the perception of the procedures used by this specific group in the online space. The Association for the Development of Education in Africa (ADEA) (2021) reported that "many countries were, and still are, not well prepared to provide distance learning solutions to all children, especially those in areas lacking the necessary infrastructure and human capacity to package and deliver the content." There is also the issue of the digital divide discussed in the preceding paragraphs, such as the generally limited infrastructure in many African countries, or the divide caused by limited income within families. Some schools operate without a trained Librarian or a Library. Mutare Polytechnic Library, in Zimbabwe, for example, realized this gap and introduced outreach programs to assist schools to establish and develop school libraries, especially in Manicaland Province, the region where it is located. The author is the coordinator of the program and has some first-hand information about the state of other school libraries. The school may not have a library and/or Librarian, this scenario would tell a lot if the issue of using social media in library service delivery could be talked about. If there is no librarian, who then could start any library service? This shows a huge digital divide, especially in schools in rural areas. Tarisayi and Munyaradzi (2021) in a study noted that during the internet shutdown teachers' communication and research activities at the selected schools were severely curtailed during the internet shut-down period. The ramifications of the internet shutdown on teaching and learning at the selected schools in Zimbabwe fit into Merton's unintended consequences of the government's decision to shut down the internet.

Institutional Support for School Media Centers during the COVID -19 Pandemic

There is no question that principal support is vital to the establishment and maintenance of a quality library media program. Hartzell (2012) lamented that the problem is that support flows from the trust and trust-flows from understanding. The author added that many decision-makers do not understand what librarians do, nor do they appreciate the potential the library media program has for contributing to student and faculty achievement. Findings revealed that lack of support was indicated in responses from all instruments that libraries were said to be changed to be classrooms or when anyone without library expertise may be seconded to work in the library. This trend has been ongoing in some situations, though in other cases the trend could be declining due to advocacy work in libraries. Hartzell (2012) and Combs (2016) lamented that administrators and boards of education were frequently cutting, reducing, or removing the library from the campus educational plan.

Funding and Virtual Access to Resources

Citing the World Bank (2020), Artuso (2021) reported that the pandemic is estimated to have pushed 100 million people into extreme poverty in 2020, significantly affecting the already poor, while creating 'new poor' among the more urban and educated communities. Artuso (2021) added that the pandemic has exposed how the digital divide remains a global issue, with poorer communities and minorities struggling to catch up with digital demands during the pandemic. It is clear that people who were affected by poverty, would not have the means to purchase the required resources for internet connections. Even governments in such environments, that is developing nations, would focus more on alleviating poverty than to secure internet infrastructure. The digital divide created more gaps in human structures so much that there is a huge discrepancy between the developed nations and the 'haves' in developing nations.

The World Bank (2022) argued that access to broadband (or high-speed) internet should not be considered a luxury but rather a basic necessity for economic and human development in both developed and developing countries. The report further highlighted that access to the internet remained a powerful tool for the delivery of essential services such as education and healthcare among others. However, in developing nations, as noted earlier, internet infrastructure is a challenge and makes it difficult for school libraries to introduce new internet-based programs like social media. In rural areas, the challenge gets worse. Internet is also very expensive and slow. The schools find it difficult to fund such programs.

METHODOLOGY

This section will highlight the methodological transparency of the study regarding the extent of detail and disclosure about the specific steps, decisions, and judgment calls made during a scientific study. Ngulube and Ukoma (2021) argued that researchers needed to describe the research design that they are using clearly; this constitutes methodological transparency. This chapter is guided by primary information previously gathered from reports generated from the international School Library month celebrations organized by the Mutare Polytechnic between 2018 and 2019 focusing on the state of affairs in school libraries in the selected district. Interviews with the Provincial Education Director, District School Inspector, for the district under review directorate, other some school Headmasters and Librarians in the District in question were conducted. Follow-ups on how the school libraries had adjusted to the Covid 19 using social media were done through mobile phone call interviews and physical interviews with the Provincial Education Directorate. The interview questions were developed in sync with the research questions and literature relating to the use of social media during the COVID-19 pandemic. The Librarian at Mutare Polytechnic, who is the author of this chapter is the organizer/coordinator of outreach programs involving improving school libraries in the province. During the preparation of the programs, there was an engagement with school authorities as well as field visits to the selected schools. Data regarding the state of affairs was gathered during these interactions and field visits in 2018 and 2019, and before as far as 2013 when the outreach program started. The study employed a qualitative methodology using a case study approach to describe and present data. The qualitative research design is anchored on the interpretive paradigm. Russell, & Gregory, (2003) highlighted that qualitative research as a methodology is characterized by flexibility, openness, and responsivity to context and whose steps of data collection and analysis are connected. The research used a non-probability sample, namely, purposive sampling. Sampling consists of one (1) provincial education director, one (1) district school inspector, three (3) headmasters and five (5) librarians. The responses to the data collection were coded alphanumerically as follows:

- PED (1);
- DSE (1);
- Headmaster (H1, H2, and H3); and
- School Librarians (SLI, SL2, SL3, SL4, and SL5).

Data Collection and Analysis

A case study design was used in this chapter. The study utilised interviews and literature review to collect data including data previously collected for a currently ongoing study on “The challenges affecting Development of school Libraries: A case of one District in Mutare, Zimbabwe”. Thematic analysis was used to analyze data, within a critical realist framework. Meanings and experiences were examined both at the semantic and latent levels. Onwuegbuzie, (2007) argued qualitative data analysis is one of the most important steps in the qualitative research process because it assists researchers to make sense of their qualitative data. The categories for analysis were aligned to the research questions. This was followed by the presentation and interpretation of the results in the following section.

FINDINGS AND DISCUSSIONS

What is Social Media?

The responses from the Provincial Education Director (PED) (1), District School Inspector (DSI) (1), Headmaster (H1, H2, and H3), School Librarians (SLI, SL2, SL3, SL4, and SL5) indicated that there was a high-level of understanding the nature of social media in the context of schools. The respondents (PED, 1) and (SLI, SL2, SL3, SL4, and SL5) highlighted that the Constitution of Zimbabwe Section 61 (a) provides for freedom to seek, receive and communicate ideas and other information. However, from a policy position, schools in Zimbabwe do not allow students to use mobile phones in school environments since they are viewed as disruptive technologies. Respondents (SLI, SL2, SL3, SL4, and SL5) indicated that since the outbreak of the COVID-19 pandemic the use of mobile phones to access social media platforms has increased. They argued that during the lockdown mobile technologies have become handy tools for accessing learning, teaching, and research.

How did Social Media Benefit School Media Centers with regards to Information Dissemination and Access?

The respondents indicated that despite the challenges of the digital divide, social media has helped facilitate access to information. The respondents (PED, 1) and (SLI, SL2, SL3, SL4, and SL5) acknowledged that social media was useful in enabling them to communicate with teachers, parents as well as students, especially during the lockdown. The respondents indicated that they were able to provide students with access to information by sharing links to online resources.

How did School Media Centers Respond to the Covid 19 Pandemic using Social Media?

School media centers in Zimbabwe are divided into those that are technologically endowed and those that are disadvantaged. Respondents (SLI, SL2, SL3, SL4, and SL5) indicated that those school media centers in formerly group A schools found it easier to adapt to changes induced by the COVID-19 pandemic, while those formerly group B schools found it challenging to adapt to the demands of the new dispensation. School library media centers endowed with digital technology were able to access digital resources to support teaching, learning, and research. According to respondents (SLI, SL2, SL3, SL4, and SL5), the COVID-19 pandemic exposed the gap between school library media centers that have access to technology and those without. The PED (1) indicated that

We may talk of the Learning Passport by UNICEF, however, children in rural areas are most disadvantaged in terms of gadgets even internet connectivity, in towns the situation is better

The COVID-19 pandemic affected rural areas more because of the digital divide including lack of network connectivity. It should be noted that while some schools have a standard school library media center others just have a physical structure of a library without current technologies for facilitating access to information. The scenario is compounded by the fact that those rural libraries are not managed by trained librarians. According to respondent HI "We have the library, but the librarian is not trained, he performs other school duties".

How Much Support did the School Media Center Receive from School Administrators?

Responses from Headmaster (H1, H2, and H3), and School Librarians (SLI, SL2, SL3, SL4, and SL5) cited economic problems as the main cause of the lack of support for libraries. SLI, SL2, SL3, SL4, and SL5 indicated that their library had no budget due to national budgetary constraints for libraries.

Participant (SLI) "…current economic environment has impacted school libraries in terms of budgets for collection development …"

Furthermore, the participant (SL2) stated that "… while most teachers directly fall under the government through the Ministry of Primary and Secondary Education (MoPSE), librarians and librarians rely on the support from School Development Committees (SDC) but this is inadequate…"

(SL5) highlighted that "…SDCs cannot sustain school library media centers…"

Who Funded Virtual Access to Resources?

However, in Zimbabwe, the Ministry of Primary and Secondary Education in collaboration with UNICEF developed a digital learning passport in its endeavor to respond to Covid 19 restrictions. The United Nations International Children's Emergency Fund-UNICEF, (2021) reported that the Zimbabwe Learning Passport contains a digital library housing teaching and learning resources resonating with the national curriculum including open education resources from a wide range of partners, mapped to complement the local curriculum. The efforts made by UNICEF and the Ministry of Primary and Secondary Education were noble, but do all schools and children in all places even rural benefit from this program or only the skeletal elite? Findings revealed that only two hundred and forty-six schools have registered libraries with NLDS against over nine thousand (9000) public schools nationwide. Schools do not have established librarians to assist school children in accessing library resources including connecting them to new virtual technologies such as social media.

Interviews were conducted with PED (1) and DSE (1) who are the policymakers and they indicated that libraries were a grey area in the life of a school. The participants could not provide official figures on the number of schools that had libraries and those without libraries, nor statistics on librarians operating in school libraries. They indicated that it was an area that required to be researched. However, they acknowledged that some schools were operating without libraries, especially those in rural areas. However, this reflected one district understudy in one developing country. As noted earlier, in developed nations that have sophisticated technologies, and speedy internet connectivity, librarians were able to secure the support they needed to introduce social media programs for library services.

What Strategies should be utilized to Enhance the Effective Use of Social Media by School Media Centers in Zimbabwe?

School media centers should continue to lobby the government to prioritize libraries and seek ways to forge strategic partnerships with network providers, industry and commerce, and developing partners to develop a digital infrastructure that will benefit schools, students and school library centers to be empowered to support uninterrupted learning and teaching. School media centers should not work alone but partner with other key stakeholders to foster radical change in the digital transformation of the education system in line with the industry 5.0 thrust. Partnerships with non-commercial internet service providers (ISPs). School media managers should come up with a working document to convince policymakers on how they can promote responsible use of social media in schools.

CONCLUSIONS AND RECOMMENDATIONS

The findings of the study revealed that the level of use of social media in schools in District X in Mutare in Zimbabwe was affected by a myriad of factors including high costs of data, poor internet connectivity and lack of support from schools. The global digital divide that exists between the ‘haves’ and ‘have-not’ has created a huge gap in what school librarians could do in terms of introducing social media platforms to engage users. While in n developed countries, school librarians were able to navigate and introduce new services based on the usage of social media, contrary rural areas in Africa reflected a different scenario characterised by digital exclusion. The study findings reveal that social media provided an alternative means to provide access to learning resources especially during the COVID-19 pandemic. The chapter raises critical points relating to the urgent need to capacitate schools and libraries with access to digital technologies for the benefit of students. The article highlights the need for key stakeholders in the education sectors to forge strategic partnerships to enhance learning through the use of emerging technologies. Digital inclusion is a must for all and the future should afford all citizens to become bona fide netizens who are imbued and empowered with literacy skills of the twenty-first century. Librarians should be viewed as useful drivers of the digital transformation era as the world drives towards open educational learning with a focus on collaborative learning.

The study suggests the following recommendations:

- Further research should be undertaken on strategies to be implemented to improve the state of school media centres for improved reading and critical thinking skills from a tender age.
- Government should enforce a national policy that no school should operate without a library and a trained library staff.
- Governments in developing nations should invest in Internet infrastructure, and reduce data charges.
- Government should venture into private and public partnerships with mobile internet service providers such as Econet, Telone, Netone and Telecel so that they provide internet in schools.
- Librarians should lobby for the incorporation of information literacy programs to empower students with skills to intelligently navigate social media platforms.
- Schools with librarians should continue to advocate for support from school administrators; and

- Key- stakeholders like the National library Associations (ZIMLA), communities, industry, teachers, and publishers should work with the government to address the challenges being encountered by school media centres/libraries school libraries.

REFERENCES

Agim Eliezer Chukwuyere, O. I. (2020). Librarians' Use of Social Media in Disseminating Health Information on COVID-19. *International Journal of Research and Review*, *7*(7), 443–454.

Artuso, N. J. (2021). Civil Society's Response to Coronavirus Disease 2019: Patterns from Two Hundred Case Studies of Emergent Agency. Journal of Creative Communications.

Association for the Development of Education in Africa (ADEA). (2021). *School reopening in Africa: Association for the Development of Education in Africa*. ADEA.

Ayanso, A. (2010). The digital divide: Global and regional ICT leaders and followers. *Information Technology for Development*, *16*(4), 304–319.

Bichan, G. (2020). New Zealand school libraries respond to COVID-19. Schools Catalogue Information Service (114).

Binder, A. T.-C. (2020). *What we know about the gender digital divide for girls: A literature review*. UNICEF.

Bloch, L. C. (2018). A reading project to improve literacy in the foundation phase: A case study in the Eastern Cape. Reading & Writing - Journal of the Reading Association of South Africa, 9(1), 1-7.

Chisita, C. T. (2013). Zimbabwean School Libraries as Social Spaces: Empowering Students with Life-wide Skills in the New Millennium. In IASL Annual Conference Proceedings.https://journals.library.ualberta.ca/slw/index.php/iasl/article/view/7817/4648 Accessed 23 April 2022.

Chisita, C. T., & Ngulube, P. (2022). A framework for librarians to inform the citizenry during disasters: Reflections on the COVID-19 pandemic. Jàmbá. *Journal of Disaster Risk Studies*, *14*(1).

Combs, J. P. (2016). What School Principals Need to Know about Libraries: Implications for Practice and Preparation. *NCPEA Education Leadership Review*, *17*(2), 2.

Gao, J. H. (2017). Advantages and Disadvantages for Nurses of Using Social Media. Journal of Primary Health Care and General Practice.

Gomba, C. (2016). Transforming Rural Secondary Schools in Zimbabwe Through Technology: Lived Experiences of Student Computer Users. [IOJET]. *International Online Journal of Education and Teaching*, *3*(2), 108–120.

Hartzell, G. (2012). The Principal's Perceptions of School libraries and Teacher-Librarians. *School Libraries Worldwide*, *8*(1), 92–110.

Hayes, C. T. (2015). Social Media: Defining, Developing, and Divining. *Atlantic Journal of Communication*, *23*(1).

International Federation of Library Associations-IFLA. (2021). COVID-19 and the Global Library Field. Retrieved October 15, 2021, from https://www.ifla.org/covid-19-and-the-global-library-field/#services

James Friday, C. O. (2020). Social Media and Library Services: A Case of COVID-19 Pandemic Era. *International Journal of Research and Review*, *7*(10), 230–237.

Kronke, M. (2020). AfricaPortal. Retrieved September 14, 2021, from https://www.africaportal.org/publications/africas-digital-divide-and-promise-e-learning/

Kumar, P. B. (2020). Role of Library Professionals in a Pandemic Situation Like COVID-19. *International Journal of Library and Information Studies*, *10*(2), 33–48.

Ministry of Primary and Secondary Education. (2019). *2018 Primary and Secondary Education Statistics Report*. Ministry Of Primary And Secondary Education.

Ong, P. M. (2020). *Covid-19 and the digital divide in virtual learning, fall 2020*. UCLA Centre for Neighborhood Knowledge.

Ritesh Chugh, R. G. (2021). Social media usage by higher education academics: A scoping review of the literature. *Education and Information Technologies*, *26*, 983–999.

Santos, M. C. (2020). Libraries Respond to COVID-19. Texas Library Journal, 96(2), 64-70,72-73.

Sithole, N. (2012, October 28). Government has a duty to enrich school libraries. The Standard.

The American Library Association (ALA). (2021). *2021 State of Americas' Libraries: special report: Covid 19*. ALA.

Tokwe, H. (2021). Bhero in the City by the Black Paparazzi.

UNICEF. (2021). https://www.unicef.org/zimbabwe/press-releases/zimbabwe-launches-innovative-learning-platform-children-and-teachers. Retrieved October 14, 2021, from https://www.unicef.org/

YALSA Young Adult Library Services Association. (2011, February). Teens & Social Media in School & Public Libraries: A Toolkit for Librarians & Library Workers. Retrieved September 13, 2021, from www.ala.org/yalsa

Zinn, O. O. (2021). The Role of School Libraries in Supporting Inquiry-Based Methods for Teaching Science in Nigerian Schools: Challenges and Possibilities. Libri, 71(2).

KEY TERMS AND DEFINITIONS

Access to Information: The fundamental right as enshrined in the Universal Declaration of Human Rights (UDHR) and national constitutions which guarantees every citizen the right of access to information as a way to empowers citizens to obtain information held by public bodies (with limited exceptions).

It provides for the right to request and receive information, as well as an obligation for governments to publish information proactively.

Digital Divide: The lacunae that exists between individuals who have access to modern information and communication technology and those who lack access. The digital divide manifests itself technologically, economically, socially, educationally, democratically and infrastructurally

School Library: A library situated within the parameters of a school and under the aegis of the school administrators. It is also referred to as a school media centre and it serves the needs of students, staff, or parents of a private or public school. It is part of the curriculum of the school since it is an extension of the structured and unstructured learning space.

Social Media: Internet-based platform used for interaction and access to news and information, and decision making. It is a treasured communication tool with others irrespective of time and space and a special platform for sharing, creating, and disseminating information.

Chapter 9
A Data Mining Algorithm for Accessing Research Literature in Electronic Databases:
Boolean Operators

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ABSTRACT

Searching and retrieving relevant research materials from electronic databases are difficult for many students and early career researchers. Many researchers have abandoned beneficial research projects because they believe that related literature is unavailable to ground their work. This chapter serves as a guide to students, professionals, and internet users on how to pull information from electronic databases easily. The chapter begins by clarifying the concept of electronic databases, the evolution of electronic databases, and the processes involved in indexing scholarly works in an electronic database. The advantages and disadvantages associated with the use of electronic databases are also discussed. The chapter describes how electronic database search works, with insights into some poor practices. The concept of Boolean operators and how they can be used to easily mine desired contents from electronic databases are discussed. The knowledge and use of Boolean operators might become unavoidable in enabling researchers to locate relevant materials for their projects.

INTRODUCTION

The research process includes problem ideation, conceptualisation, literature review, study design, data collection and analysis, and ultimately, disseminating results (in different formats) to publishing outlets. In this chapter, two of these processes are important – literature review and result dissemination. The literature review process entails searching for previously published content from different databases (traditional or electronic). Literature review presupposes that the material to be reviewed is already

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published or disseminated to the public domain. Therefore, a symbiotic relationship exists between literature review and research dissemination. This is because the review of research literature depends on previously disseminated works. Besides, a review of existing literature is required to offer future research directions and sustain dissemination practices.

The published research literature is often managed using physical or electronic databases, with each requiring different methods of assessing indexed contents. To locate research literature from traditional/physical databases, one must visit the library. After that, a catalogue is used to search for such information depending on the form of library classification. In other cases, individuals must go through different files and folders, searching for such information. However, information search and retrieval patterns work differently from the traditional system in electronic databases. This chapter is not aimed at comparing these systems but to discuss electronic databases, their evolution, advantages and disadvantages, the indexing processes and how indexed information can be assessed using a state-of-the-art approach. The emphasis of this chapter is on the Boolean operators due to their growing importance and utility in mining records from large databases or data warehouses. These operators allow for reducing or expanding the number of records returned. Boolean operators may save time by restricting the search scope and eliminating irrelevant results to users' needs.

Therefore, after reading this chapter, readers are expected to be able to: explain the meaning of electronic databases; discuss the evolution of electronic databases; define the term data mining; mention at least four advantages and disadvantages of electronic databases; describe electronic database search works; discuss the indexing processes of scholarly materials in an electronic database; make practical use of Boolean operators in retrieving literature materials from electronic databases.

ELECTRONIC DATABASES

Meaning

There is no universally accepted meaning for electronic databases due to variations in usage across disciplines, authors, time, and place. However, an electronic database can be defined as an organised collection of information that has been saved on one or more digital media. These materials can be textual or non-textual but are in digital forms to aid easy retrieval and consumption. Stored materials in electronic databases are accessible to users with authorisation and privileges. Electronic databases are used for storing, retrieving, and managing information on a broad range of subjects. Textual materials include books, journal articles, theses, dissertations, patents, conference proceedings, monographs, and other resources stored in digital forms. These resources can be accessed using electronic devices such as computers, smartphones and tablets. On this note, Koedinger et al. (2008) state that e-learning tools, instructional technology, the Internet, and institutional archives of student records have resulted in large data warehouses that educators may access. Therefore, electronic databases are treasures of knowledge discovery that can be investigated and used to help us understand how students learn (Mostow & Beck, 2006). It has also been stated that a large amount of data is available in electronic educational databases that may be used to make better management choices (Bala & Ojha, 2012).

Because of the drive toward open science or open access publications, electronic databases offer a rich variety of scholarly content beyond the offerings of traditional libraries. Besides, in contemporary times, big data has occasioned diverse forms of non-textual materials that can meaningfully be stored and accessed electronically. These may take the form of digitally stored audio, visual and audio-visual resources. Since storing and retrieving data from an electronic database is possible, a file system can house small archives on a personal computer. Still, a network of computers or cloud services is required for big repositories. Data structures, efficient information warehousing, programming languages, security/privacy of confidential documents, and networked computing challenges (such as concurrent access and power quality) are all aspects of database architecture. Examples of popular electronic research databases include Directory of Open Access Journals (DOAJ), Educational Resources Information Centre (ERIC), Google Scholar, IEEE Explore, Jstor, Phil Archive, ProQuest, PubMed, ResearchGate, ScienceDirect, Scopus, Web of Science, Mendeley and Zenodo.

Evolution of Electronic Databases

Before computers and databases were developed, every record had to be kept on paper in ancient times. Many lists, notebooks, ledgers, and archives full of tens of thousands, if not millions, of documents, are stashed away in file cabinets (Polding, 2018). Accessing these documents was a time-consuming process that required physical effort. Many issues arose, ranging from lost documents to fires that decimated whole archives, wiping away centuries of history for individuals, groups, and nations. Security issues arose because of the ease with which physical access might be gained. As technology and understanding advanced, whole book communities were consolidated into the first actual "database" (libraries). The primary goal of the libraries was to guarantee that records or information could be stored and accessed conveniently. There is a long-standing tradition in the library world of librarians serving in an intermediary role, whether it be as reference librarians (who help patrons find and use specific resources) or as the people who design the databases and other resources that make it possible for patrons to do just that (Calhoun, 2007). However, in today's increasingly linked Internet world, information searchers are more self-sufficient, using basic but powerful search engines like Google and expanding beyond library holdings in their hunt for information. This trend led to the surge in the development of different electronic databases hosting a diverse wealth of resources as a traditional library. Each electronic database contains a collection of files and records (UKEssays, 2018) that are carefully collected and curated to meet the needs of several users. The era of big data, characterised by a high volume, variety, value, veracity and velocity of information, ushered in the need for data mining strategies to locate the right information from electronic databases. Boolean operators are an important innovation that enables users to search for information from these large databases across the globe.

Advantages of Electronic Databases Over Manual Databases

- They promote inclusive access to hosted materials.
- Data entry and modification can be done with relative ease.
- They allow for automated data updating and recalculation.
- They are easily accessible compared with traditional archives, eliminating the cost of travelling long distances to physical libraries (Owan et al., 2021).
- Electronic databases can be shared with other software packages.
- Many people may use electronic databases through a network to eliminate duplication of information.

- Electronic databases provide many pre-programmed capabilities that make calculating data faster and easier.
- An electronic database can be easily backed up and recovered in events of theft, system failure, or system replacement.
- Large amounts of data can be stored in electronic databases.
- Querying, searching, filtering, and retrieving data from electronic databases is simpler than manual databases.
- Electronic databases can be easily protected using passwords for secure and authorised access.

Disadvantages of Electronic Databases

- All users and programmes are dependent on the availability of the database management software. Therefore, the failure of a single component might shut down the whole system.
- Setting up an electronic database is very expensive, depending on the kind of gear, software, and necessary functionality.
- To get the most electronic database, users must possess adequate knowledge. An organisation's success might be jeopardised by a lack of understanding of the system (Mukalele, 2019).'
- Switching to new software and hardware resources and training employees to utilise these new systems is expensive, as is the possibility of hiring specialised people to assist with conversion and system operation.
- Most database management systems are designed to cover a broader scope, not just for a single application. Consequently, certain applications or processes may not load or operate speedily.'
- Sometimes issues of Internet connectivity can deny you access to electronic database resources.
- Some electronic databases are not freely accessible since personal or institutional subscription access is required. Examples include Scopus, Web of Science core collection and subscription-based journals.
- Expensive devices such as computers and other mobile gadgets are required to access electronic databases, limiting inclusiveness to those who can afford them.
- Mobile bandwidth and internet subscriptions from Internet Service Providers (ISPs) are not free, making it difficult for some people to use electronically hosted materials consistently.

Indexing of Research Literature in Electronic Databases

The process of constructing indices for record sets is known as indexing. Metadata about published scholarly materials are stored in an electronic database through indexing. The aim is to enable accessors to identify records or files of interest quickly. Individuals may have to sift through hundreds or thousands of entries without proper indexing to find a single document. Indexing also refers to a collection of phrases, definitions, subjects, and other items ordered in alphabetical order to bring readers to the information they need conveniently. It aids the structuring of material so that readers can quickly identify documents of interest. In practice, scholarly work(s) publication begins with submitting a fully written research report. The submitted work(s) undergoes initial editorial assessment and perhaps peer review. Upon acceptance, the work is published and made public. Published works are stored in electronic databases to promote visibility and accessibility to readers. The publishers may own these databases, or they may be hosted externally hosted for widespread coverage and long-term sustenance.

However, the indexing of research literature begins after publishing a scholarly work. Nevertheless, other electronic databases (preprint servers) can index academic work before formal publication. Preprint databases promote the timely availability and use of research materials before the peer review process (Chung, 2020; da Silva, 2017; Okon & Ubi, 2021) or while they undergo peer review (Bassey & Owan, 2019). The indexer typically gets a batch of publication page prototypes for post-publication indexing when the work is undergoing final proofing. The indexer will need page duplicates to create a list of headings and subheadings (terms to be included in the index), as well as the position of each essential source. After the preliminary index is completed, it is adjusted for structure, legibility and coherence; formatted according to requirements, proofread and sent to the scholar/researcher as a final soft copy. Indexing takes time and is dependent on the length of the document. The more material a text has, the longer it will take to index. Occasionally, drawings, diagrams, photographs, or tables are often included during the indexing process. One research material can be hosted in multiple databases so long as there are no copyright infringement concerns associated with doing so.

How Searching Works in Electronic Databases

Once research materials are hosted in electronic databases and granted public accessibility, readers' retrieval of indexed information is another concern. In a typical analogue library, interested readers physically visit libraries. Documents are sourced manually using catalogues and library classifications with the help of metadata (such as subject heading, call number, author, and other publication properties). Searching for materials under the traditional system is Herculean and time-consuming. Besides, in cases where some materials are unavailable due to lending, interested users may have to wait until they are returned. On the contrary, the search for published materials in electronic databases is relatively seamless but requires the application of some strategies to get the desired results. In searching for electronically hosted materials, keywords and phrases are used, with shorter terms providing a larger pool of results. The reader must go through each search result to identify materials that match the information of interest. Several users can simultaneously access and utilise one file or document in electronic databases. However, experience has shown that most people do not understand how searching for materials in electronic databases works. As a result, they enter a long strand of phrases or sentences, hoping to get literature materials that exactly match their search.

Let us consider a hypothetical scenario where a doctoral student is working on a dissertation topic - *COVID-19 and Students' Use of Digital Platforms for Online Learning in Nigerian Public Universities.* Most students will enter the full dissertation topic as it is to an electronic database and expect to get an exact result. Unfortunately, the emerging results will be fewer and not likely to be precise. Most of the results will be based on different combinations or permutations of phrases or keywords from the topic. These might include works on *Covid-19 and Students*, *Covid-19 and digital platforms*, *Covid-19 and online learning*, etc. A query in an information retrieval system does not identify a unique item in a collection. Rather, numerous documents usually tally with search queries but at varying degrees of significance (Lashkari et al., 2009). Information retrieval systems typically assign a numerical score to each database item depending on how well it matches the search query. Afterwards, the user is presented with the top-ranked items. If users want to fine-tune their query, they may repeat the procedure or filter the results based on other attributes. This chapter introduces readers, especially early career researchers or emerging scholars, to the art of literature review using a data mining algorithm for more specific and meaningful results from electronic databases.

THE CONCEPT OF DATA MINING

Data mining is the act of pulling hidden information, unforeseen arrangement, and innovative guidelines from massive datasets or databases. It is a fundamental component of data warehousing and database knowledge discovery. According to Romero et al. (2010), data mining is focused on developing, analysing, and applying automated techniques for detecting patterns in big sets of educational data that would be exceedingly difficult to evaluate in person due to the massive number of records included. Because of the important role that data mining (from huge databases) plays, many scholars have identified it as a key part of emerging fields such as artificial intelligence, machine learning, database management, and data science. The use of data mining is also useful to many data-driven businesses (Ming-Syan et al., 1996; Romero & Ventura, 2012). As a result, biomining is gaining much attention in library and information science (Cheng & Liu, 2019; Liu, 2018; Fernandez-Morales & Bonilla-Carrión, 2020; Nicholson, 2006).

When data mining approaches are used to pull information from electronic databases in research and library science, it is generically referred to as 'text data mining.' This name is given because most published scholarly materials are usually in textual form, with some graphical contents usually embedded in them. However, textual data or materials retrieval is embedded in all associated graphic contents (like images, tables, diagrams). In some cases where audio, video, presentation or media files are associated with textual data, text data mining could be used to get secondary links to these media files. Text mining may be pursued when data mining techniques and methodologies extract knowledge from textual data formats. Several methods may provide important information individually or combined with other text data mining approaches. Text data mining has seen several successful applications in a variety of fields. However, several deep sentiment text analysis jobs remain unsolved (Yassir et al., 2020). The use of text mining or "text analytics" can enable users to extract useful information from textual materials. It is common to use text mining to categorise and cluster words and phrases, extract concepts and entities; provide comprehensive classifications; analyse sentiment; summarise publications; and model the mappings. This chapter describes a widely adopted approach to literature search – the Boolean operators. Although the Boolean operators are popular in review studies, only a few scholars have conceived of their application as a text data mining activity (Aboalsamh, 2008; Aoga et al., 2019; Arya, 2021; Bollmann-Sdorra et al., 2003, Ketenci & Gol, 2019; Lv, 2020; Mohesh, 2019; Nguyen, 2005; Pazhaniraja et al., 2020).

THE BOOLEAN OPERATORS

Boolean operators are one of the first data retrieval methods since it uses precise matching to locate documents that satisfy a user-inputted "query." The queries are matched against documents that contain the search terms. The adjectival term "Boolean" relates to the application of Boolean algebra, which entails the logical combination of words using the Boolean operations *AND*, *OR*, and *NOT* (Lashkari et al., 2009). Boolean *AND*, for example, signifies that both propositions x and y must be true. Since both claims are in Boolean *OR*, at least one of them must be true. Three Boolean operators may combine any number of logical assertions into one. On the contrary, the Boolean Model is a basic information retrieval method that utilises the set theory. In terms of which words are more essential than others, there is no evidence (weights are binary, either 0 or 1). Using set theory language in mathematics or probability, *AND* operator *intersects* two sets of words or phrases ($A \bigcap B$), OR unites two sets of words or phrases ($A \bigcup B$); while *NOT* is an inverse form of a set or the difference between two sets.

Search engines, databases, and online catalogues may benefit from Boolean instructions. Boolean operators *AND*, *OR*, and *NOT* are the most often used in data mining from electronic databases. Parentheses, truncation, and phrases are some of the other available operations. The use of Boolean Operators for the inclusion, combination or exclusion of keywords or phrases in a search yields more systematic and accurate results. This reduces the time and effort spent searching for literature by minimising the number of entries that must be reviewed before being dismissed. Using these operations may minimise or increase the number of records returned. Boolean operators can promote time-saving by restricting queries to include only relevant results while removing irrelevant ones. Some databases and search engines uniquely use Boolean operators, whereas others need upper case letters or punctuation. Some databases (e.g., Google) also automatically insert Boolean operators for users where they are not used. This is done by attempting to guess the user's intention. However, for effective and optimal results, users should give appropriate commands of their intentions to the database rather than rely on guessed or random assignments of operators (that are often invisible). The automatic insertion of Boolean operators may yield undesired results since the database does not understand people's intentions. Sadly, this happens in natural language search, where many users enter their search phrases casually while searching for materials.

Types of Boolean Operators

AND Operator

The *AND* operator demands that all words appear in each item returned. The item is excluded from the resultant list if one word appears in the text but the other does not. The *AND* operator narrows the search scope because the combination in the search string must all be present in the document. For example, a search on *Research AND Productivity* will provide results including both words. Any document that mentions *Research* but has no mention of *Productivity* is not included, and vice versa. The *AND* operator can handle many search queries or pairs beyond just two words. For example, a search might look like this *Mentorship AND* "*Research Productivity*" *AND Nigeria*. This search string will only bring out documents that contain the three phrases or terms in no order of permutation. This can be used by a researcher interested in getting literature materials on mentorship and research productivity but focusing on Nigerian studies or authors. If a document contains only two of these terms (for instance, *"Research Productivity" and Nigeria* but no *Mentorship*), it is not included in the search results.

OR Operator

The *OR* operator restricts search results to include all the keywords presented in the search string or phrase entered by the user. It expands the scope of search results, unlike the *AND* operator. The *OR* operator is used in cases where a targeted keyword has other synonyms that are of interest to the user and which other scholars may have used. For instance, if the target phrase is the word "*teacher*", a researcher may be interested in including other related terms such as "*instructor*", "*foster parent*", "*schoolteacher*", "*tutor*", "*pedagogue*", and so on to the search results. These terms must be preceded with the word *OR* (preferably in capital letters) to use the *OR* operator. For example, the search string *Teacher OR Mentor* will yield results of all documents in the database containing either "teacher" or "mentor" or both.

NOT

The first phrase is searched when this operator is used, but records including the term placed after the operator are removed from the results. A search that attempts to be more specific but excludes relevant results might be harmful. There are several ways to make searches using the *NOT* operator, including double quotes (" "). For example, a search string "*Library Science*" *NOT* "*Library Studies*" will include all documents containing the phrase *Library Science* but exclude those containing the phrase *Library Studies*. Just as the *OR* operator is used to capture related terms, the *NOT* operator may be used to refine search results by excluding unwanted associated terms. The *AND NOT* operation can perform the same function as the *NOT* operator.

Double Quotation Marks ("…")

This operator is used to enclose a word or phrase so that exact matches are returned in the search results. In a normal search situation (natural language search), typing a group of words (phrases or sentences) may bring several unwanted results for each term in the expressions. This usually leads to search results containing irrelevant or unwanted documents. However, when quotation marks are wrapped around a group of words, the search result must be confined to produce documents containing the phrase in the same order as they appear in the search string. For example, searching for the phrase *Service Delivery* (without quotation marks) can result in either one of *Service*, *Delivery* or *Service Delivery*. The research results might be unnecessary to a researcher interested in literature materials with the mention of the phrase *Service Delivery* and not the other two. The phrase must be placed within the quotation mark to restrict the search to only documents containing the exact expression. That is, *"Service Delivery."*

Parenthesis ()

Search results will be more relevant to the subject if parenthesis is used to encapsulate search strings. Search engines typically implement the parentheses-enclosed search phrases and then execute the rest of the sentences. Example: A search on ("*Data Mining" OR "Data Warehousing") AND "Information Retrieval"* returns articles containing *Data mining* and *information retrieval*; *Data warehousing and information retrieval*; but does not produce documents on *Data mining* or *Data warehousing* when *information retrieval* is not mentioned.

Asterisk (*)

The asterisk is a truncating Boolean operator, usually appended after a word. It is mostly used to get different word forms that other writers may have used. This can be used to obtain related or alternative forms of keywords such as plural, nouns, verbs or adjectives of a word. Unlike other Boolean operators mostly used as conjunctions, the asterisk is usually placed after a truncated keyword but can also be placed before a keyword. When placed after the root word, the search result will yield materials containing both the root word and other possible extensions that can complete the truncated part of the keyword. In other words, the asterisk is attached after a stem word to search for documents containing other words that have that stem and beyond. Therefore, the user will receive results with various endings, but the stem remains present. For example, searching for *Fact** will yield results of documents containing the word *Fact* and others extending from it (such as *facts, factful, facticity, faction, factiously, factitious, factitive, factoid, factorable, factorial, factories, factorise, factors, facts, factual* and so on). As you will have noticed, the stem word (*fact*) is contained in each resulting result but with different modifications after the root word. When the asterisk is used before the stem word, the search result is almost the same as putting the search string in double quotation marks.

The Minus Sign (–)

The minus sign is used primarily to obtain accurate search results by eliminating unwanted documents. The elimination is done by filtering out unwanted keywords (noise) from an initial search result, leading to refined results. For instance, an initial search of the string "*Teachers' effectiveness*" on the Google Scholar database yielded results containing the search string but with other keywords (noise) such as *students, students' academic performance*, etc. Let us assume that we are not interested in documents discussing *teachers' effectiveness* in the context of *students* or *students' performance*. Then the use of the minus sign can enable us to eliminate further documents that mention *teachers' effectiveness* and *students'* or *students' performance*. To do this, we will enter the search string as (*"Teachers' effectiveness" -students*) or *("Teachers' effectiveness" -students' performance*) depending on whether we are eliminating *students* or *students' performance*. There is one space after the closing quotation before the minus sign, and there is no space after the minus sign.

Using File Extensions

A file extension is a suffix that comes after the title of a document, usually after a full stop (.) sign. It helps us identify a file type and the difference between classes of files. Normally, a full stop (period) separates the extension from the remainder of the filename, although, in other systems, it is separated by spaces. Very popular file extensions include *.mp3* (for music files), *.docx* (newer versions of Microsoft Word documents), *.xlsx* (newer versions of Excel documents), *.pdf* (for portable document files), *.html* (for hypertext mark-up language files), *.mp4* (for video files), *.exe* (for windows executable files), *.pptx* (for PowerPoint files), *.txt* (for text files) and so on. After the search string, the extension of interest is added to use file extensions for mining data from electronic databases. Doing this will restrict the search only to bring out documents containing the keywords of interest but of a particular file format. For example, if you are interested in getting only PDF files that mention the phrase *Research Metrics*, you should enter the search string *"Research metrics" .pdf* into the database. The search result will be all PDF documents containing the phrase *Research Metrics*; other document types such as HTML, Text files and so on will be excluded. Therefore, the use of file extensions narrows search results.

Double period or ellipsis (..)

The double period is used to restrict search results of a keyword or search phrase to a range of periods. This can be very useful for researchers writing review articles or individuals seeking to narrow their search to a period. It can also be useful to students working on a thesis with a specified date range of expected references. When a range is specified, search results will omit documents outside this range, resulting in a more refined search. For example, a researcher can use the search phrase "Teachers' effectiveness" 2017.2022 to get documents that talk about *teachers' effectiveness* published in 2017, 2018, 2019, 2020, 2021 and 2022. Works published earlier are not included in the search results. Although this may not work in all databases, it works well in the Google search engine. However, other databases such as Scopus, WoS, and Google Scholar, have handy filters that can enable you to restrict your search results.

Title Search

The title search allows users to search for keywords primarily found in the title of a document. This approach is useful for refining search queries to provide the desired keyword or phrase results only when included in the title. To use the title search, the word "*TITLE*" (without quotes and preferably in capital letters) must be entered first, followed by a parenthesis containing the keyword or phrase of interest. The result will include only documents carrying that keyword or search string in the title. For example, searching for *TITLE (Self-esteem)* will provide results of all documents containing the word *self-esteem* in the title. Unlike other operators that can yield results, if inputted keywords are found in the document's body, title search restricts search results to only document titles. From experience, the description of a document or record transcends its title to other areas, such as abstract and author keywords. However, these important sections are ignored when the title search is used. Besides, writers will sometimes employ a catchy title to attract their readers' attention. Sadly, enticing titles are not always sufficient to communicate the main text's focus. Therefore, users should always be sure of what they are looking for before using the title search. This does not imply that a title search is unimportant; it only increases the chances of missing important records, although it can provide more accurate or direct results of a user's search. The ideal application of a title search is to identify known records in an electronic database.

Author Search

The author search is an important way of checking out an author to keep track of what they are publishing or their recent publications. Maybe you met a friend or colleague with the same research interest at a conference. If you want to know about their publication history, perhaps for a potential collaboration, the author search can enable you to achieve that. The author search is used to locate documents or records about an author of interest. The author search can be used primarily in two ways: (1) to locate all the documents by an author in a database and (2) to locate specific documents of an author in a database. To locate the documents of an author in a database, a user needs to specify the command, followed by the name of the full name of the author or other possible variants in quotes. This can be performed by entering the command *Author: "Name of the author"*. There is no need for a search keyword or phrase other than the author's name in question to do this. For example, a user interested in locating all the documents of the author Valentine Joseph Owan could enter the command *Author: "Valentine Owan" OR "V Owan" OR "VJ Owan" OR "Valentine Owan" OR "Valentine Joseph Owan" OR "Owan Valentine Joseph" OR "Owan VJ"*. Note that all the possible name variants of the author have been used with the *OR* operator (previously discussed) to broaden the search into capturing documents where these different name variants may have been used for the same author.

In the second case, if a user is familiar with an article or a document of an author and wishes to locate the exact document, the author's name must be combined with the work's title or keywords. In cases where the full title is forgotten, the author's name with a keyword or search phrase of the document in question could be used. For example, a user is interested in locating an article on *research productivity* written by *Valentine Owan* but cannot remember the work's full title again. An author search could identify the work, including the recalled phrase. In the example above, the user can search for all documents written by *Valentine Owan* containing the phrase *research productivity* by entering the command *Author: "Valentine Owan" AND "research productivity"*. Note that the *AND* operator intersects the author's name with the search phrase, refining the search to the most relevant or related documents. Another way is to enter the command *"research productivity" author: "Valentine Owan"*. This will yield the same results as the previous string. To be more thorough in the search, a user may wish to combine two more author name variants alongside the keyword or phrase. For example, "*research productivity" Author: Author: "Valentine Owan" OR "Valentine Joseph Owan" OR "Owan Valentine Joseph."* Alternatively, the *AND* operator can also be used to achieve the same result such as "*Author: Author: ("Valentine Owan" OR "Valentine Joseph Owan" OR "Owan Valentine Joseph") AND "research productivity"*.

Limitations of Boolean Operators in Accessing Research Literature

- The search is only restricted to documents available in a database. This implies that it cannot provide search results for works not indexed in the database.
- They do not guarantee that search results will always be useful to the researchers. Therefore, the user requires screening and filtering to identify relevant works and ignore unnecessary documents.
- For effective use, sufficient proficiency is required. This implies that individuals must master the art of using these operators for effective leverage.
- No matter how individuals filter their searches using Boolean operators, there will always be noise (unwanted results) in search results. This means that individuals should check through each search result carefully before selection.
- Even though they assist in finding relevant documents through a refined search, it does not indicate which search results are more important than others. Therefore, the user still needs to select useful information through individual search results.
- While they can work very well for some offline electronic databases (Mendeley and Windows Explorer), their use is predominantly Internet-based. Therefore, Internet access is required to connect to online electronic databases.
- In cases where different synonyms are enclosed in parenthesis and separated with the OR operator, equal opportunity is not given to these synonyms. Usually, the last keyword or search string in the series of synonyms receives the greatest priority. Therefore, users should remove the last keyword after each assessment and selection round before searching again to optimise search results.

CONCLUSION

This chapter discussed the concept of electronic databases and how to access scholarly literature materials from electronic databases. Special attention was given to using Boolean operators as a data mining algorithm in refining the search results from electronic databases for optimisation purposes. Different Boolean operators were described and how they can be used in accessing scholarly materials. In conclusion, electronic databases are very useful and will be the future of literature review, especially as many traditional libraries are gradually gaining an online presence. Furthermore, the fact that many journals, books, and conference proceedings are slowly taking electronic forms suggests an urgent need for effective strategies to mine these resources from different databases. The knowledge and use of Boolean operators might become unavoidable in enabling researchers to locate relevant materials for their projects. However, while Boolean operators can be used individually, a combination of different operators can be implemented for more refined search results from electronic databases. Therefore, researchers, scholars, and scientists should practice the art of using (a combination of) Boolean operators for optimal results. This chapter is useful to all scientists, researchers and scholars, especially those without advanced Internet searching skills.

REFERENCES

Aboalsamh, H. A. (2008). A novel Boolean algebraic framework for association and pattern mining. *WSEAS Transactions on Computers*, *7*(8), 1352–1361. https://dl.acm.org/doi/abs/10.5555/1457999.1458022

Aoga, J. O., Nijssen, S., & Schaus, P. (2019). Modelling pattern set mining using boolean circuits. In T. Schiex & S. de Givry (Eds.), *Principles and practice of constraint programming* (pp. 621–638). Springer. doi:10.1007/978-3-030-30048-7_36

Arya, U. (2021). Reshaping the Paradox of Information Power and Overload: Data Mining Strategies for Knowledge Workers. *IUP Journal of Information Technology*, *17*(1), 33–52. doi:10.1007/3-540-44801-2_3

Bala, M., & Ojha, D. B. (2012). Study of applications of data mining techniques in education. *International Journal of Research in Science and Technology*, *1*(4), 1–10. https://bit.ly/3pd81Ee

Bassey, B. A., & Owan, V. J. (2019). Ethical Issues in Educational Research. In P. N. Ololube & G. U. Nwiyi (Eds.), *Encyclopedia of institutional leadership, policy, and management: A handbook of research in honour of Professor Ozo-Mekuri Ndimele* (Vol. 2, pp. 1287–1301). Pearl Publishers International Ltd. doi:10.13140/RG.2.2.11785.88161

Bollmann-Sdorra, P., Hafez, A., & Raghavan, V. V. (2003). A theoretical framework for association mining based on the Boolean retrieval model. In Y. Kambayashi & W. Winiwarter (Eds.), *Proceedings of the Third International Conference on Data Warehousing and Knowledge Discovery* (pp. 21–30). Springer-Verlag Berlin. https://dl.acm.org/doi/abs/10.5555/646110.679436

Calhoun, K. (2007). Being a librarian: Metadata and metadata specialists in the twenty-first century. *Library Hi Tech*, *25*(2), 174–187. doi:10.1108/07378830710754947

Cheng, Y., & Liu, Q. (2019). Process and application of data mining in the university library. In *2019 IEEE 4th International Conference on Big Data Analytics (ICBDA)* (pp. 123-127). IEEE. 10.1109/ICBDA.2019.8713202

Chung, K. J. (2020). Preprints: What is their role in medical journals? *Archives of Plastic Surgery*, *47*(02), 115–117. doi:10.5999/aps.2020.00262 PMID:32203987

da Silva, J. A. T. (2017). The preprint wars. *AME Medical Journal*, *2*(74), 74. Advance online publication. doi:10.21037/amj.2017.05.23

Fernandez-Morales, M., & Bonilla-Carrión, R. (2020). Bibliomining, data, and the decision-making process. *Revista Interamericana de Bibliotecología (Inter-American Journal of Library Science)*, *43*(2), Article e4. doi:10.17533/udea.rib.v43n2eI8

Ketenci, A., & Gol, E. A. (2019). Synthesis of monitoring rules via data mining. In *2019 American Control Conference (ACC)* (pp. 1684-1689). IEEE. 10.23919/ACC.2019.8815002

Koedinger, K., Cunningham, K., Skogsholm, A., & Leber, B. (2008). An open repository and analysis tools for fine-grained, longitudinal learner data. In R. S. J. de Baker, T. Barnes, & J. E. Beck (Eds.), *Educational data mining: The 1st International Conference on Educational Data Mining* (pp. 157–166). Computer Science Bibliography. https://dblp.uni-trier.de/db/conf/edm/edm2008.html#KoedingerCSL08

Lashkari, A. H., Mahdavi, F., & Ghomi, V. (2009). A Boolean model in information retrieval for search engines. In *2009 International Conference on Information Management and Engineering* (pp. 385-389). IEEE. 10.1109/ICIME.2009.101

Liu, M., Wan, C., & Wang, L. (2004). A fuzzy logic approach for content-based audio classification and Boolean retrieval. In *Fuzzy Logic and the Internet* (pp. 135–156). Springer. doi:10.1007/978-3-540-39988-9_7

Liu, Y. (2018). Data mining of university library management based on improved collaborative filtering association rules algorithm. *Wireless Personal Communications*, *102*(4), 3781–3790. doi:10.100711277-018-5409-y

Lv, S. (2020). Construction of marine ship automatic identification system data mining platform based on big data. *Journal of Intelligent & Fuzzy Systems*, *38*(2), 1249–1255. doi:10.3233/JIFS-179487

Chen, Han, & Yu. (1996). Data mining: An overview from a database perspective. *IEEE Transactions on Knowledge and Data Engineering*, *8*(6), 866–883. doi:10.1109/69.553155

Mohesh, G. (2019). PubMed Data Mining using AI-Based Qinsight Platform. *International Journal of Clinical and Experimental Physiology*, *6*(1), 33–34. doi:10.5530/ijcep.2019.6.1.8

Mostow, J., & Beck, J. (2006). Some useful tactics to modify, map and mine data from intelligent tutors. *Natural Language Engineering*, *12*(2), 195–208. doi:10.1017/S1351324906004153

Mukalele, R. (2019 October 24). *Manual vs electronic databases: Advantages, disadvantages and features*. https://bit.ly/376AMwx

Nguyen, H. S. (2005, August). Approximate Boolean reasoning approach to rough sets and data mining. In D. Ślęzak, J. T. Yao, J. F. Peters, W. Ziarko, & X. Hu (Eds.), *Rough sets, fuzzy sets, data mining, and granular-soft computing* (pp. 12–22). Springer. doi:10.1007/11548706_2

Nicholson, S. (2006). The basis for bibliomining: Frameworks for bringing together usage-based data mining and bibliometrics through data warehousing in digital library services. *Information Processing & Management*, *42*(3), 785–804. doi:10.1016/j.ipm.2005.05.008

Okon, A. E., & Ubi, I. O. (2021). Awareness and utilisation of *PsyArXiv* for the dissemination of research preprints among psychology scholars in universities. *Library Philosophy and Practice (e-journal),* Article 5870. https://digitalcommons.unl.edu/libphilprac/5870

Owan, V. J., Asuquo, M. E., Makuku, V., & Etudor-Eyo, E. (2021). The extent of online platforms utilisation for scholarly research dissemination: A survey of academic staff in African Universities. *Library Philosophy and Practice (e-Journal),* Article 5585. https://digitalcommons.unl.edu/libphilprac/5585

Pazhaniraja, N., Sountharrajan, S., & Sathis Kumar, B. (2020). High utility itemset mining: A Boolean operators-based modified grey wolf optimisation algorithm. *Soft Computing*, *24*(21), 16691–16704. doi:10.100700500-020-05123-z

Polding, R. (2018, August 31). *Databases: Evolution and change*. https://bit.ly/3E1Oyg7

Romero, C., & Ventura, S. (2012). Data mining in education. *Wiley Interdisciplinary Reviews. Data Mining and Knowledge Discovery*, *3*(1), 12–27. doi:10.1002/widm.1075

Romero, C., Ventura, S., Pechenizkiy, M., & Baker, R. S. (Eds.). (2010). *Handbook of educational data mining*. CRC Press. doi:10.1201/b10274

UKEssays. (2018). *The Evolution of Database Management System*. Retrieved from https://www.ukessays.com/essays/information-technology/the-evolution-of-database-management-system-information-technology-essay.php?vref=1

Yassir, A. H., Mohammed, A. A., Alkhazraji, A. A. J., Hameed, M. E., Talib, M. S., & Ali, M. F. (2020). Sentimental classification analysis of polarity multi-view textual data using data mining techniques. *Iranian Journal of Electrical and Computer Engineering*, *10*(5), 5526–5534. doi:10.11591/ijece.v10i5.pp5526-5534

ADDITIONAL READING

Ali, T. S., & Ali, R. (2020). A new chaos based color image encryption algorithm using permutation substitution and Boolean operation. *Multimedia Tools and Applications*, *79*(27), 19853–19873. doi:10.100711042-020-08850-5

Daei, A., Soleymani, M. R., Ashrafi-Rizi, H., Zargham-Boroujeni, A., & Kelishadi, R. (2020). Clinical information seeking behavior of physicians: A systematic review. *International Journal of Medical Informatics*, *139*, 104144. doi:10.1016/j.ijmedinf.2020.104144 PMID:32334400

de Mello, L. M., & Galvão, M. C. B. (2022). Searching for health information for academic and clinical purposes: Possibilities and challenges. *Research*. *Social Development*, *11*(3), e41011326726–e41011326726. doi:10.33448/rsd-v11i3.26726

Flywel, D., & Jorosi, B. N. (2018). Information literacy skills among the undergraduate students at the University of Livingstonia, Malawi. *International Journal of Library and Information Services*, *7*(2), 43–56. doi:10.4018/IJLIS.2018070104

Khurshid, Z., Tariq, R., Asiri, F. Y., Abid, K., & Zafar, M. S. (2021). Literature search strategies in dental education and research. *Journal of Taibah University Medical Sciences*, *16*(6), 799–806. doi:10.1016/j.jtumed.2021.05.012 PMID:34899122

Landøy, A., Popa, D., & Repanovici, A. (2020). In A. Landøy, D. Popa, & A. Repanovici (Eds.), *Accessing Information BT - Collaboration in Designing a Pedagogical Approach in Information Literacy* (pp. 39–55). Springer International Publishing. doi:10.1007/978-3-030-34258-6_4

Leung, B. T. H., Xie, J., Geng, L., & Pun, P. N. I. (2019). In B. T. H. Leung, J. Xie, L. Geng, & P. N. I. Pun (Eds.), *Information Search Strategies BT - Transferring Information Literacy Practices* (pp. 11–14). Springer Singapore. doi:10.1007/978-981-13-7743-3_2

Liu, J., Zamir, H., Li, Y., & Hastings, S. K. (2018). Search systems and their features: What college students use to find and save information. *Library & Information Science Research*, *40*(2), 118–124. doi:10.1016/j.lisr.2018.06.002

Lwehabura, M. J. (2018). An assessment of information literacy skills among first-year postgraduate students at Sokoine University of Agriculture Tanzania. *Journal of Librarianship and Information Science*, *50*(4), 427–434. doi:10.1177/0961000616667802

Salvador-Oliván, J. A., Marco-Cuenca, G., & Arquero-Avilés, R. (2019). Errors in search strategies used in systematic reviews and their effects on information retrieval. *Journal of the Medical Library Association: JMLA*, *107*(2), 210. Advance online publication. doi:10.5195/jmla.2019.567 PMID:31019390

Scells, H., Zuccon, G., Koopman, B., & Clark, J. (2020, April). Automatic Boolean query formulation for systematic review literature search. In *Proceedings of The Web Conference 2020* (pp. 1071-1081). 10.1145/3366423.3380185

Tella, A., Oyeniran, S., & Ibironke, E. S. (2021). Determinants of Web Search Effectiveness From the Perspective of Library and Information Science Students. *International Journal of Library and Information Services*, *10*(2), 1–15. doi:10.4018/IJLIS.20210701.oa13

KEY TERMS AND DEFINITIONS

Data Mining: Data mining is the process of seeking patterns in large databases and extracting relevant information using machine learning or algorithmic and database techniques.

Electronic Databases: An "Electronic Database" is a computer-maintained collection of data such as peer-reviewed journal papers, dissertation, books, and others, with searchable areas.

Indexing: Indexing is the process of using index words or other symbols to identify, summarise, or otherwise improve the discoverability of a document's content.

Information Search: This is the process of making conscious efforts to use systematic procedures in going through a large amount of information to locate those that are interesting.

Library: This is a room, series of rooms, or a structure where books may be read or loaned.

Literature: Literature refers to publications in fields such as the natural, behavioural, management, library, and social sciences or humanities that give new empirical or theoretical information for scientific progress or problem resolution.

Metadata: Metadata are records that explain other material, giving a systematic guide that aids in classifying and identifying the characteristics of the material it represents.

Operator: An operator is often a linkage or expression that converts items from one domain into elements from another.

Publications: This refers to the total amount of scholarly works in form of journal articles, theses, book chapters, books among others, that an author/researcher/scientist has contributed to the literature. It also refers to the total number of documents made publicly available by a publishing firm at any given time.

Research: Research refers to any work aimed towards increasing the body of existing knowledge, conducted in a methodical and innovative manner. It is also the process of gathering, organising, and analysing data to better understand a subject or situation.

Search String: A search string is a set of keywords carefully combined with Boolean operators or truncation symbols to improve the chances of individuals locating the desired digital record from an electronic database.

Chapter 10
Adoption of Institutional Repositories Towards Realization of Digital Libraries:
The Southern African Perspective

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ABSTRACT

Dissemination of the literature is crucial in scholarship for it to meaningfully contribute to development. The establishment of the Open Archives Initiative and the BOAI transformed the scholarly communication landscape. Open access institutional repository (IR) is one innovative technology through which scholarly literature can be made freely available and accessible to the public. Academic libraries across the globe, including Africa, embraced and established IRs to enable cost-free access to their institutional research output on the internet, thus increasing its global visibility and reach while ensuring long-term preservation of the intellectual output. This chapter explores the role of open access repositories in enhancing access to information and knowledge generation in academic libraries, catalogues the success of IRs in Southern Africa, and ascertains the challenges faced by universities in Southern Africa in the establishment and management of IRs.

INTRODUCTION

Dissemination of research literature is a crucial element in scholarly communication for the literature to meaningfully contribute to socio-economic development of nations. Socio-economic development relies on increased distribution and access to knowledge and information to a wider audience to promote

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active participation of researchers in scholarly communication discourse as they share ideas, opinions, and discoveries. Concern has been raised over the low visibility of intellectuals and scholars from Africa (Abrahams et al., 2010). The reasons for their global absence include, that many of them are not able to publish their works in international journals and monographs produced by the world's leading commercial publishers (Molteno, 2016; Chan, Kirsop & Arunachalam, 2011; Kotecha & Perold, 2010), works published in journals and books from developing countries are largely not indexed in major international databases such as the Arts and Humanities Citation Index. These challenges are amplified by the failure of academic libraries to sustain journal subscriptions and purchase of monographs to support research efforts of intellectuals and researchers in their institutions due to constrained budgets (Tapfuma & Hoskins, 2021). As a result, annual cancellations of journal and monograph subscriptions and purchases have become common practice (Siler, 2017). Moahi (2009) opines that the African continent's major weakness has been its failure to acquire and apply knowledge for development. Commercial publishers impose subscription and copyright restrictions which curtail knowledge sharing and wider dissemination of scholarship. As a result, critical and relevant information and knowledge generated by researchers from the African continent published in international journals oftentimes is inaccessible to the intended beneficiaries who should generate solutions for problems bedeviling the region. Johnson et al., (2018) confirm that deterrents to information access potentially result in substantial non-productive activity by researchers and knowledge workers and missed opportunities. Documented barriers to access include, pricing and cost of journals, journal articles and books, lack of awareness of available resources, and cumbersome purchasing procedures.

The open access movement ushered into the scholarly communication system a new dimension to distribution and access to scholarship by making it freely available to all potential users as pre-prints and post post-prints. The aim of this chapter is to explore the strides made by universities in Southern African countries in adopting open access institutional repository platforms to collect, preserve, facilitate broad sharing and circulation of research output from the institutions to a global audience (Tapfuma & Hoskins, 2020). To circumvent the information access restrictions imposed by commercial publishers and promote cost free access to published and unpublished scholarly literature produced by scholars within institutions, many universities in Africa have established open access repositories. Through open access, knowledge and information that has been hidden in offices (grey literature) or in inaccessible platforms can potentially be exposed to intended beneficiaries to promote scholarly discourse, discovery and generation of new knowledge leading to socio-economic development of the continent (Tennant et al., 2016). Though IRs disrupted the traditional working culture of librarians their potential advantages outweigh their challenges. The COVID-19 pandemic has amplified the need for libraries to adopt innovative technologies to facilitate increased remote access to research literature. Governments, across the globe, imposed lockdown measures which compelled companies and institutions to close, and everyone had to work from home; physical access to libraries by scholars for research was restricted as most institutions also closed their libraries and began to offer their services remotely (Tsekea & Chigwada, 2021). The chapter explores the role of open repositories in enhancing access to information and knowledge generation by academic libraries, catalogues success of IRs in Southern Africa and explores challenges faced by universities in Southern Africa in establishing and managing IRs.

Figure 1. Map of Southern Africa
(Albatros Adventure Marathon, n.d)

Africa's Research Performance

The first university in the world was founded in Africa in CE 859 (University of Al-Karaouine) at Fez in Morocco, followed by Al-Azhar University in Egypt - founded in 970 (Adams et al., 2010). Despite this fact Africa lags behind in the world of scholarly publishing and its intellectual output record is not highly visible as scholars from the region experience difficulties getting their works accepted in international journals. International publishers consider their works to be only of local or regional value and in their opinion fail to meet the quality standards required by the major commercial indexes (Chan et al., 2011). Where they manage to publish in international journals, oftentimes they are unable to purchase or subscribe to the journals to access their work, thus even hindering circulation of the research within the country and the continent at large.

The Web of Science is highly regarded by the scholarly community as the yardstick for measuring international visibility of research output though it tends to disregard journals produced in developing countries. This has contributed to the citation and reputation divide in the global south where only a few scholars almost exclusively publish in international journals which are indexed in the Web of Science (WoS), while the rest of the scholars are inclined toward publishing in local and regional journals covering topics of interest to the local readership (Chan et al., 2011). However, a strong growth in research output has been registered globally with Africa showing a positive increase in research output as well but compared to global output its performance remains low. From 2008 to 2014 the number of papers published from the region increased from 27,000 to 33 282 papers (Adams et al., 2010; UNESCO Science Report, 2015), a 60.1% rise. So, on the global landscape Africa's research output shifted from 2% to 2.6% between 2008 and 2014 (UNESCO Science Report, 2015, p. 36). Plotting Africa's research output by counting papers which had at least one author residing on Africa, Tijssen and Winnik established that research output in Africa by 2007 constituted 1.9% of world output which increased to 3.1% by 2017 (as cited in Nordling, 2018). Research output from Southern Africa according to the Web of Science (2019) amounts to 363,742 papers as shown in Table 1 below.

The Ranking Web of Universities lists South African universities in the top ten (10) of rankings in Africa and they appear in the top 900 of the world ranking, while other African universities are lowly ranked. On the world ranking, the University of Cape Town is on number 264 followed by the University of Witwatersrand on number 382, the University of Zimbabwe is on number 2057 and the University of Botswana on number 2435. It is worthwhile to note that South Africa has a track record of attracting enrollment of postgraduate students from countries across the African region (Trotter et al., 2014) compared to other African universities. The statistics reflect a low visibility of African research and

Table 1. Southern Africa's research output

Country	Research Output
Botswana	6,824
eSwatini	1,184
Lesotho	785
Malawi	9,019
Mozambique	4,350
Namibia	3,652
South Africa	325,456
Zimbabwe	12,472
Total	**363,742**

(Web of Science, 2019)

researchers in global scholarly discourse. This implies that the region's research performance is below expectation if the potential contribution of researchers in the continent is to be realized for the benefit of its populations. However, it should be noted that citation indexes have only been able to capture the few visible publications from the region and may exclude all the publications in the countries represented since the output may be scattered in other varied outlets (Rotich, 2011; Trotter et al., 2014). As a result, they miss the opportunity of being measured in the prestige-based indices, thus reducing visibility of African research output.

Some research works (grey literature, theses and dissertations) gather dust in offices after the knowledge creators fail to publish them due to high rejection rates from international journals. In addition, journals published in the region often fail to consistently publish or remain in existence, resulting in scholars losing confidence and trust in them (Abrahams et al., 2008). Hence, the generated knowledge and information hidden in varied outlets and offices are not applied or put to good use and chances of replication of the same research are high (Motleno, 2016). Africa's research therefore, remains underutilised, under-cited and undervalued in global and African research networks (Tapfuma & Hoskins, 2019a). Universities and researchers in Africa lacked a communication strategy in their approach to distribution of scientific findings and therefore some have taken advantage of information communication technologies and Web 4.0 technologies, to reach a broader global audience with the intellectual capital of their researchers and scholars and to collect, archive and preserve it for use in the future (Trotter et al., 2014). The twenty–first century transformations of scholarly communication present numerous opportunities to scholarly publishing in Southern Africa. Digital publishing, preservation of information and quick access to scholarly literature are all being made possible by new developments in ICTs. Therefore, adoption of open access (OA journals, articles, books and open digital repositories) to communicate Africa's research will contribute immensely to its visibility, reach and impact.

THEORETICAL FRAMEWORK

Adoption and usage of technologies in academic institutions for collection development, knowledge sharing, preservation and dissemination can best be understood through technology acceptance theories and model. The Unified Theory of Acceptance and Use of Technology (UTAUT) was adopted to explain usage of institutional digital repositories by institutions of higher learning in Southern Africa. The UTAUT model was developed by Venkatesh et al., (2003) who theorised that an individuals' intention to use technology is influenced by four constructs, namely, performance expectancy (refers to benefits accrued from using the technology), effort expectancy (perceived ease of use of the system), social influence (norms, beliefs and values of a social group or peers) and facilitating conditions (policies, training, resources, and infrastructure which support use of digital repositories). Successful implementation and use of IRs requires concerted efforts from the various stakeholders in the institutions who include, university management, academics and researchers, research administrators, and librarians for the institutions to obtain a return on their investment in research and IR infrastructure development.

DIGITAL LIBRARIES

The role of a library has traditionally been of collecting, storing, preserving, organising, and disseminating information in the form of printed books, monographs, and journals. Hobohm (2012) describes a digital library as a four-tiered organism whose function includes storage, usage by clients, administration (cataloguing, collection development), and offer direct access to information resources in digital form through remote access. Therefore, a digital library offers access to a digital world outside its own walls. "It is a facility for remote resource storage which requires an instrument to be used, even though access is immediate" (Hobohm, 2012, p. 219). The fact that digital libraries are into digital preservation of resources demonstrates their thrust towards archival of information and immediate publication and access to the resource upon its integration into the library system. Digital library information infrastructure comprises several elements which include a database. The traditional library card and online catalogues form the foundation of a digital library. The modern digital library database is a complex mix of items which include "electronic citations to the library's holdings (print, microform, video, graphic, and digital) and those located remotely. The database also contains full text materials in digital form (Tebbells, 1999).

A wide range of digital platforms have been adopted by academic libraries to enhance their services provision and ensure customer satisfaction, namely, databases which offer access to electronic journals, journal articles and electronic books (Ebsco host, Emerald, African journals online, Cambridge journals etc.), electronic theses and dissertations databases and institutional repositories. In addition, social media platforms are also being utilised by the digital libraries to reach out to clients, e.g., Facebook, Twitter, Linkedin, Youtube and blogs among others (Tsekea & Chigwada, 2021). These platforms offer users remote access to the library and its resources in distance education, thus, rendering the library a resource centre without walls or boundaries since it is accessible from anywhere at any time to meet the library user needs. The adoption and use of open access institutional repositories by academic libraries in Africa and the world at large is a huge milestone towards realisation of digital libraries. This chapter explores the adoption and use of institutional repositories in institutions of higher education in Southern Africa.

OPEN ACCESS INSTITUTIONAL REPOSITORIES

The worldwide web has caused significant transformations to the scholarly communication network by facilitating open access to scientific knowledge through information communication technology infrastructure. Leveraging on this development and the opportunities it offers, open access publishing systems have significantly revolutionized scholarly publishing to electronic scholarship by removing access barriers to research, thus, increasing and enabling its access, reach and impact.

Open Access

Open access is defined by the European Commission (2020) "as the practice of providing on-line access to scientific information that is free of charge to the user and that is re-usable." The roots of OA can be traced back to the conception of the Open Archives Initiative (1999) and the Budapest Open Access Initiative (2002) (BOAI) which were largely driven by the desire to promote self-archiving of research output in interoperable repositories and open access journals. The BOAI underscored the necessity to make knowledge available to all those who could utilize it, apply it, or build on it. This fell on the backdrop of challenges presented by the 'serials crisis' in which academic libraries' continued to experience budgetary cuts while commercial publishers continued to increase the number of journal titles and subscription costs. Universities are mandated to contribute to research and development so they require their scholars to research and publish as part of their conditions for tenure and promotion. For this requirement to be met, academics and researchers rely heavily on availability of scientific literature to support their research (Panitch & Michalak (2005). Availability, accessibility and visibility of scientific literature promotes research activity of scholars but the 'serials crisis' became an impediment to the achievement of this goal. Where access to knowledge and information is enabled and increased, the result is:

Enhanced transparency, openness and accountability, and public engagement; closer linkages between research and innovation; economic growth; improved efficiency in the research process; and increased returns on the investments made in research. (Johnson et al., 2018, pp. 92-93).

The requirement for academics to either publish or perish increased demand for publication avenues which prompted scholarly societies and commercial publishers to introduce new journal titles on the market; libraries could not cope with the expansion and pricing (Plasmeijer, 2002). In the end many academic libraries were overwhelmed and had to cancel some of their journal subscriptions leaving them unable to provide access to scientific literature. The internet and ICT developments ushered in new ways of accessing, collecting, preserving and sharing scholarship prompting institutions to relook at the scholarly communication business models and evaluate return on investment in research.

Open access seeks to promote cost free unlimited availability and access to research and information online on the internet (Frankland & Ray, 2017) to propagate research, allow knowledge sharing between the 'haves' and the 'have nots' and enrich education and research. Therefore, OA affords the research community an opportunity to distribute and access research information to a global audience freely without fear of copyright and licensing restrictions and access cost. Open access facilitates visibility, discoverability and impact of scholarly literature, a factor which promotes better usage of scientific findings by a wide and varied readership (Fitzpatrick, 2012; Pandita & Ramesha, 2013; Woutersen-Windhouwer, 2013). Open access, therefore, increases visibility of researchers and their respective institutions. In a nutshell open access helps researchers to:

- Build on previous research results (improved quality of results)
- Encourage collaboration and avoid duplication of effort (greater efficiency)
- Speed up innovation (faster progress to market means faster growth)
- Involve citizens and society (improved transparency of the scientific process). (European Commission, 2020).

In a bid to remain competitive academic institutions globally have adopted publication of institutional intellectual output in open access platforms to allow access to current research and promote further probing of reported scientific findings and development of new innovations and knowledge (Frankland & Ray, 2017). Several studies (Mutsvunguma, 2019; Raju et al., 2015; Van Wyk & Mostert, 2014) show South Africa as a leading champion to reckon with in acceptance and implementation of open access practices ahead of many African countries. Of late, universities, funding bodies and governments across the globe have developed open access policies mandating publication of scientific findings emanating from research they would have funded (European Commission, 2020). The National Research Foundation (NRF) of South Africa, a leading research funding organization in the country, instituted an OA policy mandating authors of scientific papers emanating from research funded fully or partially by the organization, to deposit final peer reviewed manuscripts which have been accepted for publication in institutional repositories (NRF, 2015). The organization also requires that data accompanying the publication also be deposited in the repository.

There are two approaches to open access, that is, self-archiving or green OA and open access or gold OA. Gold OA involves publishing in open access journals while self-archiving involves depositing an author's research work (pre-print or post-print) in an open access repository. The deposit is done by the author or is mediated by the repository champion or any nominated person to do so. Self-archiving follows requirements placed by a publisher for certain articles to only be made open access at the expiry of an embargo period (European Commission, 2020). This chapter will discuss the role of open repositories in enhancing access to information and knowledge generation by academic libraries.

Institutional Repository Landscape in Africa

Having realized that scholars and researchers in the continent experienced difficulties accessing African published research papers due to poor organization, lack of indexing and electronic unavailability, efforts to facilitate access and availability of scholarly literature began. The electronic Information for Libraries (eIFL.net) and the International Network for the Availability of Scientific Publication (INASP) started working on building electronic networks amongst libraries in Africa to promote the flow of institutional research works across the region. The African Journals Online (AJOL) was initiated in 1998 by INASP to assist universities and research institutions in Africa to increase their online visibility, access and use of African research output and facilitate knowledge sharing amongst African researchers. AJOL's goal is to promote awareness and use of African published journals so that output of African origin is available to the region and globally, resultantly, African research results are translated to socio-economic development. The first institutional repository in Africa was established at the University of Zimbabwe in 2005 by the eIFL.net. To date, out of 54 countries in Africa 25 have established repositories while it is not known if the remaining 29 have repositories or not (International Africa Institute (IAI), 2021; OpenDoar, 2021; ROAR, 2021). The continent has a total of 243 repositories; of these 68 are from Southern Africa with South Africa having registered 48 repositories followed by Zimbabwe (11), Botswana (4) and the rest have 1 to 2 repositories each. This is on the backdrop of the Association of African Universities (AAU) having a membership of 413 universities, research and affiliated institutions. Despite digital repositories becoming a "significant component in the provision of academic publication and information resources" (IAI, 2021), Africa's progress in harnessing and capitalizing on the affordances of IR technologies is not pleasing at all. Molten (2019) expresses disappointment at the pace of development of repositories in Africa where nearly half of the African countries do not have digital repositories and on taking a closer look at those countries with repositories, some of their universities do not have repositories at all. South Africa is surely living up to the attribution of it being the destination of excellence in research productivity and is proactively promoting visibility, reach and impact of its research output on the global sphere.

INSTITUTIONAL REPOSITORIES ENHANCING ACCESS TO KNOWLEDGE IN ACADEMIC LIBRARIES

Institutional repositories have contributed to the evolvement of the scholarly communication ecosystem as they respond to the demands of the changing knowledge-based world; literature is being produced in digital format and there is an increasingly growing need to share and avail barrier free research literature, leading to the development of digital libraries. Knowledge and awareness of IRs amongst scholars and researchers in universities across the globe has increased (Mutsvunguma, 2019; Molteno, 2019); libraries have made significant strides in marketing and mobilizing support for adoption and usage of the technology through awareness campaigns, workshops, and the open access week campaigns. The research community is now aware of the potential of IRs to increase access, research visibility, reach and simultaneous increase in value, ranking and prestige of researchers and their institutions (Asadi, et al., 2019; Tapfuma & Hoskins, 2020). Tapfuma & Hoskins (2019a, p. 4) describe institutional repositories as "conduits for collecting, preserving, and disseminating research knowledge (grey literature and published works) and allow free exploitation of knowledge for development." The first definition of IR was coined by Crow (2002) who put forward that they are "digital collections capturing and preserving the intellectual output of a single or multi-university community". Contents of IRs include research articles, that is, preprint and published journal articles, workshop reports, conference proceedings, data sets and teaching materials. Africa and other developing countries stand to benefit more from usage of digital repositories since they are hard hit by the varied access and visibility challenges mentioned earlier which impede their research productivity.

Through these open access institutional repositories knowledge and information can be easily searched, harvested, and used by a wider readership (on the internet). Xia (2007) postulates that the volume of accessible research content deposited by scholars in the institutional repository influences its usage. The more content is self-archived and the more the repository grows, the more useable it becomes. So, construction of digital repositories in African universities will go a long way in resolving the challenge of visibility and access to scientific knowledge. Molteno (2019) further envisioned a bright future for African scholarship by making the following development projections:

- As the deposit rate of theses and dissertations produced in African universities by postgraduate students increases in addition to digitizing theses and dissertations which were submitted years back, the total number of accessible scientific research findings and theoretical knowledge about Africa in diverse fields of scholarship will lead to exponential growth of output.
- Scholars in different African countries will be able to easily identify scholars pursuing similar research interests in their country or other African countries. They will also find out who is doing, or has done in the past, research on a particular topic; thus, promoting collaborative research networks.
- As more African institutions build digital repositories and grow the size of the repositories through increased content deposits young and upcoming researchers will be motivated when they see their intellectual output being widely accessed by colleagues in the African region and global scholarly community.
- The presence of digital repositories in universities in Africa would help redress the current inequalities to access to research about Africa produced by African and Western scholars, respectively.

The scholarly communication ecosystem comprises many players who include researchers, authors, publishers, vendors, libraries, and consumers whose feathers and egos have been ruffled by the IR technologies, hence their apprehensiveness toward the innovation. Speculation, questions, and reservations have been expressed over trustworthiness of institutional repositories as platforms for sharing intellectual output. According to Wasike (2013) IRs do not aim to ignore peer review and the publishing processes nor do they seek to compete with publishers. Rather they play a complementary role of providing free public access to scientific findings before they are published (pre-print) and post publication after an embargo period on a broad spectrum. IRs help institutions speed up the movement of scientific findings from their scholars toward open knowledge sharing (Shearer, 2003). The institutional repository innovation has brought librarians to the forefront, thus making active participants in the dissemination and discovery of scholarly literature (Johnson et al., 2018).

Since institutional repositories are digital collections which capture and preserve the intellectual output of a university community, they have transformed the collection development practice in academic libraries to include uploading and depositing of both published and unpublished scholarship authored by academics in an institution. Research funding organizations and universities are now demanding that research which they have funded be made publicly available in open access platforms (OA journals and institutional repositories). Universities are also mandating self-archiving of research produced by their scholars and postgraduate theses and dissertation by students in the institutional repository; the university libraries are also digitizing past theses and dissertations (Molteno, 2019).

Theses and dissertations are the most underutilized resource in African development as they are not easily accessible for the public good; they lie hidden on library shelves, office shelves and drawers or on machine readable disks yet they contain empirical data which cannot be found in international scholarly publications. In efforts towards increasing visibility of this research output from Africa, the Association of African universities initiated the construction of the database of African Theses and Dissertations – Research (DATAD-R) in the year 2000 and the database was launched in 2003 (AAU, 2020). It is worthy to note that after all the effort of putting the DATAD infrastructure together, only four countries participated in the project, i.e., South Africa, Ghana, Kenya and Zimbabwe. At least Southern Africa is represented by South Africa and Zimbabwe but the absence of many African countries from participation in the DATAD project is a cause for concern. It is important that scholars and institutions understand that they can attract funding from research funding bodies with increased discoverability and circulation of their scientific works; collaborative research opportunities may arise while citation and return on investment would also be realized. (Fitzpatrick, 2012; Swan et al., 2014). In addition, IRs save scholars from the burdensome activity of compiling a list of their publications for their curriculum vitae because the list is built by the IR over time.

RESEARCH METHODOLOGY

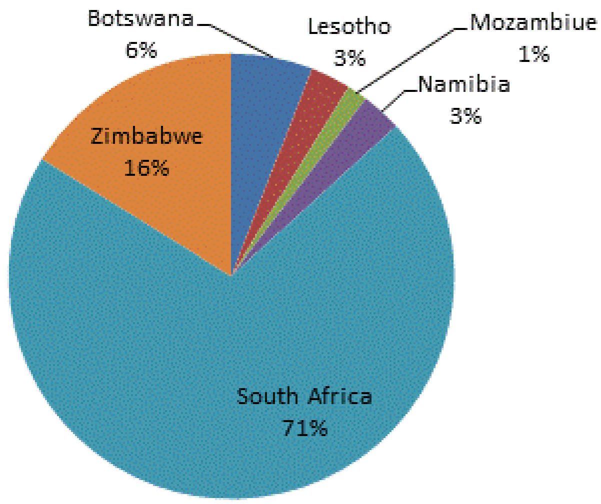
The purpose of this chapter is to explore adoption and usage of institutional repositories, as digital platforms, by institutions of higher education in Southern Africa which have the potential to enhance visibility, reach and access to the region's intellectual output and resultantly change the narrative on Africa's research performance on the global sphere. Countries of focus included Botswana, Namibia, South Africa, and Zimbabwe since they have made notable progress in establishing IRs in the region. Both qualitative and quantitative approaches were utilized to obtain in-depth knowledge and understanding of IR adoption and usage in the region. An extensive literature review was done including a desk study to obtain an overview of the IR milestones in the region. Data on the status and development of IRs in Southern Africa were collected from the Ranking Web of Repositories – Transparent Ranking: Institutional repositories by Google Scholar, Centre for World University Rankings 2021-2022, OpenDoar, Registry of Open Access Repositories (ROAR). Journal literature, theses and dissertations on institutional repositories in the countries of interest were retrieved online using databases, such as Emerald, JSTOR, Project Muse, Ebsco, Google Scholar, ResearchGate, and Academia. Due to access restrictions experienced during the search, a few full-text articles were retrieved. However, literature on IRs in the region is quite low but South Africa yielded the highest number of articles.

SUCCESS OF INSTITUTIONAL REPOSITORIES IN SOUTHERN AFRICA

There is growing worldwide awareness, knowledge, and support for OA repositories across the globe, but it must be borne in mind that knowledge and awareness alone do not translate to participation in development and usage of repositories. Studies (Van Wyk & Moster, 2014; Mutsunguma, 2019; Mutsvunguma & Hoskins, 2020; Raju et al., 2015; Tapfuma & Hoskins, 2019b, 2020; Mooketsi, 2020) were done on institutional repositories in Southern African countries; these were used to draw insights into the situation of repositories in the region.

Success of an institutional repository hinges upon support from university managers for the IR through OA policy development, awareness and adoption of the repository evidenced by active harvesting and self-archiving of content by authors and mediators to populate the repository. It is acknowledged that persuading academics and researchers to self-archive their works in the repository remains a challenge. Figure 2 shows the regional share of repositories of each country in Southern Africa. South Africa's share is 71%, Zimbabwe, 16% and Mozambique has the least proportion of 1%. The observation made by Van Wyk and Mostert (2014) still obtains that African institutions performance in making their in-

Figure 2. Share of repositories for countries in Southern Africa



ternally stored research visible on the internet through IRs is far from ideal as only a few have adopted the repository innovation and used it to their advantage.

The OpenDoar and the Registry for Open Access Repositories (ROAR) show a high preference for the DSpace open source software for hosting the digital repositories by the institutions. It is noteworthy to state that while 67% of repositories in South Africa are hosted on DSpace others use software such as E-prints (2%), VITAL (4%), SCIELO (2%), DigiTool (2%), eSango (2%) and Figshare. For repositories in Zimbabwe, 73% use DSpace, Greenstone (18%) and Eprints (9%). All the repositories are multidisciplinary. Contents of the repositories include journal articles, conference papers, reports and working papers, books, book chapters, theses and dissertations at both Masters and Doctoral level.

Molteno (2019) contends that digital repositories will only make meaningful contribution to scientific scholarship if they meet particular conditions. They should be searchable, well organized and function in conformity to OA principles. Repositories follow the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH) which enables Web search engines such as Google to index the repository contents. In turn the repository contents are easily findable on the global sphere through the internet. Statistics of repository presence in Africa are quite disheartening as African universities and their scholars are losing the opportunity to showcase their research output and increase their presence on the global sphere. Africa has only managed to build 243 digital repositories while 68 of these are from Southern Africa. Repositories in South African institutions are highly visible and searchable on the internet enabling downloads of full text articles, theses and dissertations. Most of Zimbabwe's repositories are discoverable on the internet but only provide abstracts of repository contents. South Africa is the only country in the southern region which is seriously taking advantage of the affordances of IRs to increase its presence and visibility in the world of scholarship. The country is endowed with "a strong research infrastructure with concomitantly high research output" thus positioning the country in a leading position in the region in sharing scientific findings (Raju et al., 2015). Several institutions in South Africa and a few in Zimbabwe signed the Berlin Declaration on OA, hence the increased participation of the countries in OA strategies adoption. The purpose of the Berlin declaration which was made and signed in October

2003 was fulfill the desire to ensure wide dissemination and ready availability of information to society (Berlin Declaration, 2003). The participants emphasized the need to support the new opportunities of knowledge dissemination through the open access model over the Internet. They pledged to advance by:

- Encouraging researchers/grant recipients to publish their work according to the principles of the open access model.
- Encouraging the holders of cultural heritage to support open access by providing their resources on the Internet.
- Developing means and ways to evaluate open access contributions and online journals to maintain the standards of quality assurance and good scientific practice.
- Advocating that open access publication be recognized in promotion and tenure evaluation.
- Advocating the intrinsic merit of contributions to an open access infrastructure by software tool development, content provision, metadata creation, or the publication of individual articles (Berlin Declaration 2003).

Therefore, South Africa and Zimbabwe are zealous to showcase their intellectual capital prowess to the world and attract the attention of potential research funders and partners and contribute to the global scholarly discourse. The Transparent Ranking of Repositories by Google Scholar lists 10 repositories in South African universities in the top 800 and (Ranking Web of Repositories). Table 2 below shows that items in South African repositories range from 155 to 19,800 with the University of Pretoria having the highest number of items (29,800). This shows high visibility of South African universities, their research output and scholars. The world ranking of South African repositories, which is determined by the size of the collection, growth and development in addition to visibility, demonstrates the country's success in penetrating the international scholarship space. A study by Van Wyk and Mostert, (2014) also established a similar result when South Africa had 28 functional repositories in its universities. It is unfortunate that though Zimbabwe has 11 repositories only two universities out of 15 are listed but one of them embarrassingly has nothing to show. A study by Tapfuma and Hoskins (2019b) on usage and adoption of IRs in Zimbabwe revealed a low deposit rate of content in the repositories. Botswana's universities are also visible though with very little content while Namibia and Mozambique are obscure. Mooketsi (2020) reported marginal awareness of the repository at the University of Botswana, hence the low levels of content in the country's repositories.

Statistics in Table 2 show increasing growth of repositories in South Africa while other institutions are still miles away from making an impact with their presence regionally and globally due to low or stunted growth of their repositories. Usage statistics of the University of Zululand showed a rising trajectory suggesting increased awareness of its existence by the university community (Van Wyk & Mostert, 2014). A study by Mutsvunguma and Hoskins (2020) on University of KwaZulu-Natal's IR found a 74% awareness of the repository by its academics largely due to intensive marketing efforts of the library to the university community. Similarly, Tapfuma & Hoskins' (2019b) study also revealed a high (89%) awareness of repositories by scholars in Zimbabwe. Mooketsi' s (2020) paper on adoption of repositories in Botswana reports that training of scholars impeded IR adoption, showing that awareness of IRs in the country is minimal. However, the small size of the other repositories in the region requires a close look into issues influencing the low deposit rates from content creators, the managers of the repositories and the institution's administrators in order to develop strategies that will ensure increased usage of the repositories. Most of the repositories have been supported at institutional level in building

Table 2. Ranking of repositories in Southern Africa

World Rank	Repository	Country	Number of items
130	University of Pretoria	South Africa	29800
180	Open UCT, UCT repository	South Africa	23100
224	Stellenbosch University Scholar Repository	South Africa	19900
272	University of Witwatersrand IR	South Africa	17100
467	University of Johannesburg research output	South Africa	10200
570	University of South Africa	South Africa	8340
745	University of Western Cape Theses and dissertations	South Africa	6130
1405	Durban University of Technology Repository	South Africa	2280
1523	University of Limpopo IR	South Africa	1950
1816	Cape Penninsula university of Technology Repository	South Africa	1310
1829	Bindura University of Science Education IR	Zimbabwe	1290
2274	Cape Penninsula University of Technology ETDs	South Africa	738
2798	University of Botswana Research innovation and Scholarship Archive	Botswana	327
3167	UCT Research Repository	South Africa	155
3284	Repository - Botswana International University of Science and Technology	Botswana	117
3689	South Africa Medical Research Council (SAMRC) Repository	South Africa	9
3803	ZOU Space, Zimbabwe Open University	Zimbabwe	0

(Web of Repositories, 2021).

and maintaining repository infrastructure, funding provision of requisite resources for continued and effective functioning of the repositories.

De Mutiis and Kitchen (2015) surveyed IRs in Africa and found that limited funding of the repository projects hindered retrospective digitization of materials especially theses and dissertations, a resource which is seriously underutilized in Africa. The institutions in the region have OA policies mandating deposit but challenges could be with the implementation and policing of the mandate to ensure compliance from the scholars leading to increased content deposits. However, support at the national level is lacking in OA policy development (Abbott, 2020) except for South Africa, the NRF as a major funder of research in the country's universities mandates deposit of publications from research funded by them. Like most research funders, the universities have developed deposit mandates for their scholars and academics. A mandate policy creates awareness in stakeholders of the existence of the IR, guides them on what is expected of them in contributing to the success of the IR and, creates awareness of the value of opening access to scholarly works to a wider readership (Little, 2012, p. 65). Though institutions in Zimbabwe have OA policies, their scholars are not aware of their existence, while tenure and promotion conditions are not aligned to the research deposit mandate policies. According to Mooketsi

(2020) (citing Oladokun, 2015) scholars at the University of Botswana ignored the repository because nothing compelled them to do so, suggesting that there are no policies mandating deposit in Botswana.

There are two forms of OA repository policies, i.e., voluntary, or mandatory deposit. Voluntary deposit involves non-coercion of authors to deposit but allows them to do so out of their own will. A study by Swan et al. (2014) revealed a prevalence of poor voluntary deposit patterns amongst researchers. Scholars may not be motivated to deposit due to lack of motivation to do so. The notable growing repositories in South African institutions could be attributed to the monetary publication reward system run by the government of South Africa; universities are given a subsidy for published articles by their researchers in internationally and nationally accredited journals, or peer-reviewed conference proceedings, or publication of books and book chapters (Tongai, 2013). The subsidy figure fluctuates from time to time as determined by the Department of Education. The institutions decide how they spend the incentive funds, and this varies by institution. "Depending on the institution, the researcher may pocket some or all of this money, or it is placed in an account for use for further research" (Tongai 2013). Institutions in other countries, i.e., Botswana, Namibia, Lesotho, and Zimbabwe do not offer incentives to their researchers, hence the poor participation by their scholars in populating the repositories. Though incentives or cash rewards from funding organizations or universities were found not to be sufficient motivators (Harnad, 2011) to self-archive research output, they help institutions to achieve some milestones. Mandatory deposit involves institutions and research funding organizations making it a requirement for authors who have benefitted from their funding to deposit scientific papers of findings coming out of the funded research in an institutional repository. OA's primary objective makes publicly funded research freely available to a wider audience to allow probing and continued research and knowledge development.

The content deposit levels in South African repositories attest to the finding by Xia et al. (2012) that repositories with mandates achieve better deposit rates than those without. Mandates can assist institutions mitigate faculty resistance but do not guarantee participation by scholars in populating the repositories as demonstrated by the number of items in Southern African repositories listed in Table 2. Therefore, institutions in Southern Africa face a daunting task of attracting increased content deposits before they begin realizing return on their investment in research and repository infrastructure. Universities that do not have mandate policies should develop them to raise the success levels of their repositories. Statistics in Table 2 show Southern Africa's potential to increase visibility of scientific research generated by African scholars and afford them the opportunity to actively participate in scientific discourse on socio-economic issues bedeviling their countries and the continent at large (Molteno, 2019). However, more needs to be done in terms of increasing acceptance and usage of the repositories by content creators and managers of the repositories.

CHALLENGES FACED BY SOUTHERN AFRICA UNIVERSITIES IN ESTABLISHING AND MANAGING INSTITUTIONAL REPOSITORIES

The task of establishing an institutional repository is not immune to challenges which impact success of the repositories. Abbot et al., (2016) conducted a survey on barriers and enablers to OA repositories development and management in Africa. They found that support from management on policy issues and OA repository implementation and maintenance were lacking in all the three regions surveyed, Southern Africa included. The kind of support that is required for successful implementation and running of repositories can be categorized into technical, operational level and management of the repositories.

The study by Tapfuma & Hoskins (2020) revealed stalled progress in the development of repositories in Zimbabwe in half of the institutions surveyed since administrators did not appreciate the value of the repositories, so policy development slowed down. Despite the hiccup, the institutions at least had functioning repositories either within the institution or on the public domain. Mutsvunguma and Hoskins (2020) reported commendable financial, material and policy support from the UKZN administration. The University of Botswana's repository success was delayed due to insufficient training of scholars in IR usage, inadequate ICT infrastructure, funding and low levels of the academic staff complement (Mooketsi, 2020).

Universities in Zimbabwe had trouble obtaining technical expertise and, proper equipment to host their repositories, as a result, delays were experienced in establishing the repositories. Van Wyk and Mostert (2014), Abbot et al. (2016), Tapfuma and Hoskins (2020), Mooketsi (2020) observed the absence of technical support from the institutions in terms of availability of expertise and consultants on digital skills and, training. The institutions had a shortage of skilled staff to run the repositories neither could they recruit new staff; library staff were moved from different sections of the library to manage the repository. Staff shortages hindered progress because individuals bestowed with the IR responsibility could not cope with the demands of the IR; retrospective digitization of existing library holdings, such as, theses and dissertations were affected as well. The libraries also lacked expertise in copyright clearance and permissions processing regarding obtaining and interpreting publisher copyright policies. Another challenge faced by the Southern African universities in building their repositories was the recruitment of content. Scholars were not willing to either share or submit their research to librarians for self-archiving. Fear and misconceptions of OA and IRs contributed to this behavior by the scholars. Their fears were on issues to do with understanding of copyright, trustworthiness of repositories and plagiarism.

SOLUTIONS AND RECOMMENDATIONS

Efforts to implement, run and maintain IRs in the universities in Botswana, Namibia and Zimbabwe were largely hampered by the poor support received from management. This can be attributed to insufficient knowledge and awareness of OA and its benefits to the institution and its scholars (Chan & Costa, 2005). Introduction and implementation of innovation in any organization requires involvement all stakeholders where the drivers of the change apprise them on the concept of IRs and how they can be leveraged to increase visibility, reach, and impact of the institution's research output and ultimately influence the global ranking of the universities. Collaboration amongst librarians, university administrators and policy makers will lead to the success of the repositories as they support each other to achieve a collective goal (Lynch 2003). The value and authority of the repository will be magnified while the managers will be compelled to provide financial and human resources for enhanced management and maintenance of the repository. In addition, the stakeholders will work together to draw and institute policies that support adoption and usage of OA platforms for research dissemination and sharing (Cullen & Chawner 2011). Commitment and support from management is crucial to the success of repositories in Southern Africa.

Statistics of the number of items in the repositories shown in Table 2 reflect low deposit rates which are quite worrying for Botswana, Namibia, and Zimbabwe. Though South Africa has made tremendous efforts in establishing repositories, the deposit rates are not pleasing at all. Recruitment of content is central to IR success and Covey (2011) adds that a substantial amount of content is required to attract users and more content. This calls for the universities in the region to carry out extensive IR advocacy campaigns and training workshops to increase knowledge and acceptance of the repositories by content depositors. IR policies should be drawn up, strengthened (where they exist) and implemented to speed up content recruitment and population of the repositories. The universities in the region should also consider mandating deposits as per the recommendation of the Scholarly Communication in Africa Programme's (SCAP) (Swan et al., 2014) which also advocated for alignment of the policies to research funder mandates to avoid confusing the authors due to conflicting demands especially if their funding is coming from several sources. To increase participation of scholars in populating the repositories, Botswana, Namibia, and Zimbabwe can also consider offering monetary incentives to their scholars for publication and deposit of their research works in the repository. Increase in deposits means increased visibility of research output from the region which leads to better ranking of the universities, increased networks, and collaborative research.

FUTURE RESEARCH DIRECTIONS

Further studies need to be conducted to establish the underlying causes to poor research deposit rates of research output in the IRs by academics and researchers. Increased deposit rates would contribute to high visibility of scholars and their research which encourages collaborative research and consultancy opportunities on the global sphere.

CONCLUSION

Despite the challenges faced, it can be concluded that institutions in the Southern African region have made significant strides in establishing IRs as digital platforms supporting development of digital libraries which increase visibility and remote access to research output from the region. However, deposit levels of research work in the repositories are still low considering the number of universities in the region. South Africa has notable research output performance which is visible within the continent and globally. Universities in the country as a collective embraced adoption of IRs and exploited them to increase their visibility, reach and impact in the world of scholarship. The rest of the countries in the region have a mammoth task to build and populate digital repositories and exploit them for their benefit. So far, repositories in Southern Africa have not registered success.

REFERENCES

AbbottP.AppiahK.OaiyaO. (2020). *Barriers and enablers to open access repository (OAR) development in African HLIs: Research from the LIBSENSE OAR workshop in UA, WACREN and ASREN regions*. doi:10.5281/zenodo.3884974

Abrahams, L., Burke, M., & Mouton, J. (2010). Research productivity-visibility-accessibility and scholarly communication in Southern African universities. *The African Journal of Information and Communication*, (10), 20–36. doi:10.23962/10539/19768

Adams, J., King, C., & Hooks, D. (2010). *Global Research Report: Africa*. http://sciencewatch.com/sites/sw/files/sw-article/media/globalresearchreport-africa.pdf

African Journals Online (AJOL). (n.d.). https://www.ajol.info/index.php/ajol

Albatros Adventure Marathons. (n.d.). *Map of Southern Africa*. Retrieved 16 December 2021 from: http://new.big-five-marathon.com/map-southern-africa

Asadi, S., Abdullah, R., Yah, Y., & Nazir, S. (2019). Understanding institutional repository in higher learning institutions: A systematic literature review and directions for future research. *IEEE Access: Practical Innovations, Open Solutions*, *7*, 35242–35263. doi:10.1109/ACCESS.2019.2897729

Association of African Universities (AAU). (2021). *Database of African Theses and Dissertations-Research (DATAD-R)*. https://aau.org/current-projects/database-of-african-theses-and-dissertations-research-datad-r/

Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities. (2003). https://openaccess.mpg.de/67605/berlin_declaration_engl.pdf

Chan, L., Kirsop, B., & Arunachalam, S. (2011). Towards open and equitable access to research and knowledge for development. *PLoS Medicine*, *8*(3), e1001016. doi:10.1371/journal.pmed.1001016 PMID:21483470

De Mutiis, A., & Kitchen, S. (2016). *African digital research repositories: survey report. Africa Bibliography*. doi:10.1017/S0266673116000027

European Commission. (2020). *Horizon 2020 online manual: Open access*. https://ec.europa.eu/research/participants/docs/h2020-funding-guide/cross-cutting-issues/open-access-data-management/open-access_en.htm

Fitzpatrick, K. (2012). Giving it away: Sharing and the future of scholarly communication. *Journal of Scholarly Publishing*, *43*(4), 347–362. doi:10.3138/jsp.43.4.347

Frankland, J., & Ray, M. A. (2017). Traditional versus open access scholarly publishing: An economic perspective. *Journal of Scholarly Publishing*, *49*(1), 5–25. doi:10.3138/jsp.49.1.5

Hobohm, H. C. (2012). Can Digital Libraries Generate Knowledge? *Historical Social Research. Historische Sozialforschung*, *37*(3), 218–229.

International Africa Institute (IAI). (2021). *African digital research repositories*. https://www.internationalafricaninstitute.org/repositories

Johnson, R., Watkinson, A., & Mabe, M. (2018). *The STM report: An overview of scientific and scholarly publishing* (5th ed.). International Association of Scientific, Technical and Medical Publishers. https://www.stm-assoc.org/2018_10_04_STM_Report_2018.pdf

Kotecha, P., & Perold, H. (2010). Rebuilding higher education in Zimbabwe: a needs analysis. Rebuilding higher education in Zimbabwe: implications for regional collaboration. *SARUA Leadership Dialogue Series, 2*(1).

Moahi, K. H. (2009). *Institutional repositories: Towards harnessing knowledge for African development*. Paper presented at the First International Conference on African Digital Libraries and Archives (ICADLA-1), Addis Ababa, Ethiopia. Retrieved September 25, 2021 from: https://wiredspace.wits.ac.za/handle/10539/8950?show=full

Molteno, R. (2019). *Why African digital repositories for storing research writings are so important*. https://www.internationalafricaninstitute.org/repositories/why.html

Mooketsi, B. E. (2020). Factors influencing adoption of institutional repositories in tertiary education institutions: Librarians' perspective. *Mosenodi Journal*, *23*(2), 21–40.

Motleno, R. (2016). Digital repositories – making Africa's intelligentsia visible? *Bulletin of the National Library of South Africa*, *70*(2). https://www.internationalafricaninstitute.org/downloads/Molteno-Making%20Africa's%20Intelligensia%20Visible.pdf

Mutsvunguma, G. (2019). *Institutional repositories as platforms for open access in South African universities: The case of University of KwaZulu-Natal* [PhD thesis]. School of Social Sciences, College of Humanities, University of KwaZulu-Natal, Pietermaritzburg, South Africa.

Mutsvunguma, G., & Hoskins, R. G. (2020). Use of the Institutional Repository by Academics at the University of KwaZulu-Natal", *Mousaion*. *South African Journal of Information Studies*, *38*(1).

National Research Foundation. (2015). *Statement on open access to research publications from the National Research Foundation (NRF) funded research*. https://www.nrf.ac.za/media-room/news/statement-open-access-research-publications-national-research-foundation-nrf-funded

Nordling, L. (2018). *What is Africa's real share of global science?* http://www.sun.ac.za/scistip/news/what-does-africa-contribute

Oladokun. (Ed.). (n.d.). *Open Access Implications for Sustainable Social, Political, and Economic Development.* Hershey, PA: IGI Global.

OpenDOAR. (2021). https://v2.sherpa.ac.uk/opendoar

Pandita, R., & Ramesha, B. (2013). Global scenario of open access publishing: A decadal analysis of Directory of Open Access Journals (DOAJ) 2003-2012. *Journal of Information Science Theory and Practice*, *1*(3), 47–59. doi:10.1633/JISTaP.2013.1.3.4

Panitch, J. M., & Michalak, S. (2005). *The serials crisis*. A White Paper for the UNC-Chapel Hill Scholarly Communications Convocation. https://www.unc.edu/scholcomdig/whitepapers/panitch-michalak.html

Phillips, L. L. (2010). Coming home: scholarly publishing returns to the university. *Library Publications and Other Works*. https://trace.tennessee.edu/utk_libfpubs/33

Plasmeijer, H. W. (2002). Pricing the serials library: In defense of a market economy. *Journal of Economic Methodology*, *9*(3), 337–357. doi:10.1080/1350178022000015131

Raju, R., Raju, J., & Claassen, J. (2015). Open scholarship practices reshaping South Africa's scholarly publishing. *Publication*, *3*(4), 263–284. doi:10.3390/publications3040263

Ranking Web of Repositories. (2021). *Transparent ranking: Institutional repositories by Google Scholar*. https://www.repositories.webometrics.inf/en/node/32

Registry of Open Access Repositories (ROAR). (2021). http://roar.eprints.org/view/geoname

Rotich, D. C. (2011). The present and future growth of scholarly publishing in Africa. Inkanyiso. *Journal of the Humanities and Social Sciences*, *3*(2).

Shearer, M.K. (2003). Institutional repositories: towards the identification of critical success factors. *Canadian Journal of Information and Library Science – Revue Canadienne des Sciences de l'Information et de Bibliotheconomie, 27*(3), 89-108.

Siler, K. (2017). Future challenges and opportunities in academic publishing. *Canadian Journal of Sociology/Cahiers Canadiens de Sociologie, 42*(1), 83-114.

Swan, A., Willmers, M., & King, T. (2014). *Opening access to Southern African research: recommendations for university managers.* Scholarly Communication in Africa Programme Brief 4. http://openuct.uct.ac.za/sites/default/files/media/SCAP_Brief_4_Swan_et_al_Opening_Access.pdf

Tapfuma, M. M., & Hoskins, R. G. (2019a). Attitudes of scholars towards self-archiving in institutional repositories of Zimbabwe's public universities. *Mousaion*. *South African Journal of Information Studies*, *37*(4).

Tapfuma, M. M., & Hoskins, R. G. (2019b). Usage of institutional repositories in Zimbabwe's public universities. *South African Journal of Information Management*, *21*(1), a1039. doi:10.4102ajim.v21i1.1039

Tapfuma, M. M., & Hoskins, R. G. (2020). Challenges for establishment of institutional repositories: The case of Zimbabwe's university libraries. In P. Jain, N. Mnjanma, & O. Oladokun (Eds.), *Open access implications for sustainable development*. IGI Global Publishing.

Tennant, J. P., Waldner, F., Jacques, D. C., Masuzzo, P., Collister, L. B., & Hartgerink, C. H. J. (2016). The academic, economic and societal impacts of Open Access: An evidence-based review. *F1000 Research*, *5*, 632. doi:10.12688/f1000research.8460.3 PMID:27158456

Tongai, I. (2013). South Africa: incentives for researchers drive up publication output. *University World News, Global Edition,* (280). https://www.universityworldnews.com/article.php?story=20130712145949477

Trotter, H., Kell, C., Willmers, M., Gray, E., & King, T. (2014). *Seeking impact and visibility: Scholarly Communication in Southern Africa*. African Minds. http://open.uct.ac.za/bitstream/handle/11427/2310/SCAP_Trotter_SynthesisReport_2014.pdf?sequence=1

Tsekea, S., & Chigwada, J. P. (2021). COVID-19: Strategies for positioning the university library in support of e-learning. *Digital Library Perspectives*, *37*(1), 54–64. doi:10.1108/DLP-06-2020-0058

UNESCO. (2015). *UNESCO Science Report: Towards 2030*. Paris: UNESCO Publishing. https://unesdoc.unesco.org/ark:/48223/pf0000235406

Van Wyk, B., & Mostert, J. (2014). African institutional repositories as contributors to global information: South African case study. *Mousaion: South African Journal of Information Studies*, *32*(1). https://www.upjournals.co.za/index.php/LIS/article/view/1704/858

Wasike, J. M. (2013). An assessment of the status of open access resources in Kenyan university libraries. *Library Hi Tech News*, *6*(6), 17–21. doi:10.1108/LHTN-12-2012-0074

Web of Science. (2019). https://incites.clarivate.com/#/explore/0/journal

Woutersen-Windhouwer, S. (2013). The future of open access publishing in the Netherlands: Constant dripping wears away the stone. *Journal of Academic Librarianship*, *39*(1), 105–107. doi:10.1016/j.acalib.2012.11.015

ADDITIONAL READING

Adam, U. A., & Kaur, K. (2021). Institutional repositories in Africa: Regaining direction. *Information Development*.

Ngulube, P., & Masenya, T. M. (2020). Adoption and implementation of digital preservation strategies by academic libraries in South Africa. *Mousaion*, *38*(1).

Owusu-Ansah, C. M. (2020). Conceptions of digital libraries: An African perspective. *Digital Library Perspectives*, *36*(3), 231–247. doi:10.1108/DLP-12-2019-0045

Yusuf, F. O., Ifijeh, G., & Oewolabi, S. (2019). Institutional repositories in Africa: issues and challenges. In R. K. Bhardwaj & P. Banks (Eds.), *Research Data Access and Management in Modern Libraries*. IGI Global Publishing. doi:10.4018/978-1-5225-8437-7.ch008

KEY TERMS AND DEFINITIONS

Academic Libraries: Are libraries that serve a university, college, or research institution's community.

Disruptive Technologies: Are innovations that cause change to how businesses, organizations, or communities, such as scholarly communities, operate.

Innovative Technologies: These are new inventions or technologies being utilized in a new way.

Institutional Repository: Is a platform for collecting, storing, preserving, and archiving research and records produced within an institution.

Open Access: Refers to making research freely available and accessible on the internet by the public.

Chapter 11
Supporting Data Preservation Through Institutional Repositories of the Academic Libraries in South Africa:
A Case Study of Three Academic Libraries

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ABSTRACT

Institutional repositories (IRs) are open access platforms that could be viewed as ideal platforms for supporting the management of the scientific knowledge which enhances knowledge generation, preservation, use, and sharing and for increasing the scale of research performance in a research community. This chapter investigates the use of IRs in preserving data at selected academic libraries in KwaZulu-Natal province, South Africa, guided by the Digital Curation Centre (DCC) Lifecycle Model. The interpretivist research paradigm following a qualitative research approach through a case study was employed. The findings of the study reveal uniform IRs for data preservation in the participated academic libraries. The findings also show a strong need for training and workshops to equip the librarians and researchers with the necessary skills and knowledge for preserving data in the IRs. A lack of resources is the biggest threat to preserving data for most academic libraries.

INTRODUCTION AND BACKGROUND

Institutional Repositories (IR's) are open access platforms that serve as archives for intellectual output for different research disciplines in higher education institutions (HEIs). The emergence of institutional

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repositories has proven to be integral for the dissemination and preservation of intellectual content. Institutional repositories have also been on the frontline of the open access movement by offering wide and unrestricted access to research output from a variety of faculties in higher education institutions (Adjei, Mensah & Amoaful, 2019). The literature on the subject matter essentially highlights access and preservation of data as the two underlying functions of institutional repositories (Francke, Gamalielsson & Lundell, 2017). From a global landscape, it would seem that long-term preservation of data in institutional repositories is still a grey area, as most institutional repositories focus on providing access and dissemination of data. Li and Banach (2011) argue that the implementation of data preservation is still at its infancy. Barrueco and Termens (2021) state that the scarce number of articles published confirms that the interest of repository managers has been focused on other issues other than to assure the long-term availability of the assets they store.

Seemingly, developing countries in Africa are still far behind in terms of long-term data preservation. Against this backdrop, this study investigated the University of Zululand, University of KwaZulu-Natal and Durban University of Technology's academic libraries in South Africa to establish how they support data preservation through their institutional repositories while adding to the body of literature in the Library and Information Science domain. Kari and Baro (2016) as well as Adjei, Mensah and Amoahful (2021), claim that many IR activities in most academic libraries only focus on creating repositories, depositing content, promoting discovery and access and/or encouraging the necessary cultural change, but not on how to preserve the content for long-term accessibility. Mensah (2015:2) also identify that there are inadequate data preservation methods in institutional repositories of African libraries which could result in serious ramifications such as inaccessibility and loss of data. Moseti (2016:137) attained findings of a similar nature in Kenyan universities, and further states that digital preservation has not been embedded as an integral part of the repositories' workflow and there is neither much experience nor commonly agreed best practice as to how digital preservation is best performed.

Data preservation is a term that is seldom left out in the definition of institutional repositories, yet as above mentioned, it serves as one of the key functions of institutional repositories. Barrueco and Termens (2021) view data preservation as a fundamental element in institutional repositories, owing to its potential to ensure accessibility and availability of research content in its original form over a long-term period. In the same vein, it can also be observed that the implementation of data preservation in higher education institutions is not congruent to its wide discussion by researchers in the library and information science discipline. For the successful preservation of data in an institutional repository, a variety of factors come into play, some of them being the software programme used, strategies for long-term data preservation, training for institutional repository managers among others (Prabhakar & Rani, 2017). According to Masenya and Ngulube (2020), software programmes are intended to provide academic institutions with the capability to create, capture, store, preserve, track and retrieve digital resources, regardless of the format. Strategies for data preservation are paramount for institutional repositories, as alluded to by Ebele, Anthonia and Ebikabowei (2019), who posit that strategies for the preservation of IR content and the decisions about what content requires preservation should be driven by preservation policies. The training and education of staff is an essential element when preserving or digitizing materials, as it is an extremely complex area that requires a great deal of knowledge to comprehend the phenomenon (Masenya & Ngulube, 2021).

PURPOSE AND PROBLEM STATEMENT

This chapter aimed at determining how to support data preservation through the institutional repositories of the academic libraries in South Africa by answering the following set research questions:

- What types of institutional repository software(s) are being used in academic libraries?
- What is the training needed by Librarians to support data preservation in the IRs of the academic libraries?
- Which strategies are used for long term data preservation in IR's of the academic libraries?
- What are the data preservation challenges in the IRs of the academic libraries?

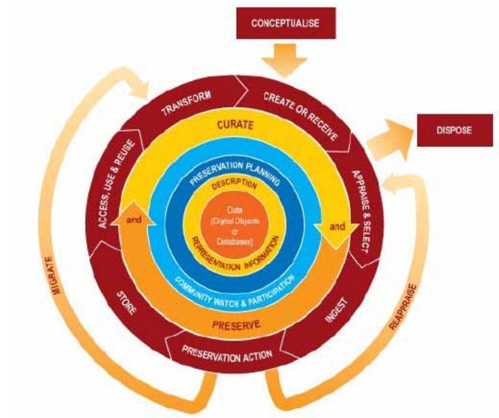
Given that Institutional Repositories (IRs) are ideal open access platforms for supporting the management of the scientific knowledge to enhance knowledge generation, preservation, use, re-use and sharing as well as increasing a scale of research performance in a research community, it was significant to unpack how IRs can support the preservation of data in academic libraries. It is however noted that preserving data in academic libraries is sometimes problematic as libraries encounter several difficulties such as a lack of formal preservation policy, technology obsolescence and glitches, lack of awareness and open access publishing among others (Ball, 2010; Abd Aziz, 2011; Gbaje, 2017; Moseti, 2016; Nunda & Elia, 2018). The aforementioned challenges prompted this current study which focuses on the preservation of data in the institutional repositories of three higher education institutions in South Africa.

THEORY AND LITERATURE REVIEW

The current study applied the digital curation centre (DCC) lifecycle model which is the model that was developed in 2007 by the Digital Curation Centre (Constantopoulos, 2009). Higgins (2008) asserts that the Digital Curation Centre (DCC) Lifecycle Model has been developed as a generic, curation-specific tool which can be used in conjunction with relevant standards, to plan curation and preservation activities to different levels of granularity. Huang, Lee and Palmer (2020) consider the DCC Lifecycle Model to be the training tool that can be used by curators in understanding processes required for successful curation as well as for developing curation and preservation practices for their organizations. Figure 1 (below) illustrates the DCC Curation Lifecycle Model diagrammatic representation indicating an overview of the lifecycle stages required for successful preservation of data in an organisation as the interest of the present study.

To better understand the processes of curation and preservation in the DCC model, Higgins (2008: 137) highlights its full lifecycle actions, sequential actions and occasional actions as forming the bases of this model. However, the current study has focused on the preservation actions as the study intended to generate an insight into the process of data preservation through the institutional repositories of the academic libraries. Preservation actions involve undertaking activities to ensure long-term preservation and retention of the authoritative nature of data (Higgins, 2008: 138). Preservation actions are believed to facilitate the creation of a stable environment to maintain authentic, reliable and usable data at all times while maintaining its integrity. Among other actions in the preservation of data, Higgins (2008) emphasizes data cleaning, validation, assigning preservation metadata, assigning representation information and ensuring acceptable data structures or file formats. Preservation actions involve storing; access,

Figure 1. The DCC curation lifecycle (Higgins, 2008: 136)



use and reuse; and transformation of data in an institution and these processes are thus discussed in the next sections (see section a, b and c).

- **Storage**

Data should be kept securely and its storage should abide by relevant standards. Harvey (2013: 49) indicates that data should be stored on an appropriate media. Harvey (2013) also suggests data to be copied on a reliable digital system. Normally, data storage is customarily facilitated by institutions' policies, predominantly the research data management policies or procedures and most policies stipulate a 5 and 10-year period of data storage, preservation and curation. For example, the University of Southampton Research Data Management Policy (2019: 2) stipulates a minimum of 10 years for research data from its collection, creation or publication of results in accordance to section 6 of the policy. Just like the University of Southampton RDM policy, the University of Pretoria, Open University and Cape Peninsula University of Technology RDM policies also lay down a 10-year period for data storage (Crane, 2018; University of Pretoria Research Data Management policy, 2018; Cape Peninsula University Research Data Management Policy, 2016). Storing data is believed to be a crucial aspect of the management of data which prevents data loss or damage in an institution, an academic library in this context.

- **Access, Use and Reuse**

For research visibility, an organisation should always ensure that data is accessible to both designated users and re-users, on a daily basis (Higgins, 2008: 138). Publicly available published information can re-enforce the actions of access, use and reuse in an organisation, an academic library in this context. Thanos (2017) is of the view that data reuse "allows the reanalysis of evidence, reproduction and verification of results, minimizing duplication of effort, and building on the work of others". Shearer's (2015) suggests investigators to be accountable for data availability to enhance data access and sharing more especially during results publication. Though some of the information may be publicly available, Higgins (2008) proposes strong access control and verification procedures to be applied through authentication and use of links. Miller (2016: 7) recognises that a library can play a significant role in facilitating data use and sharing processes regardless of the RDM structure being present in an institution. Unal et al (2019) notes prominence of sharing and re-use of research data as improving the economic growth and stability in an institution, an increase in research visibility, an increase in resources efficiency and other immense benefits relating to open access to research data. Given the successful access, use and re-use of data in an institution, data sharing is encouraged.

- **Transformation**

Higgins (2008: 138) believes that a transformation of data could be undertaken through creating new data from the original. Higgins views that this could be achieved through migrating data into a different format or by way of creating a subset or a query selection. In this vein, transforming data in an academic library could be achieved through converting data from one format into another, for example converting manual theses and dissertations of the researchers to compact discs or PDFs.

TYPES OF THE INSTITUTIONAL REPOSITORIES IN ACADEMIC LIBRARIES

The role played by institutional repository software platforms has proven to be immensely significant in the current era of digital knowledge management. Not only have they improved access and dissemination of data, but also its preservation for long term use and availability. According to Tapfuma and Hoskins (2019), one of the most crucial factors for the success of an institutional repository is the software platform on which it is hosted. There are quite a number of software platforms that can be utilised to run an institutional repository which can either be free or commercial. Masenya and Ngulube (2021) highlight DSpace, Eprints and Fedora as the most commonly used software platforms for data preservation. Similarly, Cherukodan Kumar and Kabir (2011: 219) also observe DSpace, Fedora, Eprints and Greenstone as the most commonly used software platforms. Again, Verma and Kumar (2018: 361) identify DSpace, Eprints and Greenstone. However, it has been noted in literature that not all of them fully support the data preservation function. On this note, Madalli, Barve and Amin (2012), suggest that it is necessary to ascertain that the software and tools used lend support to long term preservation of digital content. The next section deliberates on the commonly used institutional repository software.

- **DSpace**

DSpace is a digital asset management system that facilitates the creation, indexing, retrieval and dissemination of an institution's digital content. According to Abdulkadir, (2011), the DSpace software platform was developed by Hewlett-Packard (HP) and Massachusetts Institute of Technology (MIT), with the purpose of creating a home for digital materials to be stored and preserved for a long-term period. Its focus was directed towards open knowledge sharing and long-term preservation. Cherukodan Kumar and Kabir (2011) define DSpace as an open source software designed to capture, manage, preserve and disseminate digital scholarly research material in all forms. Moreover, it is the most popular software platform that can capture items in any format and preserve them over a long-term period.

- **EPrints**

The EPrints is an open-source software package that was developed by the University of Southampton as a solution for building open access repositories (Castagne, 2013). EPrints is primarily used for institutional repositories and scientific journals as it provides immediate online access to the full text of research articles within the repository, and also provides a set of ingest, preservation, dissemination and reporting services for open access needs (Rosa, Craveiro & Domingues, 2017). The biggest quality of EPrints according to Verma and Kumar (2018), is its ease of use for both the end users and administrators, and its convenience for organisations with limited resources.

- **Fedora**

Garret, Ramstadt and Silva (2013) define Fedora software as a general-purpose, open source digital object repository management system for managing and delivering digital content. It incorporates a number of features that support preservation including the use of XML and open standards, such as Simple Object Access Protocol (SOAP) and the Metadata Encoding and Transmission Standard (METS). According to Wilcox and Weinraub (2017), Fedora has the capability to be a key component of any digital preservation strategy, whether as an access repository, an asset management platform, a preservation tool, or some combination thereof. The concept of durability has always been a key component of the Fedora architecture; this includes not just the preservation of the bits as they reside in a storage layer, but the accessibility of digital objects over time.

PROVISION OF TRAINING TO FULFIL TRAINING NEEDS OF LIBRARIANS

As previously mentioned, the preservation of data for a long-term period is a complex process that necessitates a lot of significant resources, one of them being training for librarians and institutional repository managers. Moseti (2016) asserts that institutions implementing institutional repositories must ensure that they have the required staff with the requisite skills and knowledge to manage issues relating to digital preservation as well as the required equipment in place. In this note, continuous professional development (CPD) of staff in the form of workshops, induction programs, in-house short courses, external study courses are recommended (Maesaroh & Genoni, 2010). The need for training and skills enhancement for librarians cannot be overemphasized due to the fact that technology is constantly evolving and they must be able to adapt to the changes. Masenya and Ngulube (2020) are of the view that academic libraries need more blended librarians to offer the best combination of skills and services, with the ability to use digital technologies to ensure the survival of these institutions. This may possibly be the same reason why Anyaoku, Baro and Echedom (2018) lament on the dearth of librarians that possess the skills needed to initiate, manage and participate in digital preservation activities in South Africa and other developing countries. Masenya and Ngulube (2020) therefore propose that Information professionals at various levels need to strive hard to implement and apply the latest ICT advancements in their libraries and also to handle electronic or digital documents to bring change in the environment as per the goals of the parent organisation. Another alternative solution is for educators to determine the necessary skills and knowledge required by digital librarians through skills audits and research and then subsequently designing appropriate courses and teaching approaches for training competent digital librarians (Anyaoku, Baro & Echedom, 2018)

STRATEGIES FOR LONG TERM DATA PRESERVATION IN IR'S

Data always needs to be securely preserved for long term posterity and that demands several strategies to achieve that goal. This is in line with the observation made by Gbaje (2017) who indicates digital preservation strategies to be the methods used for keeping stored digital objects permanently accessible for long-term re-use in an organisation. The data preservation strategies that an institution adopts is believed to be highly depended on the file format as well as the infrastructure. The study by Anyaoku and Baro (2018) found out that "the majority of the IRs have digital preservation policies to guide the implementation of digital preservation for the IR content, while others are in the drafting process". Usually, policies play an immense role by supporting service delivery and the provision of uniform services by responsible personnel in an organisation, like librarians in the context of the current study. Data preservation strategies as defined by Masenya and Ngulube (2020) are approaches formulated to advance continued access to archived digital materials. Shimrai and Ramaiah (2018) describe the aforementioned strategies as properly deliberated documentation methods for the preservation of digital contents that must be accomplished through careful or clinical examination of their cost-benefit and metadata creation.

Preserving data for a long-term period and ensuring that it is sustained beyond the limits of technological obsolescence is a complex process, and as such, strategies for data preservation are a necessity. The ephemerality of the technology that is used poses a challenge on the preservation of data for future use, and this is pointed out by Gbaje (2011) who states that, preservation strategies are a crucial part of managing risks associated with rapid hardware and software obsolescence. It is highly improbable that there will be data preservation strategies that are standard and unique due to the different needs and preferences of each and every academic library. Many data preservation strategies have been proposed, but no one strategy is appropriate for all data types, situations or institutions (Bountouri, 2017). The integrity and authenticity of data however must be considered when selecting a strategy for data preservation. The next section deliberates on some of the strategies of data preservation used to maintain its origin, context, authenticity and integrity.

- **Migration**

Migration is a data preservation strategy that entails the movement of data from a single technology to another. Bountouri (2017) shares that through migration, data is copied or converted from one technology to another, trying at the same time to preserve the significant properties of a digital resource. The purpose of migration as explained by Ismail and Affandy (2018), is to preserve the integrity of digital data and ensuring that it can be retrieved and utilized despite technological changes. For this process to work successfully, the new technology is designed to be able to read the format of the existing data that is being migrated.

- **Emulation**

This preservation strategy seeks to preserve the environment where the data was originally created and stored, which essentially means that current or new technology is designed to mimic the original environment (Gbaje, 2011). It is the replication of the functionality of an obsolete system, where the main aim is to reproduce all the characteristics of the software and or hardware needed in order to re-create the functionality and look of a digital resource (Bountouri, 2017). The goal of emulation is to preserve the content, layout and functionality of digital objects instead of preserving the ageing hardware and original operating software. Emulation requires the creation of emulator programs that translate code and instructions from one computing environment so it can be properly executed in another.

- **Technology preservation and sustainability**

The technology preservation strategy is the inverse of emulation as it seeks to preserve the ageing technology instead of re-creating its replica. This preservation strategy is also referred to as the "museum style approach", owing to its focus on preserving the original technology used to access and store data. It involves the preserving of the digital object along with the actual rendering system as means of preserving the look and feel of the digital environment (Gbaje, 2011). Technology preservation may be the best solution at least in the short-term because it ensures that the material is accessible by preserving the access tools as well as the object itself. Moreover, it offers the potential of coping with media obsolescence, assuming the media has not decayed beyond readability (Ismail & Affandy, 2018).

- **Proactive digital preservation**

Proactive digital preservation refers to processes and plans aimed at the preservation of data, which are formulated before the actual creation of digital data. Unlike other preservation strategies which are created reactively, this one is formulated proactively or in advance before the digital data exists. Bountouri (2017) highlights that proactive digital preservation starts from the early creation stages of a digital resource, engaging also the producers of the digital material. Moreover, one of the basic steps in this strategy is to put in place processes and policies early enough to allow for the digital resources to remain accessible and usable over time.

CHALLENGES AFFECTING THE PRESERVATION OF DATA IN IR'S

There are several difficulties that could be encountered in the process of data preservation using institutional repositories that academic libraries need to overcome as born digital data and technology are ever developing. Ball (2010) on the Digital Curation Centre, noted a lack of a formal preservation policy from 21 surveyed repositories in the year 2006. Abd Aziz (2011) observed technology obsolescence as one of the dominant challenges affecting the preservation of data. This author relates this challenge to the hardware and software used to store and access digital information which is said to be affected by constantly upgrading outdated systems in most institutions. This concurs with Gbaje (2017) who notes that the rapid developments in information technology can result in hardware and software obsolescence. In this note, Abd Aziz (2011) suggests that developers need to ensure continued access to digital materials. Maintaining a balance between ease of deposit and the need for preservation is also observed to be challenging (Abd Aziz, 2011: 8). Recently, Barreuco and Termenes (2021) found out that there are few cases of software applications used to carry out integrated management of preservation activities in institutions around the globe. They only identified the Archivematica with its very limited detail about how it is being implemented. On the other side, Moseti (2016) observed distrust and lack of awareness as the key factors hindering the use of institutional digital repositories for preservation of scholarly content in most universities in Kenya. Similarly, Gbaje (2017) also noticed a lack of awareness and lack of institutional policy on digital preservation, as well as a lack of technical know-how as the chief challenges surrounding the preservation of IR contents. Again, Nunda and Elia (2018) found students to have a positive perception towards the use of the institutional repositories and thus using them, however, awareness and adoption were found to be stumbling blocks. Correspondingly, Christian (2009) also found issues related to a lack of awareness of the open access publishing in academic and research institutions in developing countries, inadequate information and communication infrastructure, lack of funding as well as poor advocacy for open access as well as copyright management to be affecting the development of institutional repositories. Issues related to funding were also the case in Anyaoku and Baro's (2018) study as it also revealed a lack of long-term funding and lack of the necessary technical staff with prerequisite skills to handle and manage the IR. Anyaoku and Baro (2018) also noted few university libraries as having been successfully created and managing IRs to preserve their electronic materials in Africa. This was related to self-archiving which was found to be low. Gozetti (2009) highlights a lack of use by scholars, tightening of publishers' position, lack of interest and long term commitment by faculty administration (which can be disastrous affecting IR policies), decreasing quality of library services due to amount of work committed to librarians, and training of staff as the dominant challenges that were cited during their study. Robertson and Borchert (2014) found born digital data to create an added challenge when it comes to deciding what exactly needs to be preserved in an IR of an institution.

GAPS IN LITERATURE

The reviewed literature portrays data preservation as a topic that has received a great deal of attention especially in academic institutions where the long-term preservation of digital data is still a burning issue. The current study identified some research gaps from some of the objectives covered in the above literature discussion. The first research gap identified relates to the software platform used for data preservation in academic libraries. It has been observed that the DSpace is the only software platform that was designed with the intention of long-term data preservation in mind. Other reviewed software platforms clearly support data preservation but the intention behind them coming into existence was access and dissemination of data in the institutional repositories of academic libraries.

For second research gap, literature suggests that migration is one of the key data preservation strategies that has been adopted by a majority of academic institutions for ensuring continued access to data. The actual gap is the lack of research that has been conducted on an in-depth scale towards other data preservation strategies. This research gap comes after it was observed that some academic libraries adopt migration because of other libraries that are successfully using it. A careful and scientific investigation of the other strategies can shed some much-needed light on their benefits thus increasing their visibility and adoption in academic libraries.

The last research gap is identified from the challenges affecting data preservation through the institutional repositories. One of the challenges is the reluctance of researchers to deposit data in the IR's, which therefore gives rise to the research gap concerning the lack of research on the search-ability and retrieve-ability of data that is kept in institutional repositories.

RESEARCH METHODOLOGY

This study employed an interpretivist research paradigm following a qualitative mode of inquiry in a form of a case study. The adoption of the interpretivist school of thought along with the qualitative mode of inquiry was employed as it allowed the researchers to view the world through the perceptions and experiences of the academic librarians from the participated institutions to understand how they support data preservation through their Institutional Repositories (IRs). After receiving permission to collect data from the participated institutions, primary data was collected through conducting interviews using Microsoft Teams. This study employed virtual interviews mainly because it was carried out during the COVID-19 pandemic and there were lockdown regulations in place restricting the researchers' mobility and face to face interactions. Five Librarians dealing with the institutional repositories, digital services, electronic resources and metadata were purposively selected from each participating institution. Two Librarians dealing with the institutional repositories at the University of Zululand and three from the Durban University of Technology participated in the study. Unfortunately, the University of KwaZulu-Natal did not participate.

At the outset of conducting each interview, the participants were given briefs of the study. After the introduction and briefing, permission to record the interviews was requested before each interview began. There are several qualitative data analysis techniques, such as discursive, structured and instrumental, and thematic data analysis, among others (Ngulube, 2015), and the thematic method was deemed suitable and employed for the current research. In the current study, narrations from interviews were organised, sorted, arranged and transcribed. All the data were carefully read through to get a general sense of the gathered information on the problem investigated, which helped to get a reflection of the overall meaning. After studying the data, it was coded. Coding is the process of categorising the text data collected and labelling them with terms, which are usually the actual language of the participants (Creswell, 2014; Kumar, 2011). The coding of responses for this study was achieved by categorising the collected data into themes derived from the set objectives of the study. This was done to create a text-based version of the original audio that was recorded during the interviews. The coding was achieved through the use of direct quotes or verbatim narratives and by paraphrasing some responses of the study participants. The results of this preliminary study are reported in the next section.

RESULTS OF THE STUDY

The results of this research study are from the five participants from the two participating academic libraries (the University of Zululand library and Durban University of Technology library) from the three targeted. As the study was targeting three academic libraries, one of them (University of KwaZulu-Natal) did not participate. The study participants were identified, and their responses are coded as Participant 1(P1)- Librarian 1, Participant 2 (P2)- Librarian 2, Participant 3 (P3)- Librarian 3, Participant 4 (P4)- Librarian 4 and Participant 5 (P5)-Librarian 5. The results are interpreted in line with the following research themes:

Biographical Information

The section on biographical data covered institutional names, highest academic qualifications, job titles, period of work in their job positions as well as their research related duties. Two participants of the study were from the University of Zululand (UZ) and three from Durban University of Technology (DUT). P1 holds Masters in Library and Information Science, P2 has Honours in Information Science, P3 and P4 hold Masters in Library and Information Science, and P5 has Masters in Information Technology. The participants of the current study included the Librarians dealing with the institutional repositories, digital services, electronic resources and metadata. Most participants had more than three years of working experience. The participants research related duties included research support by facilitating data storage and planning as well as the dissemination of research through the institutional repository, source and present electronic resources to the rest of the university community, upload research articles, electronic theses and dissertations, book chapters and do the authority control among other duties.

Types of the Institutional Repository Software in Academic Libraries

The participants of the study were asked about the type of the institutional repository software that is currently used in their respective academic libraries. All the five participants of the study indicated that they are using DSpace. P4 and P5 specifically indicated they are currently using DSpace-CRIS. The study participants were also asked if the institutional repository software they used supports long term data preservation or not. All the five participants of the study attested that DSpace supports long term data preservation. P4 indicated that “DSpace provides curation tasks to check the integrity of the data. Also, CNRI handles (unique, persistent identifiers) are assigned to all items stored in the repository”. P2 articulated that definitely it does, and if there are no technical glitches, all the data that has been kept going back as far as 10 years, is always accessible. For example, the data that has been submitted in the year 2010 is still available and retrievable instantly”. P3 also confirmed that, “it does, because we have retrospective theses available on our IR”. P5 also concurred by stating that, “yes it does, in the way it stores it; the stored data is kept forever”.

Data Preservation and Access in IRs

It was also significant to understand if the IR software used can be regarded as a preservation channel or only facilitates access to data. All the study participants attested that their IR software does both the functions of preservation of data and facilitates access to data. The study participants were asked to share their experiences on how they preserve data on their IR. P4 acknowledged that “Tabular research data is stored in a separate CKAN repository. Other forms of research (articles, etds, and presentations) are stored directly in the DSpace repository in the /asset store directory. This directory is regularly backed up to another server as are the databases of both repositories. Both the CKAN and DSpace repositories are Vms in the University’s data centre, and are backed up according to IT Support Services policies”.

Data Preservation in Support for Academic Performance

The study participants were asked to share their views on how data preservation in the IR supports academic performance. P4 felt that researchers have a portfolio of their work that is publicly available and they can also access other research and research data so that they can build on it and identify potential collaborators. P5, acknowledged that since data is readily available online, academics, researchers and anyone studying can have access to it immediately. P2, indicated that "the correct capturing process of any data equals to the good support of and the trust being built by the library and the consumers of the information which are the researchers". P3 felt that data preservation helps academic performance through helping students and researchers to undertake their research works and assignments. P1 indicated that data preservation supports its re-use among the researchers in an institution or even elsewhere. The verbatim from responses however indicated that researchers cannot self-preserve their data as the fact remains that data preservation requires more administrative work. Promisingly, the institutions are planning to help the researchers to self-preserve their data in the near future.

Availability of the Training needs for Librarians

The study participants were asked if they have ever received any training for preserving data in their IR. The majority of the study participants indicated not to have received any training, instead they do self-learning whereby they learn as they go along. Some of them did receive training. For example, P3, revealed that "Yes I received training which was more about why it is necessary to upload theses, dissertations and research articles bearing in mind who is supposed to upload them as well as how to prepare records before submitting in the final repository". P1, submits to have received research training on DSpace which entailed the uploading of the research works from the institution. P1 has also revealed to have also received training on metadata.

Knowledge and Skills

Study participants were asked to share their views on whether they have enough skills and knowledge for performing data preservation duties on the IR. The majority of the study participants vouched to have enough skills and knowledge. However, P2 indicated that "Yes I do, but when it comes to learning and upskilling, there is always a room for improvement". P3 shared the same sentiment as participant 2, also indicating to have enough skills and knowledge but also acknowledging that "there is always room for improvement". 'Room for improvement' was associated with the new developments that is always brought by technological improvements. Though most participants vouched to have sufficient skills and knowledge, P5 felt not to have skills as they rely on the curation tasks supplied with DSpace.

Training Mechanisms

This question was asked to get an insight on the training mechanisms through reflecting on the resources and staff in place to support data preservation in the IRs. The majority of the study participants indicated to have enough resources for the provision of training. P5, acknowledged that "if we have to train staff, yes, we have enough resources and human capital". P2 stated that "resources are there and I think it a matter of how we utilise those resources for maximum gain". However, P4 and P1 felt that their libraries do not have enough training mechanisms. P1 added to say there is a need for a dedicated space for digitisation in the library.

Collaboration between the Stakeholders

As data preservation involves a certain process and human labour, it was significant to understand the chain within the departments or entire organisation for a successful support of preserving data in libraries. P4 indicated that they work with the IT Support Services who provide the central servers and backups for disaster recovery. P1 highlighted that "I work with the Electronic Librarian and Research Support Librarian". P5 stated that "I work with the other metadata Librarians, Digital Librarian and obviously with the Research Officers and Faculty Officers". P3 acknowledged to work with the Metadata Librarians, Cataloguing Librarians, Systems Librarians and the Faculty Research Officers. P2 articulated that, "I work with the Faculty Librarians, Technician and Systems Manager". P2 added that "Faculty Librarians deal with the client services part, whereas the Technician is responsible for physical hardware and the Systems Manager deals with the back end of the staff like IR and that ensures that the system is running smoothly every day.

Strategies used for Long Term Data Preservation in IR's

This question was asked to get an insight with regard to the strategies used for long term data preservation in the IRs' of the academic libraries. P4 indicated to be using backups and data integrity checks and also unique, persistent identifiers which are assigned to all items. P4 also indicated that they use Rsync for scheduled backups, DSpace curation tasks for integrity checks, and, CNRI handles and Crossref DOIs for identifiers. P2 acknowledged that they always create safe space on a Google drive folder where they store data. This is done through creating a folder of all the deposited physical content along with the spreadsheets of the metadata. They also create a cloud drive storage space, whereby should they want to share some of the information or retrieve in case their DSpace goes crashing, they always have backup data. They also keep the physical items as safe as possible such as on compact discs whereby information is classified and saved in the drawers as well as the printed items. This shows that if the system crashes, it is always easy to retrieve the information either for access by the users or rebuild in terms of their collection.

Institutional Policies guiding Data Preservation in the IRs

The participants of the study were asked about the available institutional policies for guiding the preservation of data in their academic libraries. P4 articulated that "Yes we do have the policy called the Institutional Repository Policy which governs the operations of the institutional repository and mentions data preservation". P5 pointed out that there is an institutional repository guideline or policy. P2 highlighted that there is no specific IR policy, instead they rely on the research policies of the institution. P3 stated that "Yes we do have the policy called the DUT IR policy which helps in collection, dissemination and preservation of the intellectual efforts and research outputs of both staff and students of the institution. It also ensures that the University contributes to the global body of knowledge and maximises the exposure of the DUT research by raising the profile of the institution".

Benefits of Data Preservation for Researchers

Study participants were asked to share their view points on the relevance of data preservation for the researchers. P3 felt that data preservation helps to promote the intellectual property and preserve research outputs of both staff and students in the institution. P4 felt that researchers are assured that their research outputs will be available into the future. P5 indicated that data can be recycled or re-used and that could prevent duplication and also data becomes easily accessible for the researchers. P2 felt that data preservation helps to bring an insight on the strides that have been taken and that helps to identify the gaps on what is it that needs to be done reflecting on the current landscape. P1 felt that data preservation promotes the re-use of data.

Challenges affecting the Preservation of Data in IR's

The study participants were asked to share their experiences on the challenges they encounter when preserving data on the IRs of their respective academic libraries. P4 indicated that "researchers are unwilling to make their research data available as open access". Relatively, P1 highlighted that "most researchers are unwilling to share their research data". P1 added that the buy-in is really the challenge. P2 stated that "the main challenge is the system glitches". P3 pointed out that "the system is sometimes slow, sometimes there are locked PDF files of the thesis when uploading on the IR, some information is missing (e.g. pages), there are some delays of completing the tasks due to a lack of collaboration between the stakeholders involved, and begging the faculty reps to upload theses and dissertations". P5 also indicated a delay in the process of uploading theses as a results that responsible personnel do not treat it as urgent, then it piles up when students graduate as they do not do it timeously. P5 also reflected on a lack of collaboration between the stakeholders involved.

Ways to Overcome the Encountered Challenges

It was significant that the study participants share their perceptions on the ways they think can be done to overcome the encountered challenges regarding the preservation of data on the IRs. P4 felt that "the University policy should mandate making research data available with research outputs". P1 suggested that there really is a need for convincing people (the researchers) on the benefits of sharing their data. In terms of the buy-in, P1 felt that the library and research office need to put a serious sensitisation on data sharing and the management of data and also having any data related policy could help. P2 acknowledged the development of the local software platforms. P3 revealed that sticking to the given guidelines would really help out. P5 stated that "I would say that the faculty officers need to be aware of the importance and urgency of continuously uploading all the research articles and theses". P5 also felt that if the uploading of the theses and articles could be done by only the few Librarians all in one go and avoid involving people from other departments as it causes more delays.

DISCUSSION OF FINDINGS

What Types of the Institutional Repository Software(s) are being Used in Academic Libraries?

The findings of the current study revealed that the institutions that participated are currently using DSpace for preserving data on their IRs. Masenya and Ngulube (2021:8) discovered findings of the same nature, where the DSpace software platform was widely used for data preservation in academic libraries. It is also revealed in the study by Masenya and Ngulube (2021) that the software complies with the OAI, which thus allows items in IR's to be easily discovered by web search engines, services and indexing tools. The finding made by the current study is also corroborated by the research findings of Anyaoku, Echedom and Baro (2018), which reveals a 95, 8% rate of respondents in Africa that use DSpace for preserving their digital content in IR's. The current study also found that DSpace allows long term data preservation which significantly helps in the re-use of data in academic libraries. This concurs with the findings of Friday and Eze (2021), which state that "a number of universities in Nigeria use DSpace, Fedora, EPrints and Greenstone. DSpace however is the most preferred software platform for ensuring long-term digital preservation".

What are the Training Needs of the Librarians to Support Data Preservation in the IRs of the Academic Libraries?

The verbatim from the study participants portrays a picture that there is no formal training received by the librarians other than self-learning. Fortunately, the librarians who participated possess sufficient knowledge and skills for preserving data. However, there is always room for improvement when it comes to re-skilling as we are currently living in the technological driven landscape whereby skills are ever developing. This need for re-skilling or upskilling concurs with the findings by Masenya (2018), whereby library personnel involved in the digital preservation initiatives did not possess the required skills to manage and preserve digital resources. A lack of training was also found in the study by Masenya and Ngulube (2020) which portrays that in most academic libraries the leading problems encountered in preservation of digital resources was a lack of staff training in digital preservation. The current study also revealed that there are enough resources and staff in place to support data preservation in the IRs, though a lack of collaboration between the stakeholders involved in the process of preserving data in the IRs still exists. Masenya and Ngulube (2020) obtained similar findings and recommended that management in academic libraries need to seek appropriate opportunities to collaborate with other institutions and organizations on digital preservation initiatives so that their institutions may benefit from shared resources available to deal with shared challenges.

Which Strategies are used for Long Term Data Preservation in IR's of the Academic Libraries?

Academic libraries are using backups, data integrity checks, unique persistent identifiers, Google drive, and cloud drive storage. The overall findings show that digital migration is the commonly used data preservation strategy in both institutions. Moseti (2016) also attained findings that resemble the findings of the current study where portable storage and hardcopies were utilized as means of preserving digital content in IR's, where the staff backed up digital content, migrated files to newer computers, and saved data in PDF format while also making hard copies of the data. A study conducted by Adjei, Mensah and Amoaful (2019) shows migration as the most preferred strategy of data preservation in academic libraries in Ghana. All the participants of the current study reported that IR content was backed up and stored in secure storage systems. Friday and Eze (2021) attribute the dominance of migration as a data preservation strategy to its effectiveness in academic libraries, which has thus led to its wide adoption in other academic libraries. The present study also revealed some academic libraries to have specific institutional repository policies whereas some do not but rely on the research policies of the institutions. Ismail and Affandy (2018) share that policy development is a vital element in the development of a data preservation strategy, as it assists to plan coherent preservation programmes. Additionally, the findings of the current research reveal that preserving data in an institution is believed to promote data re-use other than anything else. Similarly, Higgins (2008: 138) in the current employed theoretical model (DDC curation lifecycle model) highlights that publicly available published information can re-enforce the actions of access, use and reuse in an organisation.

What are Data Preservation Challenges in the IRs of the Academic Libraries?

There are several challenges with regard to preserving data in the IRs of the academic libraries, however unwillingness to make research data available as open access from the researchers, system glitches, a lack of collaboration between the stakeholders involved seem to be most dominant challenges. Joo, Hofman and Kim (2018) claim that the greatest problem in institutional repositories is that faculty members are reluctant to deposit their research publications. As highlighted in the literature, Gozetti (2009: 18) also laments on the reluctance of scholars to deposit their research materials in the IR's. Considering the issue of collaboration between stakeholders involved in data preservation, Formenton and Gracioso (2020) aver that success in overcoming challenges of digital preservation requires greater collaboration between organizations, teams of professionals and creators of digital objects to be maintained.

RECOMMENDATIONS

- Given that there are several identified gaps in the current study, it is recommended that University policy should mandate making research data available with research outputs.
- In terms of the researchers being reluctant to make their data available on the open access platforms, awareness programs on the benefits of sharing their data is recommended.
- There is also a need for academic libraries and research office to put a serious sensitisation on data sharing and the management of data. In this regard, having data related policy is really significant in the preservation of data in academic libraries.
- There should also be a local development of the systems used for data preservation.
- Additionally, there really is a need for collaboration between the stakeholders involved in the preservation of data in academic libraries.

LIMITATIONS OF THE STUDY

The study only presented the findings based on qualitative data collected from two of the three institutions targeted in KwaZulu-Natal due to the Covid-19 pandemic and restrictions. As this study employed a case study, as a rule, the results cannot be generalized. Future studies could cover a wide scope in terms of the academic libraries in the country in relation to data preservation in IRs. On the same note, being an empirical study, the strength of this chapter is its originality in terms of adding insights, therefore a comprehensive study which includes more than two academic libraries is recommended in the future.

CONCLUSION

Guided by the digital curation centre (DCC) lifecycle model, this study examined how to support data preservation through the institutional repositories of the academic libraries in South Africa, particularly those based in the province of KwaZulu-Natal. The study revealed that there is no formal training received by the librarians other than self-learning in support for data preservation in the two academic libraries which formed part of the research participants. Promisingly, librarians seem to have sufficient skills and knowledge to perform data preservation duties. A lack of collaboration between the stakeholders involved in the process of preserving data in the IRs still exists. Not all the academic libraries have specific institutional repository policies and therefore they rely on institutional research policies. Additionally, unwillingness to make research data available as open access from the researchers and system glitches are still the dominant challenges hindering data preservation in academic libraries.

REFERENCES

Abd Aziz, M. F. (2011). Challenges in developing and implementing institutional repositories in higher educational institutions. *Jurnal PPM: Journal of Malaysian Librarians*, *5*, 1–14.

Abdulkadir, A. (2014). *The use of DSpace software in the preservation and management of library resources: conference paper*. 10.13140/2.1.3718.2088

Adjei, E., Mensah, M., & Amoaful, E. A. (2019). The story so far-digital preservation in institutional repositories: The case of academic libraries in Ghana. *Digital Library Perspectives*, *35*(2), 80–96. doi:10.1108/DLP-12-2018-0039

Affandy, H. B., & Ismail, A. (2017). *Conceptual paper: Digital preservation strategies in archival institution*. Academic Press.

Barrueco, J.M., & Termens, M. (2021). Digital preservation institutional repositories: a systematic literature review. Digital Library Perspectives, 37(1).

Bountouri, L. (2017). *Archives in the Digital Age: Standards, Policies and Tools*. Elsevier.

Castagné, M. (2013). *Institutional repository software comparison: DSpace, EPrints, Digital Commons, Islandora and Hydra*. Available at: http://hdl.handle.net/2429/44812

Cherukodan, S., Kumar, G. S., & Kabir, S. H. (2011). Using open source software for digital libraries: A case study of CUSAT. *Emerald*, *31*(2), 217–225.

Creswell, J. W. (2014). *A concise introduction to mixed methods research*. SAGE publications.

Ebele, N. A., Anthonia, U. N. E., & Ebikabowei, E. B. (2019). Digital preservation practices in university libraries: An investigation of institutional repositories in Africa. *Digital Library Perspectives*, *35*(1), 41–64. doi:10.1108/DLP-10-2017-0041

Formenton, D., & de Souza Gracioso, L. (n.d.). *Digital Preservation challenges, requirements, strategies and scientific output*. Academic Press.

Francke, H., Gamalielsson, J., & Lundell, B. (2017). Institutional repositories as infrastructures for long-term preservation. *Information Research*, *22*(2).

Friday, J. E., & Eze, M. E. (2021). Digital Preservation of Electronic Theses and Dissertations in Public University Libraries in South-East Nigeria. *Library Philosophy and Practice*, 1-21.

Garrett, L., Gramstadt, M., & Silva, C. (2013). Identifying and selecting the infrastructure required to support the curation and preservation of visual arts research data. *International Journal of Digital Curation*, *8*(2), 68–88. doi:10.2218/ijdc.v8i2.273

Gbaje, E. S., & Mohammed, M. H. (2017). *Long-term accessibility and re-use of institutional repository contents of some selected academic institutions in Nigeria*. Paper presented at IFLA SOCRS satellite meeting 2017.

Higgins, S. (2008). *The DCC curation lifecycle model*. Academic Press.

Joo, S., Hofman, D., & Kim, Y. (2018). Investigation of challenges in academic institutional repositories: A survey of academic librarians. *Emerald*, *37*(3), 527–548.

Kari, K.H., & Baro, E.E. (2016). Digital preservation practices in university libraries. *De Gruyter, 45*(3), 134–144. doi:10.1515/pdtc-2016-0006

Kumar, R. (2011). *Research methodology: A step-by-step guide for beginners* (3rd ed.). Sage.

Li, Y., & Banach, M. (2011). Institutional repositories and digital preservation: Assessing current practices at research libraries. *D-Lib Magazine*, *17*(5). Advance online publication. doi:10.1045/may2011-yuanli

Madalli, D. P., Barve, S., & Amin, S. (2012). Digital preservation in open-source digital library software. *Journal of Academic Librarianship*, *38*(3), 161–164. doi:10.1016/j.acalib.2012.02.004

Maesaroh, I., & Genoni, P. (2010). An investigation of the continuing professional development practices of Indonesian academic libraries. *Library Management*, *31*(8/9), 621–634. doi:10.1108/01435121011093397

Masenya, T. M., & Ngulube, P. (2020). Adoption and implementation of digital preservation strategies by academic libraries in South Africa. *Mousaion*, *38*(1), 1–21. doi:10.25159/2663-659X/7123

Masenya, T. M., & Ngulube, P. (2020). Factors that influence digital preservation sustainability in academic libraries in South Africa. *South African Journal of Library and Information Science*, *86*(1), 52–63. doi:10.7553/86-1-1860

Masenya, T. M., & Ngulube, P. (2021). Digital preservation systems and technologies in South African academic libraries. *South African Journal of Information Management*, *23*(1), 1–11. doi:10.4102ajim.v23i1.1249

Mensah, M. (2015). Digital preservation in the context of institutional repositories in public universities in Ghana. *International conference on African digital libraries and archives*.

Ngulube, P. (2015). Trends in research methodological procedures used in knowledge management studies. *African Journal of Library Archives and Information Science*, *25*(2), 125–143.

Prabhakar, S. V. R., & Manjula Rani, S. V. (2017). Benefits and perspectives of institutional repositories in academic libraries. *Scholarly Research Journal for Humanity Science & English Language*, *5*(25), 6904–6909.

Rosa, C. A., Craveiro, A., & Dominques, P. (2017). Open source software for digital preservation repositories: A survey. *International Journal of Computer Science & Engineering Survey*, *8*(3), 21–39. doi:10.5121/ijcses.2017.8302

Shearer, K. (2015). Comprehensive brief on research data management policies. Academic Press.

Shimray, S. R., & Ramaiah, C. K. (2018). Digital preservation strategies: An overview. *Proceedings of 11th national conference on recent advances in information technology*.

Tapfuma, M. M., & Hoskins, R. G. (2019). Usage of institutional repositories in Zimbabwe's public institutions. *South African Journal of Information Management*, *21*(1), 1–9. doi:10.4102ajim.v21i1.1039

Thanos, C. (2017). Research data reusability: Conceptual foundations, barriers and enabling technologies. *Publications*, *5*(1), 2. doi:10.3390/publications5010002

Unal, Y., Chowdhury, G., Kurbanoglu, S., Boustany, J., & Walton, G. (2019). *Research data management and data sharing behaviour of university researchers*. Academic Press.

Verma, L., & Kumar, N. (2018). Comparative analysis of open source digital library software's: A case study. *DESIDOC Journal of Library and Information Technology*, *38*(5), 361–368. doi:10.14429/djlit.38.5.12425

Wilcox, D., & Weinraub, E. (2017). *Supporting Digital Preservation and Access with Fedora*. Available at: http://library.ifla.org/id/eprint/1758

ADDITIONAL READING

Mannheimer, S. (2021). Data Curation Implications of Qualitative Data Reuse and Big Social Research. *Journal of Escience Librarianship*, *10*(4), 5. doi:10.7191/jeslib.2021.1218

Austin, C. C., Brown, S., Fong, N., Humphrey, C., Leahey, A., & Webster, P. (2016). Research data repositories: Review of current features, gap analysis, and recommendations for minimum requirements. *IASSIST Quarterly*, *39*(4), 24–24. doi:10.29173/iq904

Lin, D., Crabtree, J., Dillo, I., Downs, R. R., Edmunds, R., Giaretta, D., & Westbrook, J. (2020). The TRUST Principles for digital repositories. *Scientific Data*, *7*(1), 1–5. doi:10.103841597-020-0486-7 PMID:32409645

KEY TERMS AND DEFINITIONS

Data: Is any information gathered, stored, and processed in order to generate and validate original research findings.

Data Preservation: Is the act of maintaining data safety and integrity.

Institutional Repository: Is a digital archive for gathering, maintaining, and sharing digital copies of a research institution's intellectual work.

Chapter 12
Application of Blockchain Technology for Distributed Management of Digital Research Library Holdings

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ABSTRACT

Technological advancement is gradually shifting the paradigm of how network records and transactions are processed and secured without third-party intervention. The importance of blockchain technology in performing these roles cannot be overstated. This technology has a wide application in the health, banking, insurance, real estate, media, and transportation sectors. Nevertheless, the role of blockchain technology in the distributed management of digital research library resources has received limited attention. This chapter discusses the distributed management of digital research library resources through blockchain technology. It explains the meaning, features, and components of blockchain technology. Concepts such as distributed library management and digital research library were clarified. The digital research library materials were highlighted along with how they can be managed. The chapter thus argues that blockchain technology can be used in the distributed management of digital research library resources.

INTRODUCTION

Blockchain technology emerged as an attempt to offer a solution to the long-lasting problem of third-party involvement in the management, exchange, and sharing of information and tenders among people

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involved in a transaction. Bitcoin has successfully applied this user-to-user data sharing or exchange model to allow free movement and exchange of digital currencies and information across different local and international locations. This end-to-end technological advancement can also be a feasible mechanism for fully implementing a distributed library management system. Although Cabello et al. (2017) proposed this model, it appears to be deficient in tackling issues of multiple library database registrations among library patrons in the global research community. Thus, this chapter was designed to explain how blockchain technology can be used to enhance the effective implementation of distributed management of research library resources and correct issues of multiple user identities in research libraries. The reader should be able to do the following after reading this chapter:

- explain the concept of blockchain technology
- state the uses of blockchain technology
- define a digital research library
- describe distributed management of research libraries
- discuss the application of blockchain in distributed management of digital research library resources

BLOCKCHAIN TECHNOLOGY

Blockchain is a highly secured and dependable transactional and information database that has received global recognition as a global record-keeping mechanism and has been found effective in managing big data (Muheidat et al., 2022). It is an integrative and decentralised database developed to record, validate, maintain, make public and distribute records of transactions among clients on the same network (Kondor et al., 2014; Sarmah, 2018; Yli-Huumo et al., 2016). It applies cryptography as a security mechanism in which every individual record, transaction, and message is cryptographically signed, thereby reducing the incidence of network hacking, data mutilation, and data compromise (Kawaguchi, 2019).

Blockchain technology is made up of blocks that allow everyone on the network to access the activities of other users in the same network. With this structure in place, it becomes more difficult for a single central block to exert influence over the network. Customers may see their transaction records without the participation of a third party, which is a vital goal of the system's architecture. The idea behind the concept of blockchain technology was to remove all barriers to the free flow of digital currency among clients in a block network across the globe through cryptography. Thus, the domain of this technological innovation originally was currency cryptography (Chen et al., 2018). Blockchain is tied to Satoshi Nakamoto, the man who formally applied the technology to operationalise the cryptocurrency called Bitcoin in 2008.

Blockchain technology is built so that no central database or block regulates, rules, or supervises it. Rawat et al. (2021) noted that to avoid the need for a trusted third party, the distributed ledger technology known as "blockchain" records all transactions and processes in an uninterrupted sequence of blocks. Every user in all the blocks in the network has adequate access to the activities of other users. Once information is verified and recorded in the blockchain, it cannot be manipulated, altered, or erased. It is sent to the network whenever a transaction is made, where automated systems verify its validity. Once transactions are validated, they are connected to the transaction log, creating what is known as a "blockchain" or "chain of transactions". The global acceptability of blockchain technology is hinged on the level of transparency and security that characterize its operations. For instance, Kawaguchi (2019) notes that instead of all the databases on the network maintaining their separate dataset, every user has controlled access to a shared dataset. This creates a single source of truth, giving everyone working with this data confidence that they are using the most recent, accurate, and reliable dataset.

Key Operational Elements of Blockchain Technology

Blockchain technology works using three operational elements (Agrawal et al., 2021; Czachorowski et al., 2019; Kawaguchi, 2019). These are (a) a hash, (b) timestamped batches of recent valid transactions, and (c) the hash of the previous block

- **Hash:** Hash is the programme that performs the function of blockchain computation. It is a function responsible for converting data into an irregular fixed-length value. This operational element of blockchain is designed to prevent hacking as it makes it nearly impossible to guess the length of the hash, thus preventing people from hacking the network. It is a one-way function that helps scramble plaintext, data, messages and records using salt into an unreadable form that cannot be decrypted.
- **Timestamped batches of recent valid transactions:** In the blockchain network, transactions are stored in each block in a unique pattern serially. This helps to ascertain the particular or exact time the block has been mined and validated by the network. This process is called timestamping. It involves recording data on a blockchain to prove that it existed at a specific date and time. Kawaguchi (2019) notes that the timestamp element of blockchain proves that the data must have existed or been mined in the network.
- **The hash of the previous block:** In the blockchain network, as new transactions are timestamped, validated and hashed, they are linked to the hash of the previous blocks. This helps prevent the alteration of blocks or a situation where blocks are inserted between two blocks that already existed on the network. This operational element of blockchain technology is meant to perform verification functions in the network so that successive blocks strengthen the verification of the previous block. With this function, data are verified, timestamped, and recorded serially with adequate attention to time.

Features of Blockchain Technology

There are crucial distinguishing features that make blockchain technology different from other conventional digital information database systems. These include decentralised databases, corruption-proof, trackability and consensus (Andoni et al., 2019; Chen et al., 2018; Crosby et al., 2016). These are explained as follows:

i. *Decentralisation of the database:* Distributed structures are used in the blockchain to verify data storage, management and transfer since no one block is responsible for all of the functions of the blockchain. Due to blockchain's reliance on a decentralised network of nodes, data is constantly routed via many nodes, guaranteeing that the original data's integrity is never compromised, even if one node is compromised

ii. *Corruption-proof:* All ongoing activities among blocks in the network are accessed by all users in the blockchain structure. Also, any time a transaction is tampered with or verified data altered, all other nodes are notified using the same verification process. The chain is secured and free from corrupt practices with this operational structure. Due to the lack of a single point of failure, blockchain technology is more secure than its rivals..
iii. *Trackability:* All transactions on the blockchain are ordered chronologically with a cryptographic hash function which enables a block to be connected to other blocks. In this way, every operation or activity is traceable using hash keys associated with a block's metadata.
iv. *Consensus:* All blocks in the network must verify an entry or transaction for it to be authenticated or recorded on the chain. This means that all the blocks must make efforts to verify a transaction coming from each block in the blockchain. The efficiency of blockchain technology is mainly attributable to the consensus algorithm. In reality, it is a characteristic shared by all blockchains. Consensus is a method for network nodes to make collective choices. Here is where you should turn if you need a contract urgently. When millions of nodes validate a single transaction, a system's functioning requires a consensus to run smoothly. This may be contrasted with a voting system in which the majority wins, and the minority must support it. In reality, consensus destroys public faith in the system. They may not trust one another, but they may have confidence in the algorithm behind the system. Therefore, every decision taken on the blockchain is beneficial to the system.
v. *Increased capacity:* This is the first and most important component of Blockchain. The most striking characteristic of Blockchain technology is that it increases the capacity of the whole network. Many computers working together provide greater power than a small number of centralised ones. Several computers work together, resulting in a greater overall output. This enhanced potential is shown by Stanford University's initiative to create a supercomputer capable of replicating protein folding for medical research.
vi. *Imutability:* The establishment of immutable ledgers is one of the main advantages of blockchain. A central database is susceptible to hacking and fraud since it depends on the trust of a third-party intermediary to keep it secure. For example, Bitcoin's blockchain keeps its ledgers going forward at an unending rate. The digital ledger is available to all network nodes. Before a transaction can be added, every node must validate its authenticity. If the majority agrees, it's added to the ledger. This guarantees that the system is transparent and devoid of corruption. In addition, once transaction blocks are added to the distributed ledger, the procedure cannot be undone. As a consequence, no other network user may modify, delete, or update the file.

Components of Blockchain Technology

Blockchain technology has four essential components that enable its operations. These are (a) distributed ledger, (b) smart contacts, (c) distributed applications, and (d) the digital signature. Each of these components is discussed below.

- *Distributed Ledger:* Blockchain technology functions through distributed digital ledger technology (DLT). When using the distributed DLT, nodes (the machines that make up a distributed ledger) capture, transmit, manage, and verify transactions in each ledger.
- *Smart Contracts:* This uses a set of highly configured protocols or programs on the blockchain to automatically implement contracts and transactions between two or more parties. It ensures

transparency in the transaction(s) to increase confidence among parties without needing a third party and save time.

- *Distributed Applications:* These are programmes built into the blockchain that enable information on every transaction among users in the blocks to be recorded and shared across multiple computers on the network on a peer-to-peer basis.
- *Digital signature:* A digital signature is used to promote security in the blockchain and promote safe transactions between nodes. Two types of digital signatures are required when using blockchain technology. These include the private key (used for encrypting transactions sent to a user) and the public key (used to encrypt transactions after verification that the transaction is complete).

Uses of Blockchain Technology

The following are some uses of blockchain technology:

i. *Provision of peer-to-peer digital currency system:* Blockchain technology enables direct transactional interaction between blocks on the network without any intermediary. Once transactions are broadcasted on the network and verified by recipients, payment is made through a cryptographic process.

ii. *Protection and preservation of digital records of individual blocks:* Blockchain technology prevents all verified records on each block in the network from alteration and removal. Once all the blocks in the network verify records, data, information or transaction, they are distributed and stored in the database of each block. This makes it difficult for any block to tamper with it.

iii. *Distribution of digital records:* Another practical use of Blockchain technology is the distribution or sharing of records among the blocks in the network. The technology allows every database, in the form of a block, to be linked to another database through nodes. Thus, other blocks can assess every individual's digital records or activities in each block on the network.

iv. *Data mining:* In blockchain technology, this is called blockchain mining and involves verifying each stage of the transaction and movement of cash from one block to the other. This process allows for quick verification of data.

v. *Asset tracking:* Blockchain technology is a method for monitoring assets and determining evidence of possession or origination (Fahmy, 2018). This function of blockchain technology enables the tracking of all activities carried out by clients in all the blocks of the blockchain network. This reduces the tendency of online property theft.

vi. *Digital Identity:* This is another important use of blockchain technology. Every client is given a private and public digital key that is immutable and verified or known by every block within the chain network.

DISTRIBUTED LIBRARY MANAGEMENT

The distributed library is an emerging innovation in the library and information science discipline. It is a collection of library resources available for borrowing by users. The library catalogue is maintained on fragmented, linked together databases and accessible to users through the Internet (Melnik et al., 2021). Some researchers have observed that the distributed library system employs a vertical fragmentation strategy, allowing for the vertical division and storage of information about loans, books, and members for all users (Khan & Hoque, 2010; San & Nyunt, 2010). A distributed library is based on a distributed database system, interconnected logically with a shared collection of data kept on computers at various locations. The data on the computer network is accessible to all users from different locations on the network. There are two types of architecture in a distributed library system: peer–to–peer (P2P) and Client-Server architectures (San & Nyunt, 2010).

A peer-to-peer (P2P) network is a distributed system of computers (known as nodes) that act as clients and servers simultaneously or separately. Under this network architecture, each node is an equal peer. Furthermore, all distributed library nodes are linked to the server hosting the network in a client-server design. Similarly, distributed library management follows the Distributed Database Management System (DDBMS) works. The DDBMS is a software that allows the administration of a distributed database and makes the dispersion of the database visible to users (Rahimi & Haug, 2010; San & Nyunt, 2010).

Each fragment of the DDBMS is kept on one or more computers under the supervision of an independent Distributed Database System (DDS) linked through communication networks to the rest of the DDBMS. Distributed Library Management (DLM) connects different distributed libraries on a single network that allows all users to have adequate access to the resources held by the various distributed libraries. According to San and Nyunt (2010), the use of the "Distributed Library Management System" (DLMS) provides access to sites from remote locations and assists in query and data transfers between different databases through the network. In addition to delivering metadata of specific distributed data storage, the DLMS also offers security control through the appropriation of access to distributed data. The DLMS also guarantees the consistency and robustness of requested data.

DIGITAL RESEARCH LIBRARY

The purpose of research libraries is to serve the research requirements of academics worldwide. While all university libraries are considered research libraries, the government and other organisations may also have specialised research libraries. A research library is often associated with scholarly communication services, such as assistance for institutionally sponsored open access publications and maintaining an institutional repository (Newton et al., 2010). Most research libraries are institutionally oriented and are intended to support the institution's research operations. A digital research library is hosted virtually by an institution to gather, administer, preserve much digital information for the long term and provide specialised services to users and communities according to standards (Trivedi, 2010).

Collecting digital resources for information management tools does not constitute a research library. Several activities must connect library resources (collections) to people and services (Suna & Yuanb, 2012). This can be done through a complete research data cycle, including creation, dissemination, use, storage, and retrieval (Odigwe et al., 2020; Owan & Bassey, 2019). The audience of a digital research library is the worldwide community. A typical digital research library consists of four essential components: people (researchers), online information resources (such as electronic reference sources, indexes, library catalogue electronic texts and journals), and technology such as computers, the Internet, meta databases, display technologies, search, retrieval, and routing software, among others (Bansode & Shinde, 2019).

Materials in Digital Research Libraries

There are numerous materials in digital libraries that boost their functionality. These include data storage, data sharing, user interface, and data mining materials.

i. *Data storage materials:* These are digital devices that enable the library to store and preserve information, records and transactions permanently for future use. These materials include a database and repository).
ii. *Data sharing materials:* These are machines that enable digital libraries to move information, records, transaction, and other resources from one location to another. These include intranet and Internet.
iii. *User interface materials:* These applications help library users interact with library resources anytime and anywhere. These include Chrome, Firefox, Edge, Brave, Opera, Internet Explorer, Safari etc. Researchers also have an emerging concern to incorporate social media tools into libraries for a more accessible user interface (Cho, 2013; Paul, 2014).
iv. *Data mining materials:* These software applications enable digital libraries to locate, collect, prepare and store metadata about library users. Examples are web crawlers, Boolean operators and wildcards.

Managing Digital Research Library Resources

One of the problems of digital research libraries is the effective management of digital resources in their possession. This involves ensuring that users' records are not altered, research data are not tampered with, and uninterrupted access to desired resources on demand. Many researchers believe that applying Distributed Library Management System (DLMS) is a feasible measure to ensure effective management of digital research library resources (Bansode & Shinde, 2019; Chiu et al., 2021; San & Nyunt, 2010). These will involve the following practices:

i. *Application of Distributed Database system:* Distributed databases are "logically connected" collections of shared data on a computer network that may be accessed from any system in the network (San & Nyunt, 2010). This organised approach makes digital research library materials accessible from anywhere on the network.
ii. *Application of Peer-to-Peer (P2P) distributed system:* The application of peer-to-peer distributed database architecture can allow users to access all the activities going on in the library. This P2P distributed system can also help control illegal research practices if users or the database do not have access to the activities carried out by other users or databases.
iii. *Linking all resources in the library to a database:* This involves clustering library holdings into fragmented databases and connecting them to a network through nodes. With this structure, every resource in the library is assigned a Digital Object Identity based on the database it belongs and thus makes accessibility easy.
iv. *Developing a digital identity for every library user:* Digital research library resources cannot be managed when there is no model to identify those using the resources and those supplying the library. When a digital identity is used, it helps establish a link between an individual and the digital entity with which they are linked (Al-Khouri, 2014; Davis, 2014). Assigning every library user a

unique digital identity can help trace resource use to different users and track all their activities in the library.

Digital Research Libraries Initiatives

The development of Digital Research Libraries (DRL) can be traced back to the works of scientists like Vannevar Bush and J.C.R. Licklider. Their motivation and interest were to identify and develop innovative technologies and approaches toward knowledge sharing as fundamental instruments of progress (Candela et al., 2011). Digital Library Initiative (DLI) formally started in the U.S. in 1994 (Guion, 2021). This initiative was preceded by a system called "e-print archive" developed by Paul Ginsparg in August 1991 and named arXiv. It was a free distribution service for open-access scholarly writings in specific scientific disciplines. Following the operation of arXiv, the DLI emerged, which funded projects aimed at offering more of the functions of the traditional libraries in adding to collection development. Guion (2021) notes that these collections included scholarly papers and digitized maps, photographs, satellite images, videos, and more through DLI. It was possible to pull together research in digital library projects previously fragmented among discipline-specific communities. Berry (1996) notes that during this time, six U.S. institutions received funding for Digital Library Initiatives from the National Science Foundation (NSF), the Department of Defense Advanced Research Projects Agency (ARPA), and the National Aeronautics and Space Administration (NASA) beginning in the fall of 1994. These institutions were Carnegie Mellon University (Pittsburgh), The University of California at Berkeley and Santa Barbara, Stanford University (Palo Alto, CA), the University of Illinois at Urbana Champaign, and the University of Michigan (Ann Arbor).

The first-generation digital library projects were launched, including California Environmental Digital Library, Alexandra Digital Library, Informedia Digital Video Library, Interspace, and the University of Michigan Digital Library. At this time, digital research Libraries served specific communities, organizations and institutions with limited coverage. It has been argued that most of these first-generation digital libraries were "start from scratch" and had monolithic applications, lacking reusability, ease of installation, customization, and configuration (Candela et al., 2011). Though it was complicated to link different institutional digital libraries together, institutions were able to develop their digital library system. Besides, different achieves such as Electronic Thesis and Dissertation Repositories (ETDs), Achieves of Cognitive Science papers (CogPrints), and Research Papers in Economics (RePEc) were developed during this time. The inadequacy of first-generation digital libraries infrastructure to enable interoperability of institutional digital libraries reshaped the thinking of James R. Davis and Carl Lagoze about digital library infrastructure that could facilitate collaboration and sharing of research information among institutions. Two crucial research library initiatives are discussed in this chapter to offer more clarifications on the subject. These are the national and international research library initiatives, discusses hereunder.

National Digital Research Library Initiatives

In 1995, James R. Davis and Carl Lagoze of the Department of Computer Science at Cornell University developed the Networked Computer Science Technical Research Library (NCSTRL) (Davis & Lagoze, 2000). This was the first attempt to introduce the concept of open architecture in a digital library in which the library was made public, not a proprietary system owned by a particular company or community of scholars. NCSTRL operated through Dienst, a protocol and architecture for distributed digital libraries. At this time, the concern was to build a national digital library architecture in which all institutional digital libraries could be linked together to form a national online research repository. With Open Architecture (OA), institutions could create a digital library using sets of standard protocols called "Dienst". Davis and Lagoze (2000) note that Dienst has four core functions: it specifies the operational characteristics of core digital library services; it has a structured document model; it mandates an open, extensible protocol for communicating with digital library services and accessing these documents; and provides a mechanism for definition and administration of a distributed collection. The Dienst architecture also specifies four core digital library services - user interface, repository, index and collection services. The user interface services provide a human-friendly gateway to the information obtained from other services. According to the Dienst document model, the repository services store and provide access to documents. The index services provide search capabilities, accepting a query and returning a list of document identifiers that match the query. The collection services define the digital library collection's components, services, and documents, making it possible for user interface services to interact with them.

The development of NCSTRL gave birth to the National Digital Library Initiative (NDLI). The first project arising from this initiative was the National Digital Library Project of the Library of Congress in the United States. Corporations and foundations are privately funded to make some of their large text and image collections publicly accessible through computer networks (Bearman, 2007). The success of the National Digital Library Project of the Library of Congress sparked the interest of other countries. Thus, in 2005, the National Digital Library Project (NDLP) was launched in China. Similarly, the National Digital Library of India (NDLI) project was initiated in 2015 and launched on June 19, 2018 (Bashir et al., 2019). In 2014, an Elsevier Foundation supported Ethiopia's National Digital Library Project through a grant. This was officially launched in Addis Ababa, Ethiopia, on 13-15 June 2014 (The Elsevier Foundation, 2014). Pakistan's National Digital Library Programme (NDLP) was also introduced in 2003 as part of the Higher Education Commission's (HEC) mission to build and strengthen the research culture in Pakistan (Arshad & Ameen, 2017). However, with the development in networking worldwide, the need to design a global digital library that can enable research information sharing and data interaction across nationals. This led to the International Digital Library Initiative (IDLI).

International Digital Research Library Initiatives

The international research library initiative has been in progress since the 1970s (Berry, 1996). The Digital Library Federation (DLF) is one of the significant International research library projects designed to pioneer the use of electronic information technologies to extend collections and services. It was launched in 1995 as a program by the Council on Library and Information Resources (CLIR) (Wani, 2022). The Google Books Library Project is an international digital library project launched in 2004. In December 2004, Google announced its partnership with libraries of the University of Michigan, Harvard, Stanford, Oxford, and the New York Public Library to scan their books and make the full text searchable online. Another international digital library initiative is the Networked Digital Library of Theses and Dissertations (NDLTD). Wani (2022) notes that NDLTD is an international organization dedicated to promoting the adoption, creation, use, dissemination, and preservation of electronic theses and dissertations (ETDs). In 2009, The World Digital Library (WDL) was operated by UNESCO and the Library of Congress, U.S.A at UNESCO headquarters in Paris on April 21 (Zhang, 2011). WDL makes available on the Internet, free of charge and in multilingual format, significant primary materials from countries and cultures worldwide. The "International children digital library (ICDL)" was designed in 2002 for children aged 3 to 13 years. The library contains digital materials collected in many languages across different countries. The ICDL was developed by the College of Information Studies and the Human-Computer Interaction Laboratory at the University of Maryland, College Park.

BLOCKCHAIN TECHNOLOGY AND THE DISTRIBUTED MANAGEMENT OF DIGITAL RESEARCH LIBRARY RESOURCES

There are several applications of Blockchain technology in the world today. For instance, Blockchain technology is used for digitising the taxation system, power loss prevention system, and health records system in Pakistan (Khalid et al., 2020; Shahnaz et al., 2019; Tan et al., 2021; Vistro et al., 2021). Blockchain technology was proposed as an application for Open Educational Resources jointly called OpenEduChain and the healthcare system in the USA (Benniche, 2019; Holotescu, 2018). Blockchain technology was proposed as an efficient blockchain-based inner-campus book sharing system called BookChian in China (Zeng et al., 2019). Although there is yet a digital library fully implementing blockchain technology worldwide, this chapter proposes its use in the distributed management of digital research libraries due to its functionality in other applications. The need for distributed management of digital library resources is very apt given the growing demand for problem-solving research and the need to make research data readily available for scholars. Apart from these, a growing concern is ensuring the integrity of data available in the global research community. Similarly, with unethical research practices on the Internet, adopting distributed management of digital library resources is very necessary. Since the distributed management of digital research library resources thrives on the web, it is imperative to implement a technology that will make the system free from all forms of unethical and corrupt research practices. Blockchain technology appears to be a promising model that corrects all anomalies associated with the operations of digital research libraries. The link between the application of blockchain technology and the functionality of distributed management of research library resources is explained using the following:

Peer to Peer Distributed Database System

Applying a peer-to-peer distributed database system, a key feature of distributed research library management needs Distributed Applications (DAs). Das are programmes built into the blockchain to enable information on every transaction or activity among users in the blocks to be recorded and shared across multiple computers on a peer-to-peer network basis. The idea is that every digital research library is a block (distributed database) linked through nodes to form a blockchain of digital research libraries. This system will allow library users adequate access to the activities carried out by other users in any database that is connected to the chain network. Thereby reducing the chances of unethical and corrupt research practices in the libraries.

Adoption of Digital Signature (DS)

Utilising digital signatures to ensure communications security inside the blockchain network is necessary. Every user has a public and a private key (digital signature) in the blockchain. The argument here is that when every digital library user has a Digital Signature (DS), it makes for easy tracking of all activities carried out by every digital research library user across the globe.

The Need for Distributed Ledger (DL)

Distributed management of digital library resources cannot function without distributed digital ledger technology embedded in blockchain technology. Using the Distributed digital ledger technology (DLT), transactions are recorded, shared, maintained, and synchronised amongst nodes (computers) in a distributed ledger system. Every digital research library is an independent database that records, shares, and supports research data and other library resources. The separate databases (nodes) are linked together to form a chain of digital libraries.

Distribution of Research Records

A key aspect of distributed management of digital libraries is the distribution of research records and other library resources among the distributed databases within the network. Blockchain applies this system to share transactional records among the blocks in the network. The application of this system in the distributed management of digital libraries will allow every digital library to access research data, information and activities of other library users in the network. This makes library resources and records immutable and secured.

Data Mining

Distributed management of the digital library involves the movement of records, information, and research data from one digital library to another within the library chain. This approach is called blockchain mining and involves verifying each stage of the transaction and movement of cash from one block to the other. This application will allow for adequate verification of library users' research records and other library resources moving from one digital library to another.

CONCLUSION

The distributed management of digital libraries is an innovation in library and information practice that gives a new dimension to managing resources effectively. Different researchers have recommended the application of distributed management of digital libraries as a feasible model for managing digital research library resources within an institution. However, there appears to be limited knowledge on how it can be applied in the global digital research library network. Besides, there is little information on how users' records, research data and other library resources can be distributed across different digital research libraries and made accessible to users with a high level of integrity. As discussed in this chapter, blockchain technology promises to be a pragmatic model that can drive distributed management of digital library resources at the global level. This is because it has all the applications that can effectively distribute digital research library resources among digital research libraries (distributed databases) and reduce the chances of unethical and corrupt practices within the global research community.

REFERENCES

Agrawal, T. K., Kumar, V., Pal, R., Wang, L., & Chen, Y. (2021). Blockchain-based framework for supply chain traceability: A case example of textile and clothing industry. *Computers & Industrial Engineering*, *154*, 107130. doi:10.1016/j.cie.2021.107130

Andoni, M., Robu, V., Flynn, D., Abram, S., Geach, D., Jenkins, D., McCallum, P., & Peacock, A. (2019). Blockchain technology in the energy sector: A systematic review of challenges and opportunities. *Renewable & Sustainable Energy Reviews*, *100*, 143–174. doi:10.1016/j.rser.2018.10.014

Arshad, A., & Ameen, K. (2017). Scholarly communication in the age of Google: Exploring academics' use patterns of e-journals at the University of the Punjab. *The Electronic Library*, *35*(1), 167–184. doi:10.1108/EL-09-2015-0171

Bansode, N. N., & Shinde, M. G. (2019). Impact of new technologies in the digital libraries. *Journal of Advancements in Library Sciences*, *6*(1), 279–283. https://www.researchgate.net/publication/337209596

Bashir, B., Nasreen, N., & Loan, F. A. (2019). National digital library of India: An overview. *Library Philosophy and Practice (e-journal),* Article 6462. https://digitalcommons.unl.edu/libphilprac/6462

Bearman, D. (2007). Digital libraries. *Annual Review of Information Science & Technology*, *41*(1), 223–272. doi:10.1002/aris.2007.1440410112

Benniche, S. (2019). Using blockchain technology to recycle cancer drugs. *The Lancet. Oncology*, *20*(6), e300. Advance online publication. doi:10.1016/S1470-2045(19)30291-8 PMID:31085048

Berry, J. W. (1996). *Digital libraries: new initiatives with worldwide implications*. IFLANET. https://origin-archive.ifla.org/IV/ifla61/61-berjo.htm

Cabello, J., Janßen, G., & Mühle, A. (2017). *Distributed library management system based on the blockchain technology*. Technische Universitat. https://bit.ly/3pgzJ2T

Candela, L., Castelli, D., & Pagano, P. (2011). History, Evolution, and Impact of Digital Libraries. In I. Iglezakis, T. Synodinou, & S. Kapidakis (Eds.), *E-publishing and digital libraries: Legal and organizational issues* (pp. 1–30). IGI Global. doi:10.4018/978-1-60960-031-0.ch001

Chen, G., Xu, B., Lu, M., & Chen, N. S. (2018). Exploring blockchain technology and its potential applications for education. *Smart Learning Environments*, *5*(1), 1–10. doi:10.118640561-017-0050-x

Chen, W., Xu, Z., Shi, S., Zhao, Y., & Zhao, J. (2018). A survey of blockchain applications in different domains. *International Conference on Blockchain Technology and Applications (ICBTA)*. arXiv Preprint. 10.1145/3301403.3301407

Chiu, W. Y., Meng, W., & Li, W. (2021). LibBlock: Towards decentralised library system based on blockchain and IPFS. *18th International Conference on Privacy, Security and Trust (PST)*, 1-9. 10.1109/PST52912.2021.9647821

Cho, A. (2013). YouTube and academic libraries: Building a digital collection. *Journal of Electronic Resources Librarianship*, *25*(1), 39–50. doi:10.1080/1941126X.2013.761521

Crosby, M., Pattanayak, P., Verma, S., & Kalyanaraman, V. (2016). Blockchain technology: Beyond bitcoin. *Applied Innovation, 2*, 6-18. https://j2-capital.com/wp-content/uploads/2017/11/AIR-2016-Blockchain.pdf

Czachorowski, K., Solesvik, M., & Kondratenko, Y. (2019). The application of blockchain technology in the maritime industry. In V. Kharchenko, Y. Kondratenko, & J. Kacprzyk (Eds.), *Green IT engineering: Social, business and Industrial applications* (pp. 561–577). Springer. doi:10.1007/978-3-030-00253-4_24

Davis, J. R., & Lagoze, C. (2000). NCSTRL: Design and deployment of a globally distributed digital library. *Journal of the American Society for Information Science*, *51*(3), 273–280. doi:10.1002/(SICI)1097-4571(2000)51:3<273::AID-ASI6>3.0.CO;2-6

Fahmy, S. F. (2018). *Blockchain and its uses*. https://www.sheriffadelfahmy.org/wp-content/uploads/2018/01/doc-1.pdf

Guion, D. (2021, June 26). *A brief history of the internet and digital libraries*. Reading, Writing, Research. https://www.allpurposeguru.com/2021/06/a-brief-history-of-the-internet-and-digital-libraries

Holotescu, C. (2018). Understanding blockchain opportunities and challenges. In *Proceedings of the 14th International Scientific Conference "eLearning and Software for Education"* (pp. 275-283). National Defence University Publishing House. https://proceedings.elseconference.eu/index.php?r=site/index&year=2018

Kawaguchi, N. (2019). Application of blockchain to supply chain: Flexible blockchain technology. *Procedia Computer Science*, *164*, 143–148. doi:10.1016/j.procs.2019.12.166

Khalid, S., Maqbool, A., Rana, T., & Naheed, A. (2020). A blockchain-based solution to control power losses in Pakistan. *Arabian Journal for Science and Engineering*, *45*(8), 6051–6061. doi:10.100713369-020-04464-z

Khan, S. I., & Hoque, A. S. M. L. (2010). A new technique for database fragmentation in distributed systems. *International Journal of Computers and Applications*, *5*(9), 20–24. doi:10.5120/940-1318

Kondor, D., Po'sfai, M., Csabai, I., & Vattay, G. (2014). Do the rich get richer? An empirical analysis of the Bitcoin transaction network. *PLoS One*, *9*(2), 86197–86207. doi:10.1371/journal.pone.0086197 PMID:24505257

Melnik, E. V., Orda-Zhigulina, M. V., & Orda-Zhigulina, D. V. (2021, April). Distributed Library Model Based on Distributed Ledger Technology for Monitoring and Diagnostics System. In *Computer Science On-line Conference* (pp. 501-509). Springer. 10.1007/978-3-030-77442-4_43

Muheidat, F., Patel, D., Tammisetty, S., Lo'ai, A. T., & Tawalbeh, M. (2022). Emerging Concepts Using Blockchain and Big Data. *Procedia Computer Science*, *198*, 15–22. doi:10.1016/j.procs.2021.12.206

Newton, M. P., Miller, C. C., & Bracke, M. S. (2010). Librarian roles in institutional repository data set collecting: Outcomes of a research library task force. *Collection Management*, *36*(1), 53–67. doi:10.1080/01462679.2011.530546

Odigwe, F. N., Bassey, B. A., & Owan, V. J. (2020). Data management practices and educational research effectiveness of university lecturers in South-South Nigeria. *Journal of Educational and Social Research*, *10*(3), 24–34. doi:10.36941/jesr-2020-0042

Owan, V. J., & Bassey, B. A. (2019). Data management practices in Educational Research. In P. N. Ololube & G. U. Nwiyi (Eds.), *Encyclopedia of institutional leadership, policy, and management: A handbook of research in honour of Professor Ozo-Mekuri Ndimele* (Vol. 2, pp. 1251–1265). Pearl Publishers International Ltd. doi:10.13140/RG.2.2.16819.04647

Paul, K. (2014). Social networking: A powerful tool for the LIS professionals in the digital era. *Asian Journal of Multidisciplinary Studies*, *2*(6), 82–87.

Rahimi, S. K., & Haug, F. S. (2010). *Distributed database management systems: A Practical Approach*. John Wiley & Sons. doi:10.1002/9780470602379

Rawat, D. B., Chaudhary, V., & Doku, R. (2021). Blockchain technology: Emerging applications and use cases for secure and trustworthy smart systems. *Journal of Cybersecurity and Privacy*, *1*(1), 4–18. doi:10.3390/jcp1010002

San, S. M., & Nyunt, K. Z. (2010). *Implementation of library system using vertical fragmentation method in a distributed database*. http://onlineresource.ucsy.edu.mm/handle/123456789/1127

Sarmah, S. S. (2018). Understanding Blockchain Technology. *Computing in Science & Engineering*, *8*(2), 23–29. doi:10.5923/j.computer.20180802.02

Shahnaz, A., Qamar, U., & Khalid, A. (2019). Using blockchain for electronic health records. *IEEE Access: Practical Innovations, Open Solutions*, *7*, 147782–147795. doi:10.1109/ACCESS.2019.2946373

Suna, J., & Yuanb, B. (2012). Development and characteristics of the digital library as a library branch. *IERI Procedia*, *2*, 12–17. doi:10.1016/j.ieri.2012.06.044

Tan, L., Shi, N., Yu, K., Aloqaily, M., & Jararweh, Y. (2021). A Blockchain-empowered access control framework for smart devices in green Internet of things. *ACM Transactions on Internet Technology*, *21*(3), 1–20. doi:10.1145/3433542

The Elsevier Foundation. (2014, June 24). *National digital repository building project kick-off meeting conducted in Addis Ababa.* The Elsevier Foundation. https://elsevierfoundation.org/national-digital-repository-building-project-kick-off-meeting-conducted-in-addis-ababa

Trivedi, M. (2010). Digital libraries: Functionality, usability, and accessibility. *Library Philosophy and Practice (e-journal),* Paper 381. https://digitalcommons.unl.edu/libphilprac/381

Vistro, D. M., Farooq, M. S., Rehman, A. U., & Khan, M. A. (2021, September). Fraud prevention in taxation system of Pakistan using blockchain technology. *Proceedings of the 3rd International Conference on Integrated Intelligent Computing Communication & Security (ICIIC 2021),* 582-586. 10.2991/ahis.k.210913.074

Wani, G. A. (2022). Digital library initiatives: An overview of national and international scenario. *IP Indian Journal of Library Science and Information Technology*, *6*(2), 66–72. doi:10.18231/j.ijlsit.2021.015

Yli-Huumo, J., Ko, D., Choi, S., Park, S., & Smolander, K. (2016). Where is current research on blockchain technology? A systematic review. *PLoS One*, *11*(10), 163477–163504. doi:10.1371/journal.pone.0163477 PMID:27695049

Zeng, J., Dai, X., Xiao, J., Yang, W., Hao, W., & Jin, H. (2019). BookChain: Library-free book sharing based on blockchain technology. In *Proceedings of the 15th International Conference on Mobile Ad-Hoc and Sensor Networks* (pp. 224-229). IEEE. 10.1109/MSN48538.2019.00051

Zhang, A. B. (2011). The world digital library. In C. Xing, F. Crestani, & A. Rauber (Eds.), *Digital libraries: For cultural heritage, knowledge dissemination, and future creation*. Springer. doi:10.1007/978-3-642-24826-9_47

ADDITIONAL READING

Frederick, D. E. (2019). Blockchain, libraries and the data deluge. *Library Hi Tech News*, *36*(10), 1–7. doi:10.1108/LHTN-09-2019-0059

Fu, M.-H. (2020). Integrated Technologies of Blockchain and Biometrics Based on Wireless Sensor Network for Library Management. *Information Technology and Libraries*, *39*(3), 11883. Advance online publication. doi:10.6017/ital.v39i3.11883

Hu, L. (2022, February). Intelligent Value Added Service Platform of Smart Library Based on Blockchain Technology. In *2022 IEEE International Conference on Electrical Engineering, Big Data and Algorithms (EEBDA)* (pp. 1391-1394). IEEE. ttps://10.1109/EEBDA53927.2022.9744776

Hussain, A., & Pervaiz, A. (2021). Adoption of Smart Technologies in University Libraries of Pakistan: A Qualitative Review. *Library Philosophy and Practice,* Article 6055. https://digitalcommons.unl.edu/libphilprac/6055

Khan, A. U., Zhang, Z., Taleby Ahvanooey, M., & Rafique, W. (2022). Opinion mining towards blockchain technology adoption for accessing digital library resources. *Aslib Journal of Information Management*, *74*(1), 135–157. doi:10.1108/AJIM-01-2021-0016

Liu, X. (2019, July). A smart book management system based on Blockchain platform. In *2019 International Conference on Communications, Information System and Computer Engineering (CISCE)* (pp. 120-123). IEEE. 10.1109/CISCE.2019.00035

Masenya, T. M. (2020). Application of modern technologies in the management of records in public libraries. *Journal of the South African Society of Archivists*, *53*, 65–79. doi:10.4314/jsasa.v53i1.5

Meth, M. (2019). *Blockchain in Libraries*. ALA TechSource.

Ojobor, R. C., Ojobor, C. I., & Oluranti, J. (2022). Blockchain Technology and Organizational Practices: The Case of Nigerian Academic Libraries. In S. Misra & A. Kumar Tyagi (Eds.), *Blockchain Applications in the Smart Era. EAI/Springer Innovations in Communication and Computing*. Springer. doi:10.1007/978-3-030-89546-4_9

Omame, I. M., & Alex-Nmecha, J. C. (2021). Application of Blockchain in Libraries and Information Centers. In B. Holland (Ed.), Handbook of Research on Knowledge and Organization Systems in Library and Information Science (pp. 384-397). IGI Global. doi:10.4018/978-1-7998-7258-0.ch020

Oyelude, A. A. (2019). What's trending in blockchain technology and its potential uses in libraries. *Library Hi Tech News*, *36*(9), 17–18. doi:10.1108/LHTN-09-2019-0062

Rafi, M., Jian Ming, Z., & Ahmad, K. (2022). Estimation of the knowledge management model for performance measurement in university libraries. *Library Hi Tech*, *40*(1), 239–264. doi:10.1108/LHT-11-2019-0225

Rojas, W., Gayoso Martínez, V., & Queiruga-Dios, A. (2019, May). Blockchain in Education: New Challenges. In *Computational Intelligence in Security for Information Systems Conference* (pp. 380-389). Springer. 10.1007/978-981-16-7182-1_24

Shaw, J. N., & De Sarkar, T. (2021). A cloud-based approach to library management solution for college libraries. *Information Discovery and Delivery*, *49*(4), 308–318. doi:10.1108/IDD-10-2019-0076

Sivadanam, Y. L., Ramaguru, R., & Sethumadhavan, M. (2022). Distributed Ledger Framework for an Adaptive University Management System. In *Proceedings of International Conference on Computational Intelligence and Data Engineering* (pp. 295-306). Springer. 10.1007/978-981-16-7182-1_24

Wang, C., & Li, B. (2019, October). Research on traceability model of aircraft equipment based on blockchain technology. In *2019 IEEE 1st international conference on civil aviation safety and information technology (ICCASIT)* (pp. 88-94). IEEE. 10.1109/ICCASIT48058.2019.8973137

Wang, Q., & Su, M. (2020). Integrating blockchain technology into the energy sector—From theory of blockchain to research and application of energy blockchain. *Computer Science Review*, *37*, 100275. doi:10.1016/j.cosrev.2020.100275

Wang, R., Ye, K., & Xu, C. Z. (2019, June). Performance benchmarking and optimization for blockchain systems: A survey. In *International Conference on Blockchain* (pp. 171-185). Springer. 10.1007/978-3-030-23404-1_12

KEY TERMS AND DEFINITIONS

Blockchain: A blockchain is a network system that execute transactions among connected nodes using high level security.

Data Mining: Data mining is a process of extracting and verifying data or information on a network.

Database System: Database system is a warehouse that manages information.

Digital Research Library: This is an online database that hosts diverse researcher materials that can be inter-operated or remotely accessed by different users on the internet.

Library User: This is any individual that uses the library.

Management: Management is the process of planning, organizing, directing, coordinating and controlling human and material resource to achieve a goal.

Network: A network is a collection of computers that allow for data sharing.

Peer-to-Peer System: This a network system involving two nodes without a server.

Research Records: These are source documents or files for verification of research information on a network.

Technology: This refers to the application of scientific knowledge to solve practical problems.

Chapter 13
Adoption and Maintenance of the Next Generation Integrated Library Systems (ILS) in Academic Libraries

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ABSTRACT

The next-generation library integrated systems (ILS) are becoming increasingly popular throughout the world. However, determining appropriate decision-making aids for the implementation and maintenance of the next-generation ILS is complicated and difficult to manage. This chapter is based on a systematic literature review related to the adoption and maintenance of next-generation ILS in academic libraries published between 2016-2022. Roger's diffusion of innovation (DoI) was used as a framework to examine ways of understanding and accepting new technologies. Existing research indicates that academic libraries in South Africa are using next-generation ILS to ensure interoperability between the various systems, platforms, and devices that are part of modern library systems. Despite its potential benefits, there are significant barriers to the adoption of ILS such as lack of technical knowledge and skills in using emerging technologies and the perception among LIS professionals worldwide that they will negatively impact their jobs and lead to unemployment.

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INTRODUCTION

The use of Information and Communication Technologies (ICTs) to execute operations like acquisitions, reference services, cataloguing, and serial control is known as library automation, large-scale open-source library automation systems can improve bibliographic production efficiency (Ponelis & Adoma, 2018). In most academic libraries globally, the integrated library system (ILS) continues to be the most popular information system for library automation (Grammenis & Mourikis, 2020; Ahmat et al., 2018) The previous traditional ILS has become obsolete and is no longer capable of handling the increased number of electronic or digital resources; libraries usually had to deploy other tools for search and discovery of their e-resources (Liu & Fu, 2018).

Although new systems acquisitions are foremost in choosing library service platforms, recent developments show that most academic libraries continue to rely on integrated library systems with Ex Libris Alma now experiencing mass adoption (Grammenis & Mourikis, 2020). Innovative offers several Integrated Library Systems (ILS) including Sierra and Polaris, but the ILS academic library market is less populated than the ILS public library market; The introduction of FOLIO, an open source learning management system based on the concept of flexibility, with a variety of modules available (and interchangeable) as required, is recently being considered for adoption by most academic libraries (Association of College and Research libraries, 2020). Grammenis and Mourikis (2020) further state that "the next-generation library integrated system (ILS) was developed as a separate system in the sense of electronic resources management systems (ERM) to help libraries organize and provide electronic resources".

In the history of academic libraries globally there is a story and a high level of acceptance of the introduction of the next generation ILS. Previously, traditional ILS were only designed to manage printed materials, creating difficult situations where libraries separated their workflows and staff from the traditional workflow (Liu & Fu 2018). In contrast to ten years ago, only a few academic libraries are involved in separate procurement projects for search services accepting the discovery product that comes with its LSP (Library Service Platform) namely: Primo with Alma or World CAT Discovery Service with World Share Management services or using a partnership between its ILS provider and one of the Discovery Service Providers, usually EBSCO Information Services (Breeding, 2016).

In the literature, a few studies of ILS implementation at specific institutions, including Uganda, have been reported (Ponelis & Adoma, 2018), Nigeria (Omeluzor & Oyovwe-Tinuoye, 2016; Moruf & Ngozi, 2020, USA (Yeh & Walter, 2016) and South Africa (Atua-Ntow, 2016), Uganda (Polines & Adoma, 2018), Canada (Liu & Fu, 2018), Iran (KardanMoghaddam,2022), India (Balaji, 2021), Greece (Kouis,2020; Grammenis & Mourikis, 2020). Even though libraries have studied the global impact of new technologies, there is still a lack of literature on the adoption and maintenance of next-generation ILS in academic libraries (Adegbore, 2018). The purpose of this chapter is to learn more about how next-generation ILS is being used in academic libraries in South Africa. To consolidate existing research on these impediments, employs Roger's diffusion of innovation (DoI) theory as an organizing framework to provide a structured overview and synthesis of existing research (Rogers, 2003).

The next generation of ILS is hosted "in the cloud," cloud computing can be considered as a model for providing convenient, on-demand network access to a shared pool of configurable computing resources such as networks, servers, storage, applications, and services (Adegbilero-Iwari & Hamzat, 2017). As academic libraries became more aware of the limitations of various ILS, technology companies began developing library management systems that could address those shortcomings more effectively. The difference between traditional and next-generation ILS is that the latter has an open architecture and is more agile and unified in its workflow and user interface (Grammenis & Mourikis, 2018). Libraries today have zero tolerance for secure technology products that limit access to underlying data and are difficult to integrate into related business systems. While libraries face the challenge of reacting prudently to industry changes and the emergence of new technologies, and as vendors develop synergies between content and technology products, they must ensure that results are in line with their strategic goals and objectives (Breeding, 2016; Kouis et al., 2021). However, studies have shown that before adopting and implementing any automation software, libraries must evaluate its power and capacity in managing their library holdings, as well as its cost (Omeluzor and Oyovwe-Tinuoye, 2016). Adegbore (2018) mentions this, stating that while libraries have investigated the global impact of emerging technologies, there is still a lack of literature on the adoption and maintenance of next-generation ILS in academic libraries.

Problem Statement

Academic libraries in South Africa are confronted with major problems regarding the adoption and maintenance of the next-generation integrated library systems (ILSs) for effective management of library information resources. The complexities of managing all resources types and formats with traditional integrated library systems (ILS) make it difficult for libraries information resources to meet their business requirements (Fu and Carmen, 2015:1). Libraries are currently facing a challenge in managing digital content effectively as the previous ILS system were designed to mainly accommodate physical resources. Usually, the adoption of next generation ILS in academic libraries is not executed successfully, partially because of non-technical challenge such as LIS professional's resistance to change, and the influence of organizational culture and politics. The current ILS are becoming redundant because of the declining of loaning of library physical material including lack of support and evolvement of universities in the management of information resources (Berard, 2013).

Traditional ILS are limited in functionality, moving to the next generation ILS may impact the staffing model due to new architecture and functionality of the next generation ILS. According to the latest trends in academic libraries and higher education, the ILS of the future should be the "next generation" system that is user-centred, enable the use of facilitated collections, integrate with other institutional platforms, and provide modern business intelligent capabilities (Association of College and Research libraries, 2020). Many studies have been published on ILS migration, however, only a few of them focus on the next-generation ILS migration (Fu & Carmen, 2015:2).

Although the next generation ILS in academic libraries were introduced more than a decade ago, there is still slow adoption, most academic libraries in South Africa are still working in silos and are stuck in using aging client server-based ILS/LMS (Liu & Fu, 2018). Determining appropriate decision-making tools for adoption and maintenance of the next generation integrated library system (ILS) is difficult and complex to manage by LIS professionals in academic libraries in South Africa. These complexities include managing the increase number of digital contents and impact of the next generation ILS on the staffing model due to the new architecture and functionality of the system. This present study aims to explore the development of a model on decision-making for the adoption and maintenance of the next generation integrated library systems (ILS) in academic libraries in South Africa. The aim of this chapter is to explore the adoption and maintenance of next-generation integrated library systems (ILS) in South African academic libraries. Research objectives formulated for this study were:

- To ascertain the nature and extent of next-generation ILS adoption as an innovation in academic Libraries.
- To identify the required skills and competencies amongst LIS professionals for their involvement in the adoption and maintenance of the next generation ILS in academic libraries.
- To establish if there are barriers in the adoption and maintenance of next-generation ILS.

THEORETICAL FRAMEWORK

The theoretical framework introduces and describes the theory that underpins the research problem, as well as the context and elements related to library automation. Models of technology acceptance as an individual have been defined by various models. In this study, the next-generation ILS: Roger's diffusion of innovation theory model will be used.

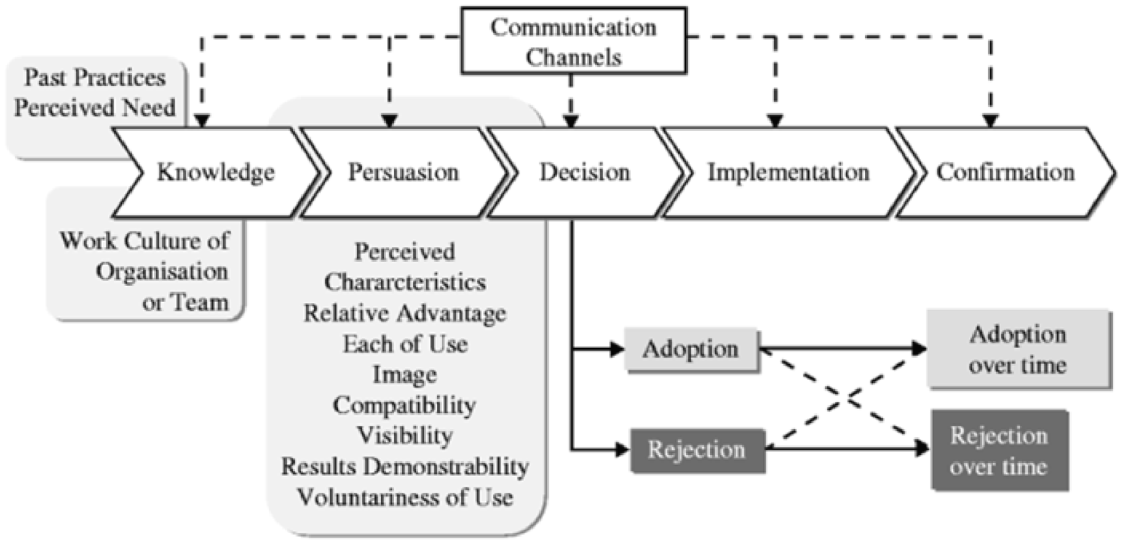
Diffusion of Innovation Theory

Roger's Diffusion of Innovation (DoI) theory can be used to explain the proliferation of next-generation ILS as an innovation in academic libraries. The diffusion of innovation theory, according to Ponelis and Adoma (2018), provides a perspective to see the various elements that will affect a person's decision to use or not use an innovation, as well as when it should be adopted in the product life cycle. According to Kardanmoghaddam et al., (2022), testing user adoption of the next generation ILS prior to implementation creates challenges and barriers in academic libraries. Before putting the library budget at risk and implementing the next generation ILS, academic libraries must first carefully organize and review the policies and ICT infrastructures that users require, overcome obstacles, and find an appropriate model for the institution to adopt and maintain the next generation ILS. The extent and patterns of diffusion are determined by the drivers and obstacles surrounding an innovation. As an innovation spreads through a population, adoption follows a bell curve, with an increase [rise] as the early and late majority start to follow innovators and early adopters, followed by a decrease as laggards use the innovation over time (or reject) (Ponelis & Adoma, 2018). The S-curve of the cumulative users over time is the result of this diffusion process. In today's emerging technology environment, staying on the forefront of technology is an important professional activity for academic librarians, but it can be daunting at best (Diyaolu et al., 2019). The introduction of technology is primarily a function of a communication channel, of which one is a part, and thus, this theory suggests the following characteristics (Musa, 2015):

- a typology of people who embrace innovation over time, ranging from innovators to laggards.
- the decision-making process by which innovators are accepted or rejected; and
- the criteria by which people evaluate innovations.

Roger's DoI is supported by four aspects: the innovation itself (relative advantage, compatibility, complexity, testability, and observability), communication channels, time, and the social system (Ponelis and Adoma, 2018). The increase in Library and Information Services (LIS) professionals in academic libraries has been examined by many studies. Models have been developed to investigate and explore why innovations are not adopted using the theory of perceived attributes (Omeluzor & Oyovwe-Tinuoye, 2016; Ponelis & Adoma, 2018, Kouis et.al, 2020). Roger's diffusion of innovation' model is the most

Figure 1. Roger's diffusion of innovation model (Rogers, 2003)



frequently cited, this model proposes that LIS professionals adopt software or system innovations in stages: knowledge, persuasion, decision, implementation, and confirmation (Roger, 2003).

LITERATURE REVIEW

The Nature and Extend of the Adoption of the Next Generation ILS in Academic Libraries

For more than two decades, software development and system engineering have primarily focused on personal computers.When the first round of library automation hit the world in the 1960s, particularly in Europe and North America, South African universities fell behind due to a variety of factors such as prolonged adverse economic conditions, budgetary constraints, absence of ICT strategies and policies, high expenses of ICT facilities, insufficient ICT skills and ineffective electricity/telecommunication infrastructure (Mutula, 2012). As academic libraries grew increasingly aware of the limitations of various ILS, technology companies began building library management systems that could more effectively address those shortcomings. Library automation software is a web-based, multi-user, user-friendly program designed to improve the administration, circulation, and acquisition of books and members of a library or institution (Muraf & Dangani, 2020). The field of library automation has changed dramatically in recent years, and the use of computer and telecommunication tools has emerged from library automation that began with handling traditional tasks in-house (Ngozi, 2020).

With the introduction of the next generation of library automation systems capable of managing all types of library collections, including print, electronic, and digital resources, and the year 2011 marked the start of a new era in library automation (Liu & Fu,2018). Shaneem (2018:5) state that integrated library systems (ILS) were built for the efficient management of print resources and did that job remarkably well during a period when client-server architecture prevails. Traditional ILS and next-generation ILS differ in that the latter has an open architecture and is more agile and unified in its workflow and user interface (Grammenis & Mourikis, 2018). As industries transform and new technologies evolves, libraries face challenges to respond thoughtfully.

As suppliers develop synergies among content and technology products, libraries need to make sure that the outcomes align with their strategic goals and objectives. Breeding (2019) states that libraries today have zero tolerance for secure technology products that restrict access to underlying data and are difficult to integrate into related business systems. Some of the factors to consider when selecting a new system are software suitability, selection, adoption, functionality, performance, updating, and maintenance, and a flaw in any of them accounted for the challenges libraries faced in an automation project, but the opportunity is fully realized when new systems perform to their full potential and justify their benefits (Diyaolu et al, 2019).

The Skills and Competencies of Library and Information Service (LIS) Professionals

The top 2020 trends in academic libraries focuses on managing change in libraries and are classified in three categories (Canadian Association of Research Libraries, 2010).

- changes in research library relationship with institutional partners,
- changes in research library organization
- changes in skills (Association of College and Research libraries, 2020).

The rapidly changing information and communication technologies (ICTs) have had a significant impact on the knowledge and skill requirements for library and information science (LIS) professionals working in the field. IT skills require LIS professionals in academic libraries to have strong knowledge and capability in the following areas (Raju, 2014).

- ILS (Integrated Library Systems
- New technologies
- Electronic resource management
- Web development
- Learning management systems (LMS)
- Database management

As academic libraries are a major employer of LIS graduates in South Africa, such skills would be useful in informing curriculum review and revision in LIS education and training (Ocholla & Shonge, 2013, cited by Raju, 2014). In this context, academic libraries are considered the heart of a university, serving an important role in providing appropriate support for various academic needs such as teaching, learning, and research. In literature, the traditional role of a librarian is the provision of information resources to library patrons. According to Shahbazi & Heyadati (2016), “IT Librarians and graduates from IS (Information Systems) schools have a more comparative advantage over the traditional librarian and can earn the same amount as an IT specialist” (Shahbazi & Hedayati, 2016 p.542). Library professionals and their teams must comprehend the tacit and explicit knowledge held by libraries and information centers, as well as management techniques, relationships, and skills that give the organization a competitive advantage (Bajpai & Margam, 2019; Shahbazi & Hedayati, 2016; Yadav, 2022). LIS professionals must also update their ICT skills on a regular basis to work effectively in a digital environment.

The basic role of a system librarian, or any other professional working with technology, had not fundamentally changed. Technology evolves and so do processes in the library academic environment. The major challenges the library is currently facing is the declining of professionally trained and unskilled staff, the level of short staffing is apparent while the little on ground are so little or no computer knowledge (Breeding, 2019:4). Breeding (2019:2) further indicate that "the key objective around applying technology to enhance the work based in the thorough knowledge of all the library strategy and operations, on awareness of available technologies, and on technical skills to shape technology around the needs of the library". Ashiq et.al (2021:1) explain that it is important for librarians working in academic institutions to stay informed about this the broader landscape of students, higher education policies, publishers, researchers, and scholarships so that they can actively participate in this change instead of responding to it. The adoption and maintenance of the next generation ILS will impact on the news skills that librarians need for future management of library management systems (LMS). According to the Association of College and Research Libraries (2020), managing change in academic libraries requires leadership to be steeped in the best practices for systematically adjusting the work of the entire organization; the urgency described in this report indicates a need of preparing a workforce of uncertainty and ambiguity; the new skills to manage change required in a VUCA (Volatility, Uncertainty, Complexity, and Ambiguity) are needed by current and future library leaders.

The Barriers in the Adoption of the Next Generation ILS on Academic Libraries

The fact that the concept of Industry 4.0 is not yet fully understood, as well as the perception among LIS professionals worldwide that it will negatively impact their jobs and lead to unemployment, causes difficulties in the adoption of next-generation ILS. Today, ILS is primarily a physical object, rather than a tool for integrated document management, whereas the widespread distribution of electronic resources, some of which have print equivalents, and the proliferation of digital libraries have created a hybrid situation in libraries (Berard, 2013). According to Yeh and Walter (2016), migrating from one generation to another is a significant initiative that affects the entire library operations. The scale and complexity of the migration process frequently result in problems with some projects falling behind migration completion schedule. Omeluzor & Oyovwe-Tinuoye (2016) on the other hand listed some necessary guidelines in selecting library application software, including i) hardware peripherals ii) software rights and the history of the supplier.

Even though the current traditional system has aided libraries in organizing, disseminating, and automating their resources, the development of the next generation ILS, combined with increased publications and dramatic changes in their collections, has resulted in new standards that libraries must followed (Grammeris & Mourikis, 2020). Association of College and Research libraries (2020) listed that effective "next-generation" systems should be i) user-centred, ii) enable the use and access to supported collections, iii)integrate into other institutional platforms and offer, among other things, iv)modern business intelligence functions and recommendations. Due to digital transformation, LIS professionals must acquire the right skills to discharge their duties efficiently and must be trained in application of various ICT tools like automation, bibliographic standards, ICT based library services, web 2.0 skills, mobile information service, ILMS (Integrated Library Management Systems), Citation, IR (Institutional Repository) and many more (Bajpai and Margam, 2019:3).

One of common effects of technology is the ability for library staff to work on mobile, enabling them to engage more with their users or customers. Currently libraries are developing diverse technology towards Library 4.0 targets which is described in the context of intelligent system, Makerspace, context-aware technology, Open Source, Big Data, Cloud Service, State of the Art, and Librarian 4.0 (Ahmat & Hanipah, 2018:55). However, due to the disruptive technology of the Industry Revolution 4.0, when purchasing or subscribing to various types of hardware and software, academic libraries should be aware of their actions in selecting the best among available options (Ahmat et al., 2018, Kutty, 2019). LIS professionals can overcome this revolution by continuing professional development with the goal of becoming thought leaders in the 4th Industrial age (Hussain, 2020).

RESEARCH METHODOLOGY

The systematic review of relevant literature was carried out in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis criteria (PRISMA). Prisma assists researchers in reporting an evidence-based set of smallest elements that are useful for systematic critical assessment of published material (Moher, et al., 2009: 264-269). PRISMA considers four study components: identification, screening, eligibility, and included record studies/records. PRISMA was created with the health-care industry in mind, but it has proven to be useful in a variety of other fields as well. The Information management/library and information science (LIS) discipline has successfully implemented PRISMA principles for systematic review of scientific research. A systematic review is an examination of pre-planned questions that uses precise and clear techniques to analyze and evaluate data from the review's research (Sam, Naicker & Rajkoomar, 2020: 1-2).

Inclusion Criteria

The study's main objective was to conduct a systematic review of the adoption and maintenance of the next-generation integrated library system in academic libraries. Three basic research objectives were designed to cover the selection and inclusion of articles in the systematic review to gain insights on the adoption and maintenance of the next-generation integrated library system. The first objective focused on the nature and scope of next-generation library ILS adoption and maintenance in academic libraries. The second objective focused on the requirements and competencies amongst LIS professionals for their involvement in the adoption and maintenance of the next generation ILS in academic libraries. The third objective focused on barriers in the adoption of the next ILS in academic libraries.

Search Strategy

This review based on a systematic methodology to locate relevant articles published in databases between January 2016 and March 2022. Six (6) academic databases were searched (Ebscohost, Emerald Insight, Proquest, Google Scholar, SpringerLink Scopus, and Web of Science). The systematic information retrieval used a combination of key search terms about the study's key concepts, as shown in (Table 1). The steps followed included developing research questions and conducting literature searches to

Table 1. Databases, search strategies and number of results

Database	Search Strategy	Number of results
Ebscohost Keywords Year range: 2016-2022	Next generation integrated library systems AND academic libraries	8
Ebscohost Keywords Year range: 2016-2022	Library services platforms and academic libraries	450
Scopus Keywords Year range: 2016-2022	Next generation integrated library systems AND academic libraries	3
Scopus Keywords Year range: 2016-2022	Library services platforms and academic libraries	200
Web of Science Keywords Year range: 2016-2022	Next-generation integrated library systems AND academic libraries	84
Web of Science Keywords Year range: 2016-2022	Library services platforms and academic libraries	1784
Emerald Insight Keywords Year range: 2016-2022	Next-generation integrated library systems AND academic libraries	593
Emerald Insight Keywords Year range: 2016-2022	Library Service Platforms and academic libraries	744
ProQuest Keywords Year range: 2016-2022	Next-generation integrated library systems AND academic libraries	459
ProQuest Keywords Year range: 2016-2022	Library Service Platforms and academic libraries	708
Google Scholar Keywords Year range: 2016-2022	Library Service Platforms and academic libraries	804

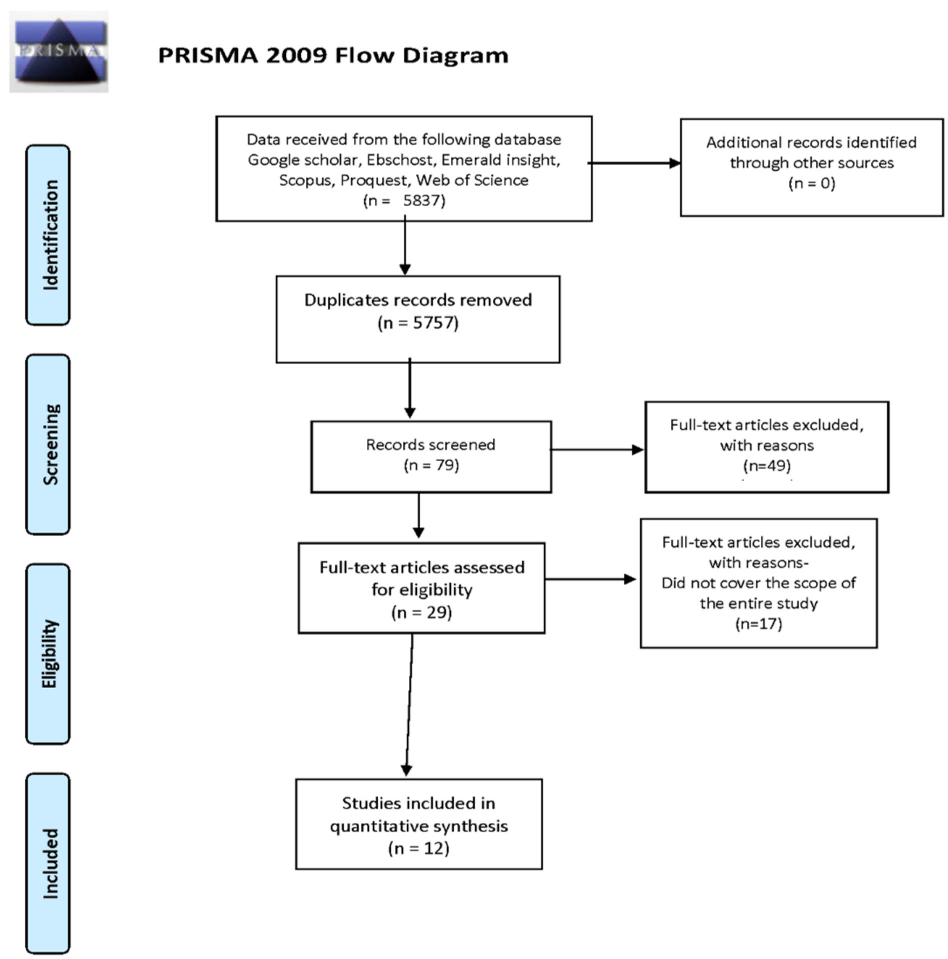
identify, screen, and select relevant articles. The following steps were taken synthesis, article analysis, and reporting of results.

The databases selected for this review are frequently used in systematic literature reviews across disciplines. The search resulted in the retrieval of 5837 records. A total of 5757 duplicate records and articles were removed, and the remaining 79 full text article records were screened for relevance using the inclusion criteria. Records that were determined to be irrelevant (49) were removed, and full-text articles (29) were evaluated for eligibility. Furthermore, full-text articles (17) that did not cover the entire scope of the review were removed, and a quantitative synthesis was performed on the 12 relevant articles.

ANALYSIS PROCESS

The articles were coded and analyzed based on research questions. Microsoft Excel was used to accomplish this. To present the review analysis, descriptive statistics in the form of tables, pie charts, and

Figure 2. Flow chart of the process of the study selection for the systematic review guided by the PRISMA method



graphs were used. As shown in (Table 2), the spreadsheet recorded useful and relevant information about each article, such as the title, author, country where the article was published, and year of publication.

FINDINGS

The literature for this study was reviewed from 2016 to 2022, and 12 articles were identified to be used. The articles were divided into two categories: conceptual and experimental. The conceptual category included articles that discussed the development of the next-generation ILS, whereas the experimental category included project set up next-generation ILS geared toward experimentation. The findings were based on the research objectives and Roger's diffusion of innovation (DoI) as a framework that were designed for the systematic review. This section discusses the findings based on the research objectives and Roger's diffusion of innovation (DoI) as a framework that were designed for the systematic review.

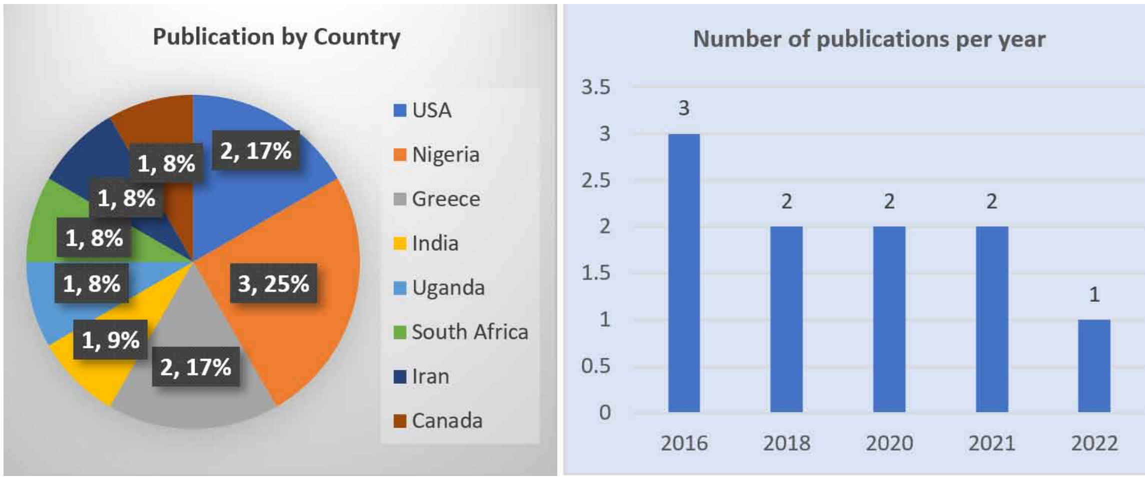
Table 2. List of articles included in the systematic review of adoption and maintenance of the next generation ILS in academic libraries

ID	Author	Title	Year	Country	Type
A1	Yeh, S. & Walter, Z.	Critical success factors for Integrated library system implementation in academic libraries: a qualitative study.	2016	USA	Experimental
A2	Stewart, M. & Morrison, C.	Breaking ground: consortial migration to a next-generation ILS and its impact on acquisitions and workflows	2016	USA	Conceptual
A3	Omeluzor, S. & Oyovw-Tinuoye, G.	Assessing the adoption and use of integrated library systems (ILS) for library service provision in academic libraries in Edo and Delta states, Nigeria	2016	Nigeria	Experimental
A4	Moruf, H. & Dangani, B.U.	Emerging library technology trends in academic environment: an updated review.	2020	Nigeria	Conceptual
A5	Ngozi, A.S.	Library automation in university: a literature review	2020	Nigeria	Conceptual
A6	Kouis, D. et.al	Migrating to a shared library management system: evaluation from the perspective of librarians and lessons learned.	2021	Greece	Experimental
A7	Grammenis, E. & Mourikis, A. 2020.	Migrating from integrated library systems to library services platforms: an exploratory qualitative study for the implications on academic libraries' workflows	2020	Greece	Experimental
A8	Balaji, B. et.al	A review of integrated library systems and web-scale discovery services in India	2021	India	Conceptual
A9	Polines, S. & Adoma P.	Diffusion of open-source integrated library systems in academic libraries in Africa: the case of Uganda	2018	Uganda	Conceptual
A10	Atua-Ntow, C.	Staff assessment of the success of the integrated library system: the case of the University of Ghana Library System	2016	South Africa	Conceptual
A11	Liu, G. & Fu, P.	Shared next generation ILSs, and academic library consortia: trends, opportunities, and challenges	2018	Canada	Experimental
A12	KardanMoghaddam, H., Rajael, A & Jafari. 2022	Determining effects factors in cloud computing acceptance using Rogers Diffusion of Innovation Model and Davis' Technology Adoption Model: a case of financial Institution	2022	Iran	Experimental

Nature and Extent of Adoption of the Next-Generation ILS

As integrated library systems (ILS) evolve, large software vendors continue to acquire more ILS products, smaller vendors, raising concerns that customers will become locked into vendor-specific platforms (ACRL,2020). During the adoption stage of the next-generation ILS, decision makers/LIS professionals consider whether to continue exploring, stop investing, or make the effort to comprehend the significance of ILS products, this decision is based on the academic background of the LIS professional, personality variables, communicational behaviour, and the characteristics of the LIS professional's work environment. Moruf & Dangani (2020 p.13) presented the emerging library technology trends in academic environment discussed that academic libraries need to rethink and re-strategies on how increasing technological

Figure 3. Selected articles by publication year and country



change affect their library services. Understanding the level of adoption of next-generation ILS includes technical and training aspects relating to the support available for LIS professionals willing to adapt to next-generation ILS in their libraries. Another study by (Omeluzor et.al, 2016) assessed the adoption and use of integrated library systems for library provision in academic libraries showed that there is general non-use of integrated library system (ILS) in academic libraries in Delta state, Nigeria. In the reviewed article (Balaji, 2020), stated that one of the benefits of new ILSs is that the influence of new web technologies and applications has made library functional units agile from the silos of pre-internet systems to semantically rich single-search platforms. According to the literature, there has not been much uptake in the adoption and maintenance of next-generation ILS in academic libraries. Between 2018 and 2022, literature reveals a full take in the eight (8) publications that extensively discussed adoption of next-generation ILS in Academic Libraries. The geographical distribution of the articles reviewed reveals countries such as the USA (2.17%), Nigeria (3.25%), Greece (2.17%), India (1.9%), Uganda (1.8%), South Africa (1.8%), Canada (1.8%), and Iran (1.8%).

This research objective was posed to gain an understanding of how next-generation ILS are being adopted in the context of academic libraries. According to Rogers (2003), the rate of adoption of innovation is influenced by five factors: relative advantage, compatibility, complexity, trainability, and observability.

The proliferation of the next-generation ILS a decade ago has exposed LIS professionals to the next-generation ILS which are cloud-based in various institutions. Recent developments show that although the next-generation integrated library system was introduced a decade ago with Ex Libris Alma now experiencing mass adoption, most academic libraries continue to rely on previous traditional integrated library systems (Grammenis & Mourikis, 2020). Innovative offers several integrated library system (ILS) products, including Sierra and Polaris, but its market share in academic libraries is relatively low in comparison to its market share in public library systems. Furthermore, the introduction of FOLIO in 2016, an open-source learning management system based on the concept of flexibility, with a variety of modules available (and interchangeable) is recently being considered for adoption by most academic libraries (ACRL, 2020). The scope of complexity of the next-generation ILS should be considered, as well as the efforts that LIS professionals will have to invest to learn innovations of this type of software or system, including the technical, knowledge and skills involved in the adoption and maintenance of the

Table 3. Interconnected trends that emerged from the article

Article (A) ID	Motive	Count	Percentage %
A5, A6, A8, A9, A10, A12	Relative advantage	6	50%
A2, A6, A7	Complexity	3	25%
A3, A4	Trainability	2	16.67%
A13, A12	Compatibility and visibility	2	16.67%
A1, A2, A3, A11, A2, A8, A9	Observability	5	58.3%
A5, A6, A8, A9, A10, A12	Relative advantage	6	50%

next-generation ILS (Balaji, 2021 & Kouis et al., 2021). There is still renewing concerns by LIS professionals in academic libraries about interoperability between the various systems, platforms, and devices that make up modern library systems today (Ngozi, 2020, Balaji 2021 & Kardan Moghaddam, 2022)

Skills and Competencies amongst LIS Professional's Adoption and Maintenance of Next Generation ILS

This research objective was posed to gain an understanding of how next-generation ILS are being adopted by LIS professionals in the context of academic libraries. The identified trend from the review Roger's diffusion of innovation' model proposes that LIS professionals adopt software or system innovations in stages: knowledge, persuasion, decision, implementation, and confirmation (Roger, 2003). To supplement this, and importantly to be more accurate reflection of the skill and competencies requirement of LIS professionals in the adoption and maintenance of the next generation ILS in the academic library environment, the ACRL 2020 top trends in academic libraries (Association of College and Research Libraries Planning and Review Committee, 2020) was consulted and the evolving integrated library systems was one of disciplinary knowledge added four qualities on the next generation ILS.

- Be user centred
- Enable the use and access of facilitated collection
- Integrate with other institutional platforms and
- Modern business intelligent capabilities

The articles sampled also revealed that LIS professionals must adjust themselves rapidly changing environment by acquiring various ICT skills in the adoption and maintenance of the next generation so that they can be valuable asset for the organization (Balaji, 2021). Other articles reported that the adoption and maintenance of the next generation ILS in academic libraries encourage collaboration opportunities for LIS professionals to benchmark skills and competencies in the library and academic environment.

Barriers the Adoption of the Next Generation ILS

The introduction of the cloud, interest in consortium-level work to push for new ILS that include improved handling of electronic resources (e-resources), and the search for more advanced discovery systems has drove a rapid change in design and concept of the next-generation ILS (Stewart & Morrison 2016, Grammenis & Mourikis, 2020 & Kouis et.al, 2021). The advantages of next-generation ILS (cloud-based) are weighed against the disadvantages of traditional ILS (proprietary systems). From an article by Steward and Morrison (2016) positive and negatives of ILSs has been explored. In the reviewed article, he noted that continued funding challenges in higher education made cost savings and staff efficiencies appealing to institutions investigating the possibility of adopting new systems; however, there are still concerns about security, as cloud-based systems will not be behind local firewalls, and a higher risk of event failure because of consolidating services with a single vendor. It is evident from the sample of articles included on this review, that there are barriers experienced by LIS professionals while adopting the next-generation ILS's in academic libraries. This is alluded to by Ponelis and Adoma (2018) in their reviewed article on the diffusion of open-source integrated library systems (ILS) in academic libraries in Africa that, as expected by Roger's DoI theory, the cumulative adoption of open-source ILS in Ugandan academic libraries approximates the S-curve, and expectations will continue to rise with the intention of those academic libraries that are not yet using open ILS to migrate to an open ILS in Uganda.

DISCUSSIONS

According to Rogers DoI Theory (Hollard, 1997), the cumulative introduction of next-generation ILS in academic libraries is approaching the S-curve. The curve is expected to grow further, with the goal of transitioning academic libraries in South Africa that are still using traditional ILS to next-generation ILS. The results show that academic libraries are late adopters of the next generation ILS, most libraries struggle to implement the next-generation ILS according to their planned scheduled because and budget constraints. Adoption of next-generation ILS is hampered by factors such as inadequate ICT infrastructure, a limited budget, human resources, and organizational culture. These are the same barriers that have been reported in the literature. However, there is an underestimating and lack of knowledge of the total cost of the next generation ILS, as well as the fact that IT competence is in high demand. The capacity of the next- generation ILS to be customized and flexible to match the demands of academic libraries is a major driver for the adoption of next-generation ILS in academic libraries. However, without the necessary ICT infrastructure, skills, and support, exploitation of the implementation stage is difficult. Countries require IT-skilled employees, but they require ILS expertise far more if they are to extract value from their IT. This is a significant issue because next-generation ILS training and support are neither widely available nor standardized. Among the issues preventing full implementation of library software are insufficient technical support from software vendors or their technical representation in the county (Omeluzor & Oyovwe-Tinuoye, 2016). In examining the process of evaluating library systems and their usefulness, several criteria for evaluating system quality that are more appropriate for information gathering and educational applications in the library environment have been identified. Functionality, reliability, usefulness, efficiency, maintainability, and portability are just a few of them. In academic libraries globally, the role of library consortia is gradually declining. Previously, libraries purchased ILS and collaborated through provincial consortia. Library Consortia's currently assists member institutions in obtaining greater value-for-money when purchasing electronic or digital resources, such as e-books, databases, and e-journals, than libraries could not do on their own.

RECOMMENDATIONS

The purpose of this chapter was to explore the adoption and maintenance of next-generation integrated library systems (ILS) in academic libraries. This chapter was supplemented by Rogers Diffusion of Innovation (DoI) used as a framework to explore the way of understanding and accepting new technologies in academic libraries and to make recommendation that these libraries will advance its diffusion. The trends in academic libraries by LIS professionals play a significant role in the amount of change our institutions are driving, managing, and navigating. The effort to comprehend ILS products made available by various library vendors has a significant impact on the DoI throughout the adoption of the next-generation ILS's offer valuable opportunities to accelerate diffusion through decision and action by LIS professionals in academic libraries, professional associations, library consortia, university and/or library level. Fit can be improved through technical and training aspects relating to the support available for LIS professionals willing to adapt to next-generation ILS in their libraries. Because information and communication technologies (ICT) play a significant role in library automation, library automation as an innovation encompasses far more than just hardware and software. It is recommended that when adapting to information systems, such as next-generation ILS, high-level support from library and university management, ICT, and other relevant stakeholders be informed during the initial decision stage of the adoption of next-generation ILS, the investment required for the implementation stage must include these aspects in addition to software and hardware costs. It is recommended that developing a comprehensive, well-targeted training program that covers all aspects of the exercise, such as teaching librarians the fundamentals of system configuration, software installation, and data entry.

Furthermore, similar to Omeluzor & Oyovwe-Tinuoye (2016) recommendation for academic libraries in Nigerian on the adoption ILS for library university management should support academic libraries financially to be able to adopt to suitable ILS to render effective library services, and academic library management should train and retrain staff for effective use of ILS in delivery of library services. Finally, it is recommended that LIS professionals reunite and reconvene previous consortiums in academic libraries to join an ILS/Software Consortium to share their experiences and developments, as well as speak out against copyright and intellectual property ownership with a single voice. Successful projects in academic libraries rely on bringing all library staff together as stakeholders so that the skills of each participant can be used; Communication in this regard is a critical tool that the advent of the ILS has provided.

CONCLUSION

This study shows that diffusion of the next-generation ILS, in particular the next-generation integrated library system (ILS) ALMA Ex Libris, is experiencing mass adoption in most academic libraries since it was introduced a decade ago. Academic libraries, regardless of collection size, should continue to take advantage of library automation while maintaining the flexibility to meet changing needs at what is perceived to be an affordable cost. The introduction of FOLIO in 2016, an open-source learning management system is regarded to be cost effective based on the concept of flexibility, with a variety of modules available (and interchangeable) is recently being considered for adoption by most academic libraries. Participating libraries that are not yet automated or using traditional/proprietary software in LIS professionals are considering implementing the next-generation ILS like ALMA Ex Libris or open-source ILS Folio in academic libraries. According to Roger's DoI theory, the cumulative adoption of these software/systems approximates the S-curve, and expectations will continue to rise with the intention of those academic libraries that are not yet using the new generation system to migrate. When considering library automation or migration using next-generation ILS, consider your ICT infrastructure, local support community, available training, and be realistic about the costs. Libraries, library associations, and consortiums should advocate for less restrictive procurement policies and national procurement legislation.

REFERENCES

Adegbore, A. M. (2018). Adoption factors of integrated library management system (ILMS) in selected Nigerian university libraries. *Library Philosophy and Practice (e-journal).* http://digitalcommons.unl.edu/libphilprachttp://digitalcommons.unl.edu/libphilprac/1994

Ahmat, M. A., Adauwiyah, R., & Hanipah, A. (2018). Preparing the libraries for the fourth Industrial Revolution (4th IR). *Journal of Malaysian Libraries*, *12*, 53–64. https://www.researchgate.net/publication/332319225_Preparing_the_Libraries_for_the_Fourth_Industrial_Revolution_4th_IR

Association of College and Research Libraries. (2020). A review of the trends and issues affecting academic libraries in higher education. *Research Planning Review, 81*(6). https://crln.acrl.org/index.php/crlnews/article/view/24478/32315

Atua-Ntow, C. (2016). *Staff assessment of the success of the integrated library system: the case of the University of Ghana Library System* (Thesis). University of Pretoria, Cape Town. Available at: https://repository.up.ac.za/handle/2263/59625

Bajpai, B. K., & Margam, M. (2019). ICT skills and competencies of library and information science professionals working in college libraries, University of Delhi: A study. *Library Philosophy and Practice (e-journal), 2275.* https://www.researchgate.net/publication/332552909_ICT_Skills_and_Competencies_of_Library_and_Information_Science_Professionals_working_in_College_Libraries_University_of_Delhi_A_study

Balaji, B. P., Vinay, M. S., Anitha, K. V., Khan, M. R., Edwin, E., & Shalini, B. G. (2021). A review of integrated library systems and web-scale discovery services in India. *Library Hi Tech News*, *38*(7), 14–18. https://www.emerald.com/insight/content/doi/10.1108/LHTN-09-2021-0061/full/pdf?title=a-review-of-integrated-library-systems-and-web-scale-discovery-services-in-india

Breeding, M. (2016). Strategic technology strengthens the capacity of libraries to serve their communities. *Proceedings of the 82nd IFLA General Conference and Assembly*. http://library.ifla.org/id/eprint/1320/1/137-breeding-en.pdf

Canadian Association of Research Libraries. (2010). *Core competencies for 21st Century CARL librarians. Librarians as researchers and writers: Research priorities for Canada's Research Public Libraries*. https://www.carl-abrc.ca/strengthening-capacity/human-resource-management/core-competencies-21st-century-carl-librarians/?cn-reloaded=1

Diyaolu, A. M., & Oso, O. O. (2019). Challenges of integrated library system (ILS) migration in selected academic libraries in Oyo State, Nigeria. *Library Philosophy and Practice (e-journal), 2535*. https://digitalcommons.edu/libphilprac/2535

Grammenis, E., & Mourikis, A. (2020). Migrating from integrated library systems to library services platforms: An exploratory qualitative study for the implications on academic libraries' workflows. *Qualitative and Quantitative Methods in Libraries (QQML), 9,* 343–357. http://lnu.diva-portal.org/smash/get/diva2:1234039/FULLTEXT01.pdf

KardanMoghaddam, H., Rajael, A., & Jafari. (2022). Determining effects factors in cloud computing acceptance using Rogers Diffusion of Innovation Model and David' Technology Adoption Model. *Journal of Electrical and Computer Engineering Innovations, 10*(1), 175-194. Available at: https://jecei.sru.ac.ir/article_1603_f5ca4190f95fa37bb6a530ab062c3b60.pdf

Kouis, D., Kyprianos, K., Efthymiou, F., Koulouris, A., & Karabela, A. (2021). Migrating to a shared Library Management System: Evaluation from the perspective of librarians and lessons learned. *Library Management*, *42*(6–7), 448–458. https://www.emerald.com/insight/content/doi/10.1 108/LM-12-2020-0177/full/html

Liu, G., & Fu, P. (2018). Shared Next Generation ILSs, and Academic Library Consortia: Trends, Opportunities and Challenges. *International Journal of Librarianship*, *3*(2), 53–71.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & Group, P. (2009). Preferred reporting items for systematic reviews and Meta-analyses: The prisma statement. *Annals of Internal Medicine*, *151*(4), 264–269.

Muraf, H. A., & Dangani, B. (2020). Emerging library technology trends in academic environment: An updated review. *TheScientificWorldJournal*, *15*(3), 13–18. https://www.researchgate.net/publication/344438404

Musa, A. I., Gbaje, S. E., & Monsurat, M. F. (2015). Perceived attributes of Diffusion of Innovation Theory as a Theoretical Framework for understanding the non-digital library services. *Information and Knowledge Management*, *5*(9), 82–87. searchgate.net/publication/309479883

Mutula, S. (2012). Library automation in sub-Saharan Africa: case study of the University of Botswana. *Programme: Electronic Library and Information Systems, 46*(3), 292-302. https://www.emeraldinsight.com/0033-0337.htm

Ngozi, A. S. (2020). Library Automation in University: a literature review. *Predestinasi, 13*(2), 115-134. Available at: https://ojs.unm.ac.id/predistinasi/article/view/21934

Ocholla, D., & Shongwe, M. (2013). An analysis of the library and information science (LIS) job market in South Africa. *South African Journal of Library and Information Science*, *79*(1), 35–43. https://sajlis.journals.ac.za/pub/article/view/113/122

Omeluzor, S. U., & Oyovwe-Tinuoye, G. O. (2016). Assessing the adoption and use of integrated library systems (ILS) for library service provision in academic libraries in Edo and Delta states, Nigeria. *Library Review*, *65*(8–9), 578–592. https://www.emerald.com/insight/content/doi/10.1108

Ponelis, S. R., & Adoma, P. (2018). Diffusion of open-source integrated library systems in academic libraries in Africa: The case of Uganda. *Library Management*, *39*(6–7), 430–448. https://www.emerald.com/insight/content/doi/10.1108/LM-05-2017-0052/full/pdf?title=diffusion-of-open-source-integrated-library-systems-in-academic-libraries-in-africa-the-case-of-uganda

Raju, J. (2014). Knowledge and skills for digital era academic library. *Journal of Academic Librarianship*, *40*(2), 163–170. https://www.sciencedirect.com/science/article/pii/S009913331400024X

Rogers, E. M. (2003). *Diffusion of Innovations* (5th ed.). Free Press.

Sam, C., Naicker, N., & Rajkoomar, M. (2020). Meta-Analysis of Artificial Intelligence Works in Ubiquitous Learning Environments and Technologies. *International Journal of Advanced Computer Science and Applications*, *11*(9). https://thesai.org/Downloads/Volume11No9/Paper_71-Meta_Analysis_of_Artificial_Intelligence_Works.pdf

Shahbazi, R., & Hedayati. (2013). Identifying digital librarian competencies according to the analysis of newly emerged IT-based LIS in 2013. *The Journal of Academic Librarianship, 42*(5), 542-550. https://www.sciencedirect.com/science/article/pii/S0099133316300957

Stewart, M., & Morrison, C. (2016). Breaking ground: Consortia migration to a next-generation ILS and its impact on acquisitions and workflows. *Library Resources & Technical Services*, *60*(4), 259–269. https://journals.ala.org/index.php/lrts/article/view/6137/7932

Yadav, A. K. S. (2022). Key skills and competencies of LIS professionals in the digital library environment: a content analysis of job advertisement. *Library Management, 43*(1-2), 50-65. https://www.emerald.com/insight/content/doi/10.1108/LM-03-2021-0030/full/html

Yeh, S., & Walter, S. (2016). Critical success factors for integrated library system implementation in academic libraries: A qualitative study. *Information Technology and Libraries*, *35*(3), 27–42. https://ejournals.bc.edu/index.php/ital/article/view/9255

ADDITIONAL READING

Ashiq, M. (2021). Academic leadership in the dawn of the new millennium: Systematic review. *Journal of Academic Librarianship*, *47*, 102355. https://www.sciencedirect.com/science/article/abs/pii/S009913332100046X

Fu, P., & Carmen, L. (2015). Migration to Alma/Primo: A case study of Central Washington University. *Chinese Librarianship: International Electronic Journal*, *40*, 1–2.

Hussain, A. (2019). Industrial revolution 4.0: Implication to libraries and librarians. *Library Hi Tech News*, *37*(1), 1–5. https://digitalcommons.cwu.edu/libraryfac/30/. doi:10.1108/LHTN-05-2019-0033

KEY TERMS AND DEFINITIONS

Cloud Computing: Can be viewed as model of enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service providers interaction.

Disruptive Technology: Is a kind of technology that allows new users to do things but tend to interrupt existing practices.

Integrated Library System: A software for libraries that combine modules for cataloguing, circulation, acquisition, end-user searching, database access, and other library functions through a common set of interface database.

Library Automation: Refers to the use of computer to automate the typical procedures of libraries such as cataloguing and circulation.

Next-Generation Integrated Library Systems: New management system which make use of developing technologies to manage current workflows and extended access to collections.

Section 3

Library and Information Science (LIS) Curriculum/Education and Digital Skills in the 21st Century (Digital Transformation Era)

Chapter 14
A Framework for Integrating Artificial Intelligence Into Library and Information Science Curricula

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ABSTRACT

Integrating artificial intelligence (AI) into Library and Information Science (LIS) curricula is gaining momentum as scholars engage on the subject. Lots of research publications have emerged on AI in LIS. This chapter conceptualized a theoretical framework that should underpin the AI curriculum for University of Eswatini. The study is anchored on the interpretive research paradigm, which surrounds a systematic literature review. This conceptual study was preliminary, and the researchers hoped that further empirical studies based on the findings of this study could be pursued in the future. This chapter, therefore, addresses the following issues: rationale for integrating AI in the curricula of the University of Eswatini, a theoretical framework for AI curriculum, and prospects for integrating AI into the curricula of the University of Eswatini.

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INTRODUCTION

The debate about embedding artificial intelligence (AI) in Library and information science (LIS) is gaining momentum as scholars from developed and developing worlds engage on the subject. AI has emerged as a ubiquitous form of technology in our everyday lives. LIS schools have begun considering including AI modules in their curricula to prepare learners to learn about these emerging technologies. Such initiatives inevitably involve curriculum planning. As AI is an emerging field undergoing rapid changes and considering that instructors are most likely not familiar with its content, understanding how existing theoretical frameworks of curriculum planning can be invoked to respond to the situation would be of interest to the refinement of curriculum theories. While innovators among instructors are creating AI curricula, a recent review of AI in education has highlighted the lack of study on AI for LIS in Eswatini. Omame & Alex- Nmecha (2020) in their study on the state of AI in Libraries investigated several perspectives such as the extent to which AI was necessary, who should offer AI and why, who should be taught and at what levels, how long should be the duration of the course/programme and what should be included in the curriculum? This chapter builds on Omame & Alex- Nmecha 's work and proposes a framework for AI curricula for LIS education in Eswatini. Besides, the chapter explores the sources that would provide theory, corpora of knowledge and philosophical underpinning for the development of AI for LIS in Eswatini.

Understanding the subject of AI is important to appreciate the dynamics and implications of its integration in the curricula for LIS in Eswatini. AI is the science and engineering of making intelligent machines, especially intelligent computer programmes. It is concerned with the study and creation of computer systems that exhibit some form of intelligence: a system that learns new concepts and tasks, systems that can reason and draw useful conclusions about the world around us, systems that can understand a natural language or perceive and comprehend a visual scene, and systems that perform other types of feat that require human types of Intelligence (Kopcha, Neumann, Ottenbreit-Leftwich & Pitman, 2020). It is the Application of Computers and utilization of computer-based products and services in the performance of different library operations and functions or the provision of various services and production of output products. Automation implies a degree of mechanization where the routines and receptive jobs or operations are left to be performed by machines with little or no intervention by human beings. The lesser the degree of human intervention, the greater the degree of automation and this does not mean that automation totally exclude human beings.

Including AI module in LIS curricula is an essential strategic initiative in LIS education in the digital era. AI education in LIS not only helps learners understand what the AI technologies are and how they work, but it also stimulates future AI researchers, ethical designers, and software developers (Pedró, Subosa, Rivas, Valverde, 2019). Integrating technology is still currently viewed as problematic and it is important to understand teachers' value-driven and feasibility assessment processes embedded within dynamically evolving school environments (Kopcha, Neumann, Ottenbreit-Leftwich & Pitman, 2020). Building on their work, integrating AI has unique challenges in that it is new to LIS schools, with the AI content not defined and the lecturers having to figure out where it fits in a crowded curriculum. Therefore, designing AI-related LIS curricula is very challenging for lecturers and it is important to raise the challenges lecturers face to facilitate curriculum planning work. Most recent studies related to AI curricula focused on what content knowledge and skills should be included and what AI tools are more effective for student learning (Williams, Park, & Breazeal, 2019). These studies viewed teaching as a transmission of knowledge and used the syllabus and assessment methods to plan their curriculum through identifying appropriate content and effective delivery methods and enhancing students' competencies. They focused on predefined content and outcomes, rather than how lecturers, learners and knowledge interact (Kelly, 2009). In other words, the current approach to AI curriculum planning and design may neglect instructors' perspective and sense-making, and also learners' agency in their learning (Eggleston, 2018).

Accordingly, these recent AI curriculum studies do not inform us well about the overall design of a formal curriculum and its planning and design approach for this evolving subject. Besides, LIS curriculum planning is fundamentally a political process that involves arguments about questions of value (Chiu & Churchill, 2016). Therefore, instructors' beliefs and views will decide what the curriculum looks like (Chiu, 2017). Instructors' intrinsic motivation is critical in the planning and design of curricula for sustainability because AI curriculum design requires an iterative development cycle (Ryan & Deci 2000). This motivational process can be explained by the self-determination theory (SDT), which provides a theoretical framework to explain the instructors' fundamental psychological needs autonomy, relatedness, and competence for educational innovation (Niemiec & Ryan, 2009). As we discussed earlier, AI education is new to academia and LIS schools. There is a serious lack of relevant studies, particularly in planning, implementing and renowned AI curricula. AI is emerging, disruptive, and it is not part of instructor education. It thus offers an opportunity to enrich theories of curriculum design and planning processes for subject matter that instructors do not have much prior knowledge on. Instructors' perspectives are very essential to make sense of the emerging AI technology for curriculum planning (Kopcha, Neumann, Ottenbreit-Leftwich & Pitman (2020).

METHODOLOGY

The current study was anchored on the interpretive research paradigm, which surrounds a Systematic literature review. A systematic review was conducted to identify, categorize, analyze the existing literature that is relevant to the research topic. In this study, the researchers used an automatic search method to retrieve relevant studies for this mapping study. The electronic databases used are Scopus, ScienceDirect and ProQuest with a time span from 2009 to 2020. Scopus is a comprehensive paper research database in the fields of science, technology, health, social sciences, arts, and humanities. ScienceDirect is a database containing a collection of quality, full-text documents that have been peer-reviewed by Elsevier.

ProQuest is an electronic journal database that provides a source of scientific information for researchers and students in various disciplines. The researchers took a study in a number of selected electronic databases, with search keywords 'library', 'information science', 'Artificial intelligence' and 'education and training'. The search was carried out on titles, abstracts, and keywords published from 2008 to 2020. In the Scopus database, the filters used were Document Type: article and conference papers, Publication Stage: Final, and Language: English produced 81 documents. The ScienceDirect database produces 4 documents. The ProQuest database 60 documents. The total documents collected were 145 documents. Th researchers merged and removed duplicate study lists. At this stage, search results were combined, and duplicate data was removed. Papers that have been merged from various electronic databases were checked for duplication detection. From the 145 papers that were checked, there were 45 paper duplications so that the remaining papers totaled 100 papers.

Furthermore, these papers were analyzed for inclusion and exclusion criteria. The inclusion and exclusion were carried out by manual reviewing for the contents of the paper starting from the abstract and selected all publications that were not related to artificial intelligence in libraries. Then proceed with selecting based on the full text that is directly related to artificial intelligence in libraries. The researchers also removed papers that only explained artificial intelligence concepts. From 100 papers produced 80 papers based on abstract inclusion. Furthermore, from 80 papers produced 65 papers selected based on the full text that present empirical studies for further analysis.

LIS EDUCATION IN ESWATINI

LIS education has just been embraced and made part of the curricula in the University of Eswatini. A milestone was reached in this field in 2019-2020 academic year when the LIS program was launched by the Faculty of Science and Engineering (University of Eswatini, 2018-2019). However, the AI curricular into this program has not yet been adopted. University of Eswatini is the main national university on the Kingdom of Eswatini with an enrolment of about 7645 (University of Eswatini, 2021). The LIS program added to the growing number of programs and came at a much-needed period where the Kingdom was lagging behind. What informed the introduction of this program was the fact that the country was losing much revenue and suffering a high brain drain of LIS professionals who were normally sent to study outside the country. Normally, the Eswatini Library and Information Association (ESWALA) would conduct workshops for Library and information workers to enhance their service provision, which is not adequate. Especially in the long term and present time of Artificial intelligence in many aspects.

Further, most of the time, LIS skills were imported from other countries like Botswana, Namibia and South Africa as Eswatini had no LIS program. What is currently offered in Eswatini is a Diploma in Archives and records management by the Institute of Development and Management (IDM) (Institute of Develoment and Management (IDM), 2021). This is not adequate to meet the highly developing information society and industrial revolution period, further no traits of AI are evident in its content. It is noted that through the paradigm shift, many libraries worldwide are introducing AI, and thus the study proposes the introduction of AI into the LIS curricular.

It is evident that some libraries are moving on to Machine learning and robots in the developing countries. For instance, the University of Pretoria successfully engaged “Libby” the library robot as one of its Library staff in 2019 (University of Pretoria, 2019). Since these are the trends, the study proposes that UNESWA should do the same, and the introduction of the LIS program came at an opportune time. However, it stands to be seen as to whether its LIS curricula will also cover AI.

RATIONALE FOR INTEGRATING AI IN THE CURRICULA

To date, very few studies have been conducted on AI teaching and learning in LIS schools

(Omame & Alex-Nmecha, 2020). Wheatley & Hervieux (2019) also concurs that there has been low research in terms of AI and librarianship. Therefore, is it no surprise that Arlitsch & Newell (2017; 790) pointed that there is a need for libraries to take a “continuing education approach for AI” in relation to information seekers and information providers like librarians in the libraries. Therefore, there is neither an existing established curriculum nor well-defined AI content knowledge for LIS schools. Research on the curriculum development approaches adopted, the curriculum development processes and the consequences are necessary for educators to enhance the process of integrating AI module into LIS education.

Furthermore, AI technologies, different from other new technologies, are emerging and potentially disruptive. As machine learning becomes more powerful and narrow AI is performing more jobs, AI technologies and products are replacing jobs such as cashiers and proofreaders (Wang &Wang, 2019). AI future development would cause further changes in the job roles due to automation and computerization of libraries, and people need to improve AI skills to improve careers. This anxiety could cause facilitating or debilitating effects (Chiu, 2018). When learners perceive AI learning as rewarding and hold a positive attitude toward AI technologies, the facilitating effect occurs; otherwise, the debilitating effect occurs (Piniel, & Csizér, 2013). The effect is dependent on the curriculum design. This points to the importance of investigating how teachers are conceptualizing the AI curriculum and the underlying curriculum approaches that they are adopting in conjunction with the personal psychology that is driving them as teachers.

CURRICULUM PLANNING APPROACHES

Curriculum refers to all experiences that are planned and guided by a teacher and learned by learners, whether in a group or individual setting, inside or outside classrooms (Kelly, 2009). Curriculum theory, derived from educational, philosophical, psychological, and sociological perspectives, is fundamentally concerned with values and ways of viewing educational curricula and policy decisions. The literature outlines four approaches to understanding curricula: curriculum as content, product, process, and praxis.

These approaches are used independently or in an integrated manner to theorize curricula development in LIS schools (Glatthorn, Boschee, Whitehead & Boschee, 2018). Regardless of the approaches, understanding curriculum development involves unpacking the underlying relationships between purposes, knowledge, and pedagogy. The curriculum as a content approach sees education as the transmission of knowledge. Curriculum planning is thus the construction of a syllabus (a body of subject content) and the identification of effective delivery methods (Kelly, 2009). Its supporters are more likely to follow a textbook approach of an order of contents or a knowledge structure approach to a subject. They tend to limit their planning to the consideration of the body of knowledge that they want to deliver. The justification for the curriculum lies in its content but not its effects. This view of curricula is very popular amongst instructors in LIS schools (Kelly, 2009).

The curriculum as a product approach sees education as instrumental to enhancing learners' competencies. It focuses on assessing student learning outcomes (Glatthorn, Boschee, Whitehead & Boschee, 2018). The curriculum is viewed as a design for a technical exercise, and it takes the performance and competence of learners as the core components (Swanson, Pashby, 2016). It aims to prepare students adequately for specific activities, and it involves detailed attention to what the learners need to learn and know to pursue further study, work, live their lives and so on. This approach is often found in many technical, skill-based and training programs where specific tasks or jobs have been identified, as well as technology and engineering subjects where the body of knowledge and concepts are well defined. The curriculum often draws up lists of competencies and informs students what they must learn and how they will do it; therefore, the students have little or no voice in their learning. By having predefined outcomes, this approach tends to direct attention to teaching.

The two approaches discussed earlier usually generate a set of documents for implementation. John Dewey's progressive and student-centred approaches, on the other hand, spurred the curriculum as a process approach (Kelly, 2009). This approach sees education as development and it focuses on how teachers, students and knowledge interact, rather than on the delivery of predefined content and outcomes. Learning objectives tend to change as the triadic relationships evolve (Kelly, 2009). The curriculum is not a standard package of materials that need to be consistently covered and delivered in classrooms, but a specification about teaching practice (Glatthorn, Boschee, Whitehead & Boschee,2018). It is seen in terms of what happens in classrooms and what teachers and their students do to prepare and evaluate the subject matter. For example, choices of content depend on what fits student needs and interests; learning outcomes are developed from a collaboration between teachers and students, but not applied to all the students. In this approach, students are not treated as objects but as subjects who have voices.

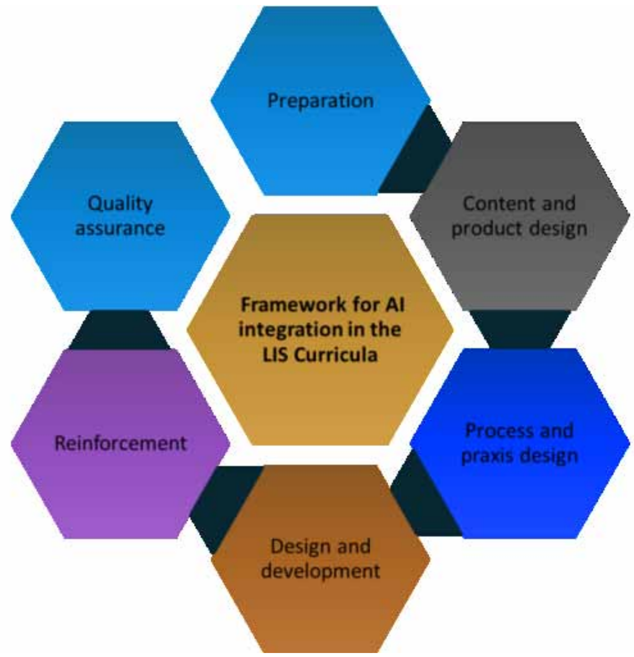
This approach shifts the focus of the curriculum from teaching to learning. The process approach emphasizes interpretation and meaning-making and does not make clear statements about the interests it serves. Bringing this issue to the center of the process, the curriculum as praxis approach sees education as committed action and focuses on making sense of the knowledge in the learning process by connecting it to real-world applications (Glatthorn, Boschee, Whitehead & Boschee, 2018). Under this approach, students and teachers reflect together and develop the problem-solving strategies and skills that they use to solve real-world problems. They are required to work out an action plan for acquiring the content knowledge and achieving the outcomes. The learning process and outcomes are continually evaluated.

Adopting a particular curriculum planning approach has a major influence on pedagogy (Priestley & Biesta,2013). For example, the content approach encourages teacher-centred approaches to teaching, the product approach places heavy emphasis on drills and practice, the process approach leads to the design of student-centred learning activities and the practice approach tends to adopt problem-based learning. However, these four approaches to curriculum planning are not mutually exclusive (Kelly, 2009). For example, supporters of the process approach would not argue that content and assessment are unnecessary and negligible, but the selection of content is a secondary consideration. The first two approaches adopt a behavioral stance and structured teaching and set objectives and attainment targets that must be taught to students. The last two approaches draw on student-centred learning theory and educational and developmental psychology. They identified and nurtured the strengths of students, with every student taking an active role in her/his learning and with both students and teachers developing the curriculum. Contemporary education favours the process and praxis approaches over the content and product approaches, which is evidenced by a massive shift from the content and praxis approaches to the process and product approaches in teaching practices and educational reforms all over the world (Kelly, 2009).

However, school curriculum planning, unlike higher education, is fundamentally a political process (Priestley & Biesta,2013). Different teachers have different views about what should be covered in the curriculum and how it should be implemented. In these approaches, the curriculum is developed based on a stable set of knowledge, such as language and science. While these existing approaches are likely to be manifested in the process of AI curriculum planning, the epistemic essence of AI technology may demand new categories of consideration that could alter current curriculum theory. For instance, the subject matter of AI is highly dynamic, and it is also highly unfamiliar to LIS instructors. In addition, there are many ethical concerns about this form of technology, such as AI bias, singularity, and superintelligence (Wang & Wang,2019). Will AI replace human workers? Will AIs' decision-making be transparent? Should AI systems be allowed to kill? Will AIs evolve to surpass human beings?

Therefore, how LIS instructors approach curriculum planning for subject matter such as AI is less likely to have been accounted for. Overall, the content and product approaches to planning tend to be adopted in technical subjects, such as physical education, and at the program level due to their focus on competencies and assessment (Swanson & Pashby, 2016). Moreover, the process and praxis approaches

Figure 1. Framework for AI integration in the LIS Curricula



are more likely to be adopted in planning more established subjects, such as language and science, and at the classroom level because the teachers can choose the units that they want to focus on for teaching (Kelly, 2009). In other words, the teachers can decide what, how and when to teach, how to connect to students and how long to spend teaching them. However, how to plan a curriculum for any emerging subject domain or disruptive education innovation is less clear, but it is a required competency as more subject areas are being renewed and re-represented with technological advancements.

THEORETICAL FRAMEWORK FOR AI INTEGRATION IN THE LIS CURRICULA

For this study, to conceptualise the AI module in the curriculum, the researchers developed a conceptual framework (see figure 1). The focus of the intended curriculum conceptualisation is to explore evaluation criteria to consider what will reflect the intention of curriculum development that developers intended for. Linked to developing a vertical knowledge structure, the intended curriculum focuses on analysing the curriculum as content, design, consumption, and delivery. This was relevant, as the University of Eswatini did not yet have a module in AI. As a result, the researchers used the constructs from the intended curriculum as reflected in the conceptual framework, that is, preparation, content and product design, process and praxis design, design and development and reinforcement.

GUIDING PRINCIPLES

The proposed framework is based on the following guiding principles:

Opportunity

To achieve the vision and mission of the UNESWA, the curriculum provides learners with a variety of opportunities to enable them to identify their needs, talents and potential. This will enable them to participate in the world of work and the development of the Swazi nation. The emphasis will be on equal access to education for all. This will enable learners to enjoy learning and reduce wastage in terms of learners dropping the programme because the curriculum is not relevant to their needs (KICD,2017).

Excellence

Every learner will be nurtured to excel in their areas of greatest interest and ability. The framework values excellence and competitiveness rather than raw competition for examination grades. This will play a role in helping to reduce the challenge of malpractice in examinations because each learner will be guided to excel in their area of interest and ability (KICD,2017).

Diversity and Inclusion

There are two dimensions in the guiding principle of diversity and inclusion. Firstly, the framework will guide learners to appreciate Eswatini diversity in terms of race, ethnicity, gender, language, culture, and religion. The second dimension relates to the fact that learners are different in terms of their learning needs and abilities and these differences need to be respected and valued within an inclusive learning environment. Inclusion will entail ensuring that all learning institutions accommodate all learners regardless of their physical, emotional, intellectual, or any other need. It involves the provision of reasonable accommodation characterized by flexibility, responsiveness, and support. The proposed framework recognizes that not all learners are academically gifted but considers every learner's social and cognitive capabilities, their needs, and desires, and respects the differences in the way children learn. The aim is to guarantee basic education for every learner according to their abilities and needs (KICD,2017).

Differentiated Curriculum and Learning

Differentiated curriculum and learning build on the principle of diversity and inclusion. It ensures that the curriculum content and instructional approaches are appropriate for each learner. It provides space for teachers to adapt the curriculum to suit the learner. It does not demand that every learner learn the same content in the same way, in the same number of hours and at the same time (KICD,2017).

Community Service Learning

Involving students in community service is a form of experiential education that enables students to apply their knowledge and skills in a different setting. Teachers then support students to analyse what they have learned by taking part in this activity and how it might be applied to their academic and personal development. Community service learning entails a balanced emphasis on both students" learning and addressing real needs in the community.

Learning outcomes are linked to meaningful human, safety, educational, and environmental needs that are co-determined with community partners and service recipients. The service experience is brought back to the classroom to enhance learning. Learners work on real problems that make academic learning relevant while simultaneously enhancing their social skills, analytical ability, civic and ethical responsibility, self-efficacy, and career development (KICD,2017).

EXPLANATION OF THE FRAMEWORK

This explanation is based on the authors' knowledge and experience of Eswatini LIS institutions. Developing a curriculum can be both exciting and challenging because proper curriculum development is time-consuming and needs the involvement of all stakeholders. In addition, the curriculum is expected to reflect the local situation as well as international trends. The framework explains and proposes what the University of Eswatini (UNESWA) should do to develop an AI curriculum. The following elements should be included:

- Preparation;
- Content and product design;
- Process and praxis design;
- Design and development;
- Reinforcement; and
- Quality assurance.

Preparation

This phase is the most critical and focuses on the preparation of instructors for curriculum planning. How instructors feel and perceive AI teaching is more important than how well they know the AI content knowledge. Therefore, UNESWA should take immediate actions rather than make prolonged promises and technology instructors prefer to receive direct, rather than indirect, support (Chiu & Churchill, 2016). UNESWA should actively endorse the new initiative of AI teaching by offering different forms of support, such as logistical, technical and financial support before it is requested by the instructors. The first relevant instructor training programs should build a sense of relatedness by focusing on helping instructors to understand the importance of AI in LIS education to their learners and that AI education in LIS schools is a global trend. This should be followed by substantial knowledge input to boost the instructors' efficacy in designing and teaching the AI curriculum. If possible, some autonomy about when and how the instructors should engage in AI training should be allowed.

Content and Product Design

This phase is to identify content knowledge and assessment criteria and approaches for the curriculum. Aligning the AI curriculum with the assessment and objectives of existing technology or AI-related subjects is essential so that the innovation has clear and consistent guidelines with which the instructors are familiar. Moreover, to effectively transmit the abstract content knowledge, Mayer's multimedia learning principles, which facilitate generative, essential, and extraneous processing, should be applied to develop teaching materials like slides, infographics, and videos (Chiu, Jong & Mok, 2020). This will not merely transmit the content knowledge to learners, but foster communication among instructors, learners, and content (Chiu & Churchill, 2015).

Lastly, the curriculum should adopt an approach of moving from local explanations to international understanding, making connections between the subject and the learner's life. The instructors should use local challenges as examples and then further extend to global issues; the LIS learners could have a better understanding of the societal and personal impact of AI by combining many high-quality local explanations that allow representing global understanding.

Process and Praxis Design

This phase is to design learning activities that encourage learners' development by addressing learners' needs and interests and alleviating AI fear through the design of socially meaningful group-based projects. To construct learner-centred learning environments, the study recommends that instructors should approach the subject area of AI from a design-thinking perspective with positive thinking that gains an empathic understanding of the people to design solutions to the problems (Cautela, Mortati, Dell'Era, & Gastaldi, 2019).

Design and Development

In this phase, the instructors design and develop materials for the AI curriculum based on the plan developed in the previous phases. The instructors should apply a revisable and independent module in designing the curriculum, one which maximizes flexibility for instructors not only to revise and teach the content based on their UNESWA environment and learners' interests and competencies but also to improve the materials and pedagogy. The researchers believe that many variations may be needed around some key AI concepts to fit the diverse and dynamic needs of the learners. In this approach, the instructors can choose the modules that they want to focus on for teaching or redeveloping.

Reinforcement

In this phase, instructors should be encouraged and supported to revise the curriculum for development renewal. Multilevel professional development networks should be adopted to sustain curriculum development. This network exists both within and across the university networks, and it includes the university professional networks. Networking outside the UNESWA does not limit itself to working with other universities. There are, in the wider community, organizations that are competent in the field of AI, for example, AI professors and AI application developers who can support instructor professional development. These networks are interwoven together to create and nurture the capacity for sustaining the AI curriculum.

Quality Assurance

Quality assurance involves various issues to different people and is relative to processes or outcomes. Quality is a complicated notion, and quality in higher education is especially ambiguous and sometimes even confusing. Quality assurance plays an important role in ensuring that learners are given quality education throughout the programme (Tsabedze & Ngoepe 2020). Quality management is about supporting and developing quality procedures that are meant to improve practice. As a final conceptual phase to take into consideration, outside the realm of knowing, acting and being, is curriculum as quality assurance. Quality assurance standards must put in place to encourage the delivery of the quality curriculum. The focus must be on:

- ensuring that the programme is of appropriate quality and consistent with national and international standards
- ensuring that guidelines to facilitate harmonisation, development, validation, and delivery of the programme is available and in use
- ensuring that the programme is developed and delivered following the relevant Eswatini education laws
- curriculum implementation, monitoring and evaluation plan (Tsabedze & Ngoepe 2020).

The curriculum has to be supported by UNESWA policies and strategies of the in terms of the following:

- Content – knowledge and skills, and learning outcomes
- Pedagogy – sound teaching and learning methods
- Motivational strategies – intrinsic and extrinsic rewards for students
- Degree of student's autonomy
- Management and administration strategies

CONCLUSION AND RECOMMENDATIONS

The authors sought to demonstrate the growing importance of AI curricula. The efforts being made by scholars to mainstream AI in the curricula were outlined. This was followed by rationalizing why AI deserves to be mainstreamed into the curricula in LIS. The theoretical underpinning for integrating AI into the LIS curricula is elucidated. The authors noted that despite efforts being made to grow AI in other universities, the University of Eswatini is trailing behind regarding the level of AI integration in the curriculum. Knowledge / technical and practical interests should be considered by following a pedagogical approach where learners become self-determined, active creators of knowledge. This can only be achieved with curriculum reform, although the factors impacting on curricula are expansive; there is no one universal model that can be used to create a framework for curriculum reform. Tertiary institutions have an opportunity to adapt and use the proposed framework discussed above to develop AI in the LIS curriculum.

This was a conceptual study, and the researchers hope that further empirical studies based on the findings of this study could be pursued in the future. The second limitation is that the study did not evaluate the effectiveness of AI in the LIS school curriculum. Research into effective curricula needs to be conducted. Effective ways to enhance students' AI identity and interest would yield more effective AI learning. Students with stronger identity and interest are more likely to have greater persistence, which will be reflected in how successfully and for how long they pursue AI studies and careers.

Therefore, the researchers recommend that more studies should be conducted on what content knowledge should be included and which instructional design should be adopted for enhancing AI identity and interest. Thirdly, while this study proposes a framework for curriculum development to support the promotion of AI education in LIS, more studies are needed to validate, enrich, and refine the proposed framework. The researchers recommend that this study could also be extended by additional studies on other emerging subjects and curriculum innovations.

REFERENCES

Arlitsch, K., & Newell, B. (2017). Thriving in the age of accelerations: A brief look at the societal effects of artificial intelligence and the opportunities for libraries. *Journal of Library Administration*, *57*(7), 789–798. doi:10.1080/01930826.2017.1362912

Cautela, C., Mortati, M., Dell'Era, C., & Gastaldi, L. (2019). The impact of Artificial Intelligence on Design Thinking practice: Insights from the Ecosystem of Startups. *Strategy*, *12*(1), 114–134. doi:10.4013drj.2019.121.08

Chiu, T. K., Jong, M. S. Y., & Mok, I. A. (2020). Does learner expertise matter when designing emotional multimedia for learners of primary school mathematics? *Educational Technology Research and Development*, *68*(5), 2305–2320. doi:10.100711423-020-09775-4

Chiu, T. K. F. (2017). Introducing electronic textbooks as daily-use technology in schools: A top-down adoption process. *British Journal of Educational Technology*, *48*(2), 524–537. doi:10.1111/bjet.12432

Chiu, T. K. F. (2018). Introducing electronic textbooks as daily-use technology in schools: A top-down adoption process. *British Journal of Educational Technology*, *48*(2), 524–537. doi:10.1111/bjet.12432

Chiu, T. K. F., & Churchill, D. (2015). Exploring the characteristics of an optimal design of digital materials for concept learning in mathematics: Multimedia learning and variation theory. `. *Computers & Education*, *82*, 280–291. doi:10.1016/j.compedu.2014.12.001

Chiu, T. K. F., & Churchill, D. (2016). Adoption of mobile devices in teaching: Changes in teacher beliefs, attitudes and anxiety. *Interactive Learning Environments*, *24*(2), 317–327. doi:10.1080/10494820.2015.1113709

Eggleston, J. (2018). *School-Based Curriculum Development in Britain: A Collection of Case Studies*. Routledge. doi:10.4324/9780429454622

Frankenfield, J. (2021). *Artificial Intelligence (AI).* Retrieved from https://www.investopedia.com/terms/a/artificial-intelligence-ai.asp

Glatthorn, A. A., Boschee, F., Whitehead, B. M., & Boschee, B. F. (2018). *Curriculum Leadership: Strategies for Development and Implementation*. Sage.

Institute of Development and Management (IDM). (2021). *Diploma in Archives and Records Management*. Retrieved from https://www.idmbls.com/course-overview/DIPLOMA

Kelly, A. V. (2009). *The Curriculum: Theory and Practice*. Sage.

KICD. (2017). *Basic Education Curriculum Framework*. Kenya Institute of Curriculum Development.

Kopcha, T. J., Neumann, K. L., Ottenbreit-Leftwich, A., & Pitman, E. (2020). Process over product: The next evolution of our quest for technology integration. *Educational Technology Research and Development*, *68*(2), 729–749. doi:10.100711423-020-09735-y

Niemiec, C. P., & Ryan, R. M. (2009). Autonomy, competence, and relatedness in the classroom: Applying self-determination theory to educational practice. *Theory and Research in Education*, *2009*(7), 133–144. doi:10.1177/1477878509104318

Omame, I. M., & Alex-Nmecha, J.C. (2020). Artificial Intelligence in Libraries In book: Managing and adapting library information services for future users. Hershey, PA: IGI Global.

Pedró, F., Subosa, M., Rivas, A., & Valverde, P. (2019). *Artificial Intelligence in Education: Challenges and Opportunities for Sustainable Development*. UNESCO.

Piniel, K., & Csizér, K. (2013). L2 motivation, anxiety and self-efficacy: The interrelationship of individual variables in the secondary school context. *Studies in Second Language Learning and Teaching*, *3*(4), 523–550. doi:10.14746sllt.2013.3.4.5

Priestley, M., & Biesta, G. (2013). *Reinventing the Curriculum: New Trends in Curriculum Policy and Practice*. Bloomsbury Academic. doi:10.5040/9781472553195

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *The American Psychologist*, *55*(1), 68–78. doi:10.1037/0003-066X.55.1.68 PMID:11392867

SenseTime. (2018). Fundamentals of Artificial Intelligence. East China Normal University.

Sleegers, P., den Brok, P., Verbiest, E., Moolenaar, N. M., & Daly, A. J. (2013). Toward conceptual clarity: A multidimensional, multilevel model of professional learning communities in Dutch elementary schools. *The Elementary School Journal*, *2013*(114), 118–137. doi:10.1086/671063

Swanson, D. M., & Pashby, K. (2016). Towards critical global citizenship? A comparative analysis of GC education discourses in Scotland and Alberta. *J. Res. Curric. Instr.*, *20*, 184–195.

Tsabedze, V., & Ngoepe, M. (2020). A framework for quality assurance for archives and records management education in an open distance e-learning environment in Eswatini. *The International Journal of Information and Learning Technology.*, *38*(1), 1–18. doi:10.1108/IJILT-03-2020-0033

University of Eswatini. (2018). Report of the Vice Chancellor 2018-2019. University of Eswatini.

University of Eswatini. (2021). *Student enrolment.* Retrieved from http://www.uneswa.ac.sz/

University of Pretoria. (2019). *Libby the library robot is on duty at UP.* Retrieved from https://www.up.ac.za/alumni/news/post_2825427-libby-the-library-robot-ison-duty-at-up

Wang, Y. Y., & Wang, Y. S. (2019). Development and validation of an artificial intelligence anxiety scale: An initial application in predicting motivated learning behavior. *Interactive Learning Environments*, 1–16.

Wheatley, A., & Hervieux, S. (2019). Artificial intelligence in academic libraries: An environmental scan. *Information Services & Use*, *39*(4), 347–356. doi:10.3233/ISU-190065

Williams, R., Park, H. W., & Breazeal, C. A. (2019). Is for Artificial Intelligence: The Impact of Artificial Intelligence Activities on Young Children's Perceptions of Robots. *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. 10.1145/3290605.3300677

ADDITIONAL READING

American Library Association. (2019). *Artificial Intelligence*. Retrieved from: https://www.ala.org/tools/future/trends/artificialintelligence/

Coleman, C. N. (2017). *Artificial intelligence and the library of the future revisited*. Retrieved from https://library.standford.edu/blogs/digital-libraryblog/2017/11/artificial-intelligence-and-library-future-revisited/

Mathou, C. (2018). Recontextualizing curriculum policies: A comparative perspective on the work of mid-level actors in France and Quebec. *Journal of Curriculum Studies*, *50*(6), 789–804. doi:10.1080/00220272.2018.1513567

KEY TERMS AND DEFINITIONS

Artificial Intelligence: Refers to the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions.

Curriculum: Refers to all experiences that are planned and guided by a teacher and learned by learners, whether in a group or individual setting, inside or outside classrooms.

Curriculum Development: Refers to step-by-step process used to create positive improvements in courses offered by a university.

Deep Learning: Refers to techniques enable this automatic learning through the absorption of huge amounts of unstructured data such as text, images, or video.

Internet of Things: Refers to smart network formed by the connection and communication between objects.

Machine Learning: Refers to the concept that computer programs can automatically learn from and adapt to new data without being assisted by humans.

Chapter 15
Digital Pedagogies of Academic Librarians in the Fourth Industrial Revolution

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ABSTRACT

Globally, the role of academic librarians as online teachers at higher education institutions is experiencing a tsunami of change. This is due to the Fourth Industrial Revolution and the influence of technology on pedagogy. The 21st-century academic librarian is challenged to adopt innovative teaching methods using technology in a digital environment. The purpose of this study was to explore the pedagogical and technological preparedness of academic librarians at University of Technologies in South Africa for online teaching. The technology pedagogy content knowledge framework guided the methodology in exploring the pedagogical and technological preparedness of academic librarians. A pragmatic approach using quantitative techniques was used in the data collection process. The data collected from the findings were analyzed and validated resulting in emerging themes. The results show a lack of pedagogical and technological skills among academic librarians at UOT in South Africa.

BACKGROUND AND INTRODUCTION

The 4IR is not limited to technology. It is also powered through the internet positively influencing core sectors in the digital age. Chiles et al., (2021) elucidate the impact of the internet in creating digital infra-

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structure in the field of cellular agriculture. The internet using web crawlers created datasets for scientific literature in cellular agriculture which is vital in understanding food production. Similarly, the internet has been central in shifting academia specifically within the context of higher education institutions into the digital environment (Davidson-Shivers *et al*., 2018). This is mainly due to the growth, development and accessibility of the internet in digital learning spaces. Globally higher education institutions have used the internet to accelerate their integration into the digital environment (Sappington and Bedford, 2017) through multimodal methods of teaching, learning and research.

The influence of the 4IR, internet and technology also extend beyond the physical boundaries of academic libraries at higher education institutions. Academic libraries in the 21st century is developing and transforming in the digital age. Jolly and Corrall (2019) provide evidence substantiating this shift terming it ‘social innovation’. Some examples of using social innovations within academic libraries include artificial intelligence, virtual library assistant and research data management. Academic libraries are changing into forward-thinking research environments for digital humanities, data curation, evolving integrated library systems, learning analytics, open access, research data services, digital pedagogies, machine learning, and artificial intelligence in a digital world (Uzwyshyn, 2018). According to Lewitzky (2020), academic libraries have evolved from being resource-based to an active and integrated digital role within higher education. This is the result of the internet and rapid technological advancements. Hence, the 4IR, the internet and technology have been drivers of ‘disruptive innovations’ for academic libraries in higher education. Chisita et al., (2022) study reveals and identifies disruptive innovations in academic libraries accelerated through the recent Covid 19 pandemic simultaneously recognizing the importance of the 4IR. Disruptive innovation “creates an entirely new market by introducing new products and services and that eventually disrupts an existing market by drawing away customers from that market” (Christensen, 2013).

Disruptive innovations have been key in identifying and influencing the online teaching role of the academic librarian. Bell and Shank (2011) used the concept of disruptive innovations to discover the online teaching role of the academic librarian resulting in a framework of blended librarianship. The blended librarianship framework combined digital and pedagogical knowledge in the teaching-learning process. However, a recent study by Beer (2022) established the blended librarianship approach needs to be repositioned to include core competencies in pedagogical knowledge and digital skills. Julien and Latham (2018) also posit academic librarians need pedagogical and digital skills. O’Neil and Pegrum (2018) agree academic librarians at higher education institutions need a grounding of pedagogical knowledge mixed with technological skills such as the use of digital learning tools for online teaching. Historically, the literature has continuously challenged the pedagogical knowledge of academic librarians and their role as a teacher at higher education institutions (Ciccone & Hounslow, 2019). However, the current influence of technology on pedagogy has added a new dimension for academic librarians who teach in a digital environment.

PROBLEM STATEMENT

Globally, there has been a tsunami of change in the teaching role of the academic librarian. The teaching role of the academic librarian has been synchronized in relation to the understanding of pedagogies and technologies. The challenging nature of higher education institutions in the 21st century intersecting with the influence of technology on pedagogy demands academic librarians to engage seamlessly within an online learning environment. The purpose of this study is to explore and probe the pedagogical and technological preparedness of academic librarians at University of Technology (UOT) in South Africa for the digital environment. This study is taking a pragmatic approach using a sequential explanatory mixed-method design. The sequential explanatory mixed-method design is a two-phase approach. During the quantitative first phase, a web-based exploratory survey was administered to academic librarians at UOT in South Africa. The findings from the web-based exploratory survey are outlined and tersely discussed in this book chapter. The emerging themes from the web-based exploratory survey will be used to design the qualitative second phase. The findings from the study will be analysed, validated and related to emerging themes from the study. The American Library Association (2017) has listed instructional design and teaching skills as one of the key areas of proficiency when identifying with the job profile of an academic librarian. However, academic librarians lag in their understanding of pedagogy, adoption of instructional design theory, practice and educational technologies (McTavish, 2019). Worldwide, research undertaken focused on bridging the gap that exists in pedagogies for librarians by concentrating on redesigning curricula in library schools to include an education component (Hensley, 2015). However, the rapid transition from face-to-face instruction intersecting with the advent of multi-modal teaching environments through various technologies has further disrupted the instructional role of the academic librarian. Parramore (2019) states there is a wealth of literature related to online library instruction, however, very little surrounds the preparedness of academic librarians in facilitating online teaching in a digital environment. This has been a 'grey area' for many scholars in different countries. Shahbazi and Hedayati (2016) and Julien et al. (2018) concluded that there is a need for academic librarians to have both digital and pedagogical skills to be proficient within the online environment.

Within the South African context, Raju (2017) analyzed 108 job descriptions related to academic librarians. Raju (2017) expounded on a baseline study from international literature as a measure to ascertain the pedagogical and technological skills needed by academic librarians with a teaching identity in South Africa. The finding illustrated academic librarians lacking in pedagogical and technological knowledge aligned to the digital environment in South Africa. However, the job descriptions reflect these skills as a prerequisite for academic librarians in South Africa. The emerging theme of exploring digital skills in relation to pedagogies has been explored by a handful of researchers in developed economies of the world. This is supported by a global systematic literature review addressing digital pedagogies and academic librarians (Omar Saib et al., 2022). Worldwide, only five articles explored digital pedagogies aligned with the emerging role of the academic librarian as an online facilitator. The findings concluded:

- Globally, the literature in developing and developed knowledge economies excludes using appropriate technologies to teach online library instruction
- Online pedagogy, use of technology and content knowledge to direct online learning is lacking
- Academic librarians as online facilitators are linked to digital skills to teach and educational tools to direct online learning in a digital environment are inadequate

Similarly, Cicone and Hounslow (2019) findings indicate academic librarians need to have a succinct understanding of pedagogy, digital skills and curriculum development to create appropriate content to teach in an online environment. Within the South African context, academic librarians are underprepared to transition into online teaching roles Raju (2017) juxtaposes similar patterns are trending in the current literature, globally (Omar Saib et al., 2022).

Presently, the influence of technology on pedagogy means that academic librarians must have both digital and pedagogical skills in delivering online library instruction. The use of technology influencing pedagogy is termed ‘Digital Pedagogy’. This involves using technology to merge pedagogical practices enabling seamless transfer of content knowledge thereby ensuring relevant learning outcomes. Thus, the aim of this study was to probe, explore and ascertain the emerging role of the academic librarian in relation to digital pedagogies applying the Technological Pedagogical Content Knowledge (TPACK) framework in South Africa. This will contribute to the knowledge base in the understanding of the online role academic librarians have as teachers in the 4IR at UOT in South Africa. The following objectives were formulated to address this research problem:

- To probe the pedagogical knowledge of academic librarians for online teaching in the current digital environment within UOT in South Africa.
- To explore the technological knowledge of academic librarians for online teaching in the current digital environment within UOT in South Africa
- To ascertain the content knowledge of academic librarians for online teaching in the current digital environment within UOT in South Africa

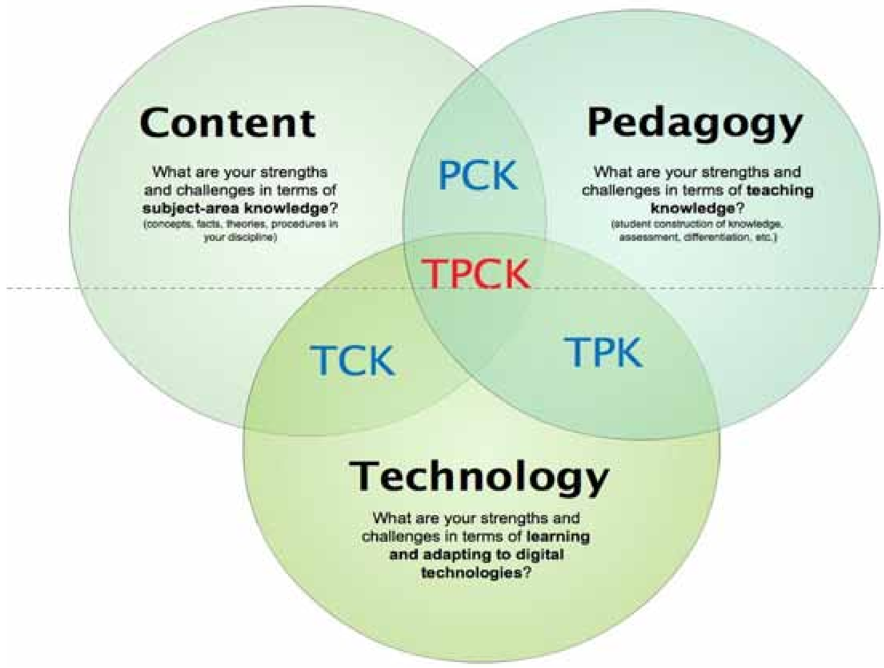
THEORETICAL FRAMEWORK

The recent global pandemic in the form of Covid 19 has severely affected society (Mofijur et al., 2021). Higher education institutions are not immune to this imposed change due to this pandemic. Covid 19 has forced higher education institutions to engage university communities through the digital environment (Turnbull et al.,2021). This resulted in teaching, learning and research landscapes at higher education institutions in the form of face-to-face and blended instruction becoming less important. Thus, the digital environment has become the medium of teaching, learning and research. However, according to Kim and Gurvitch (2020), online teaching presents several pedagogical and technological challenges.

Online teaching has also increased the demand for academic librarians to participate, collaborate, facilitate and engage in library instruction at higher education institutions. English, West and Jackson (2019), state delivering high-quality online library instruction demands germane digital skills set and a succinct understanding of 21st-century pedagogical theories. However, using technology to teach is new to an academic librarian with limited online teaching experience (Reed et al., 2022). Hence, it is a hurdle for academic librarians teaching in the digital environment. However, there are models and theoretical frameworks that can support academic librarians in their online teacher role. One of these theoretical frameworks that have been widely accepted spanning over a decade is the Technology Pedagogy Content Knowledge (TPACK) framework.

Shulman pioneered the concept of the Pedagogical Content Knowledge (PCK) framework. Shulman (1986) describes PCK as a combination of pedagogic and content knowledge directing effective teaching methods. Pedagogical Content Knowledge (PCK) allowed the teacher to facilitate learning through illustrations, demonstrations; explanations ultimately enabling learning to take place in a way that is understandable to the audience. It guided the constructs of teaching rooted in the pedagogical knowledge of the teacher supported by expert content knowledge. Later, Koehler and Mishra (2009) emphasized the fluid relationship between pedagogy, content and technology. This added an additional sphere and established the Technology Pedagogy Content Knowledge (TPACK) framework. Therefore, the TPACK

Figure 1. Technological pedagogical content knowledge
(Digital Learning Collaborative Organization, 2013).



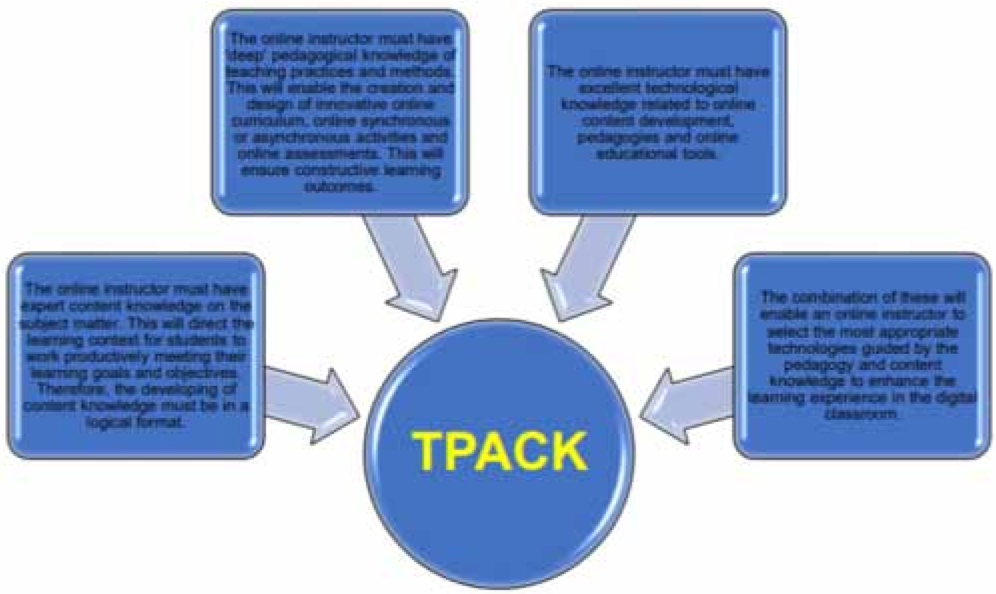
framework is recognizable initially with reference to Shulman's work in integrating content and pedagogy whereas Koehler and Mishra introduced technology.

The TPACK framework consists of three overlapping key components for online teaching and learning. Explicitly, the three components are Content Knowledge, Pedagogical Knowledge, and Technological Knowledge. These three components are interrelated and interdependent on each other as there coexist within the framework. The coexistence of these components in the framework is through the intersecting influence on each other that is further categorized into Pedagogical Content Knowledge, Technological Content Knowledge and Technological Pedagogical Knowledge (Scott, 2019). This framework allows an online instructor to explore, engage and reflect on how to use pedagogical, content and technological knowledge to teach in a digital environment (Henriksen et al., 2015). TPACK directs an online facilitator through a process of self–reflection. The following deliberations are important when using the TPACK framework (Kelly & Antonio, 2016).

An online instructor must have the ability to use the TPACK framework to develop content based on their knowledge or understanding of pedagogies and the influence of technology. Therefore, a comprehensive understanding of the subject matter is important. Content Knowledge guides the curriculum in the design of lesson plans, activities, assessments and learning outcomes. Thus, the online instructor must have relevant Technological Knowledge and Pedagogical Knowledge combined with expert Content Knowledge to teach in the digital environment (Watson & Rockinson-Szapkiw, 2021).

The TPACK framework has become one of the more popular frameworks used for designing online, hybrid and blended courses (Picciano 2017). The framework guides the online instructor in creating the

Figure 2. Pedagogical knowledge, content knowledge, technological knowledge unpacked



'right mix' prioritizing learning outcomes supported by pedagogy, content and technology knowledge. Burke (2021) used a mixed-method approach to determine if a correlation existed between TPACK, rating of participants and the use of technology. The finding illustrated participants with a higher TPACK rating provided diverse modes of learning opportunities for students. The TPACK framework is also fast becoming significant to research and scholarly writing in education. Kaplon-Schilis and Lyublinskaya (2020) agree within the past decade TPACK has become a point of reference in probing and exploring teaching with technology. Albrahim adds (2020), that the most widely used model when researching the influence of technology on education is the TPACK framework.

Academic librarians teaching in the digital environment are also engaging with the TPACK framework. Sobel and Grotti (2013) concur; that there is a rapid increase in the number of academic librarians experimenting with the TPACK framework. Academic librarians are using the TPACK framework against the backdrop of pedagogy, content and technology to understand their teaching role in the digital environment (Hartwell, 2020). This study also used the TPACK framework to probe. explore and ascertain the pedagogical and digital skills of academic librarians when teaching in a digital environment. Thus, for this study, the researcher made recommendations to improve the pedagogical and digital skills of academic librarians at UOT in South Africa using the TPACK framework.

Worldwide, there have been numerous studies focusing on the 'academic librarian as teacher', challenging the academic librarian for several decades on pedagogies (Bell & Shank 2004; McGuinness 2011; Walter 2008). However, there has been limited research in understanding the digital pedagogies of academic librarians globally and within the South African context (Omar Saib et al, 2022). It is therefore an emerging theme. This research aimed to understand the connection of digital pedagogies in relation to academic librarians at UOT in South Africa. The Technology Pedagogy Content Knowledge (TPACK) framework steered this study in unpacking digital pedagogies and the online teaching role of academic librarians at UOT in South Africa.

UNDERSTANDING DIGITAL PEDAGOGY

Howells (2012) tersely defines digital pedagogy as using technology to teach. Digital pedagogies is a method that integrates learning using technologies into online teaching, Michael and Evangelia (2016). It is the connection between teaching and technology to facilitate learning in a digital environment. Digital pedagogy is the combination of pedagogy and technology determined through a salient understanding of learning theories. This is reflective in the planning of online lectures influenced by which learning theories to apply when teaching in a digital environment. It includes the selection of the most appropriate educational tools to engage students with the content and technology supported by Pedagogical Knowledge. Therefore, online facilitators need to create an enabling environment for students to become actively involved whilst learning in an online class. The key factor in online instruction is knowledge of learning theories and pedagogy including using relevant digital learning tools to engage students with various topics within the curriculum of online instruction (Brieger et al., 2020, Ananga, 2020, Beetham & Sharpe, 2019).

Digital pedagogy is guided by the foundational knowledge of learning theories and supported by technology and not inversely (Omar Saib et al., 2022). Crawford *et al.* (2020) agree that learning theories guide online instructors on how to use pedagogies and technologies when teaching in a digital environment. Examples of learning theories include constructivism, active learning, problem-based learning and others. A comprehensive understanding of learning theories can guide online instructors to design an enriching online curriculum (Gonzalez & Vieyra, 2019).

Pedagogy and Academic Librarians

A well-designed online curriculum will result in students becoming ‘owners’ of their online learning experiences through active discussions, problem-solving and collaboration, Chen (2022). The goal and objective of an online instructor should be to unearth the intrinsic knowledge in students to build their higher-order thinking skills. This should be the outcome of implementing pedagogy against the backdrop of teaching methods such as active and problem-based learning in a digital environment. Thus, pedagogy influenced by technology is a combination of learning theories and selecting the appropriate digital educational tools leading to specific learning outcomes. The engagement of students through teaching methods such as problem-based learning with an understanding of how to use educational technologies is important for the digital environment. This will result in developing a student that is an ‘objective thinker’ in the 4IR.

Globally, 4IR has influenced and disrupted the professional development of the academic librarian as a teacher in higher education (Okunlaya et al., 2022). Generally, programmes such as Scholarship of Teaching and Learning positively influenced the ‘teacher identity’ of academic librarians. These types of programmes helped academic librarians to develop their knowledge of pedagogy (Hays, 2019). However, a dynamic shift to online teaching and learning at higher education institutions has derailed the professional development of the academic librarian as a teacher. Juxtapose, historically academic librarians have grappled with a ‘teacher identity.’ According to Hall (2013), experts are continuously examining whether academic librarians have the necessary grounding in the 'rudiments of pedagogy' to teach. Davies-Hoffman *et al.* (2013), assert that despite criticisms in the literature 'for over thirty years' academic librarians continue to teach. The criticism and the continuous examination emanate from the lack of foundational pedagogical knowledge of academic librarians to teach (Raju 2017). The emergence of teaching with technology in the form of digital pedagogies has further questioned the pedagogical and technological skills needed by academic librarians in an online teaching role (Martzoukou, 2020). Worldwide, the influence of technology on pedagogy coined 'digital pedagogies' is an emerging theme in academic librarianship (Llewellyn, 2019). The use of digital pedagogies in online teaching is an active, collaborative and self-paced approach mediated by the use of technology. Academic librarians must have a grounded understanding of digital pedagogies related to online teaching methods. This must be synchronized with a germane understanding of content knowledge connected with the use of technology to achieve optimal learning outcomes when teaching library modules in a digital environment. McTavish (2019) in a Canadian study explored the emerging role of academic librarians through an online survey and an analysis of job descriptions. The purpose was to probe the online role of academic librarians as a teacher. The findings revealed academic libraries must understand content knowledge related to library content and key technological and pedagogical skills to direct learning. This is ideal when using technology with pedagogy; however, even academics in higher education institutions are grappling with seamlessly connecting the dots in how to use digital pedagogies when teaching in a digital environment (Watermeyer et al., 2020).

Teaching with Technology and Academic Librarians

Llewellyn (2019) states the teaching role of academic librarians at higher education institutions has changed. Julien et al., (2018) concur the teaching role of academic librarians has expanded and diversified over the past few years with the rapid advancement of technology. The challenging nature of higher education institutions in the 21st century influenced by technology demands academic librarians to engage in online teaching seamlessly. However, academic librarians lag in their understanding of pedagogy, adoption of instructional design theory, practice and educational technologies (McTavish, 2019). Recent studies in developed knowledge economies such as Australia, America, Canada and United Kingdom revealed the limitations of academic librarians in understanding pedagogies and applying relevant technologies within the digital environment to enhance online learning (Ciccone & Hounslow, 2019).

The digital environment can be complex for academic librarians when teaching. Currently, academic librarians are required to integrate technology into their online teaching practice whilst establishing their 'teacher identity' in the digital environment. Corrall and Jolly (2019) agree academic librarians are incorporating their online instruction into teaching and learning at higher education institutions simultaneously emphasizing the importance of the "librarian as teacher." It is therefore critical for academic librarians to be knowledgeable in 21st-century pedagogical frameworks, learning theories, and student-centered curriculum design fashioned with effective digital skills to direct learning in a digital environment. Digital skills mixed with pedagogical knowledge will provide an impetus for desirable learning outcomes when teaching in a digital environment. The survival of academic librarians with a 'teacher identity' is linked to the understanding of pedagogies and technologies in the digital environment. Thus, digital pedagogies can positively influence the preparation of academic librarians to teach in a digital environment.

Academic Librarians and Online Teaching

Worldwide, there is an 'inherent feeling' at higher education libraries recognizing the importance of online library instruction. Fernández-Ramos (2019) posits that online library instruction is becoming increasingly popular at university libraries although the level of its development varies from institution to institution. There are studies that assert online library instruction has become prevalent and many academic libraries provide their students with online courses or training materials (Stiwinter 2013). Further, the literature reviewed suggests although face-to-face still features prominently in the last two decades, nonetheless, there has been a remarkable increase in online library instruction (Maddison *et al.* 2017) juxtaposed with a noticeable increase with the arrival of the Covid 19 pandemic (Watermeyer, 2020). The objective of online library instruction should ultimately result in students becoming 'owners' of their online learning experiences through active discussions, problem-solving skills and collaboration. Therefore, the concern is if online library instruction is achieving meaningful outcomes for students. However, with a lack of pedagogical and digital skills to design innovative curricula for teaching as the literature suggests this has become questionable. Chanetsa and Ngulube (2017) agree to achieve meaningful learning outcomes in online library instruction it is important to have relevant pedagogical and digital skills to create engaging content for students. Similarly, Cicone and Hounslow (2019) findings indicate academic librarians need to have a succinct understanding of pedagogy, digital skills and curriculum development to create appropriate content to teach in an online environment. Within the South African context, a baseline Raju (2017) assessing '108 academic librarians' job advertisements under the profile of professional librarian underscored the unpreparedness of the academic librarian in relation to pedagogies, digital skills and the workplace. Raju (2017) states a detailed study probing into the digital pedagogies of academic librarians is pressing for the purposeful integration within academia in South Africa. Therefore, the aim of this study was to contribute to the knowledge base in the understanding of digital pedagogies and academic librarianship in South Africa. Further, it will provide guidance in preparing academic librarians using digital pedagogies for the online environment. Thus, the aim of this study was to probe, explore and understand the emerging role of the academic librarian in relation to digital pedagogies applying the Technological Pedagogical Content Knowledge (TPACK) framework in South Africa.

RESEARCH METHODOLOGY

The researcher used a quantitative approach to investigate digital pedagogies and academic librarians at UOT. The quantitative approach using a survey instrument provided a deep perspective regarding academic librarians and digital pedagogies at UOT in South Africa. The method used for the collection of the data was a web-based exploratory survey through an online questionnaire. This approach involved collecting numerical data to determine patterns and relationships to understand a phenomenon within a specific population (Bertram & Christiansen 2020). A survey method was appropriate and applicable to academic librarians because the objective was to allow academic librarians the opportunity to reflect on their pedagogical and digital skills when teaching in the digital environment. The survey instrument using an online questionnaire was key in gaining insight and determining the influence of technology on pedagogy for academic librarians who teach in an online environment at UOT in South Africa. Further, in the case of academic libraries within the South African context findings from survey approaches have been instrumental in understanding various library-related topics. De Jager and Nassimbeni (2005) support this by stating survey interventions including workshops have produced meaningful results in South African higher education libraries.

The population was purposively selected for this study of 77 academic librarians from all UOT in South Africa. Academic librarians referred to library staff who are involved in teaching library instruction at UOT. Some of the terms that are used referring to academic librarians who teach at UOT in South Africa are 'subject librarians', 'faculty librarians', 'information librarians', 'information specialist', 'research librarians' and 'postgraduate librarians.' The survey instrument through a web-based exploratory questionnaire was administered to academic librarians at UOT in South Africa using probability sampling.

In quantitative research, probability samples are the gold standard in sampling methodology as it ensures the generalisability of the study results to the target population (Acharya 2013). This is termed external validity. Simple random sampling, a subset of probability sampling was used for this study. Simple random sampling allows every individual an equal chance of being selected in the sample from the population. Further, in this method of sampling minimal knowledge of the population is required, the internal, as well as external validity, is high, and it is easy to analyze the data (Acharya 2013). Hence, for this study, it was appropriate to use simple random sampling through a questionnaire as the survey design to explore digital pedagogies in academic librarians at UOT in South Africa.

According to Maree (2019) ensuring validity through pre-testing is important. Babbie and Mouton (2001), explain that to pre-test a questionnaire for validity a researcher should at least use people to whom the study is relevant. Content validity was used as it is important and relevant to the instrument as described by (Marshall & Rossman 2014). The questionnaire was pre-tested on a sample group of five academic librarians. This resulted in relevant changes to the survey instrument as suggested in the pre-test. Thereafter the questionnaire was administered to academic librarians at UOT in South Africa.

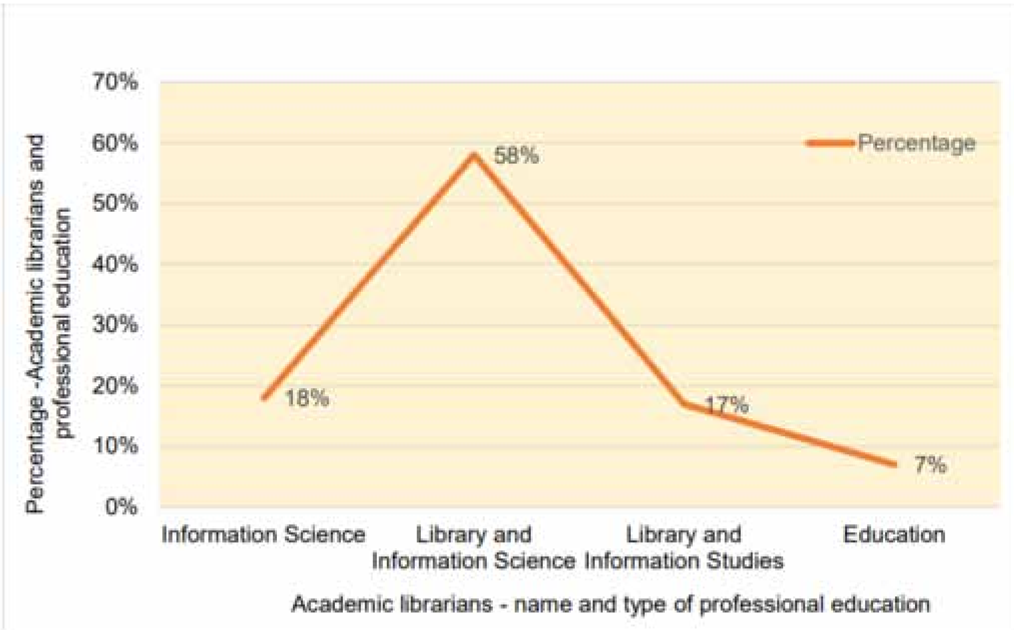
The data obtained from the questionnaires were analyzed using SPSS and content analysis was done on the data from the open-ended questions. Frequency counts were presented where possible to highlight the number of respondents that shared the same or similar views. Further, the study identified emerging themes after coding and analyzing the data (King & Horrocks, 2018). This is presented in the findings and discussions section.

FINDINGS

The aim of this study was to explore digital pedagogies and academic librarians at UOT in South Africa. The TPACK framework guided this study directed by the research objectives of exploring, ascertaining and determining the pedagogical and digital skills of academic libraries at UOT in South Africa. The interrelated and interdependence of Pedagogy Knowledge, Content Knowledge and Technology Knowledge as the three core components in the TPACK framework were used to identify the preparedness of the academic librarians at UOT in South Africa for online teaching.

Figure 3 examined the qualifications of academic librarians at UOT in South Africa. The design of the question allowed participants to select more than one option as an answer. Hence, this allowed participants with more than one qualification e.g., Information Science and Education to select both. The current job advertisements and job descriptions of academic librarians at UOT in South Africa demand a succinct grounding in pedagogy, digital skills and library-related content knowledge to teach (Raju, 2017). Therefore, this is an important question since academic librarians who teach should have a background

Figure 3. Professional education and academic librarians at UOT in South Africa – [N=62]

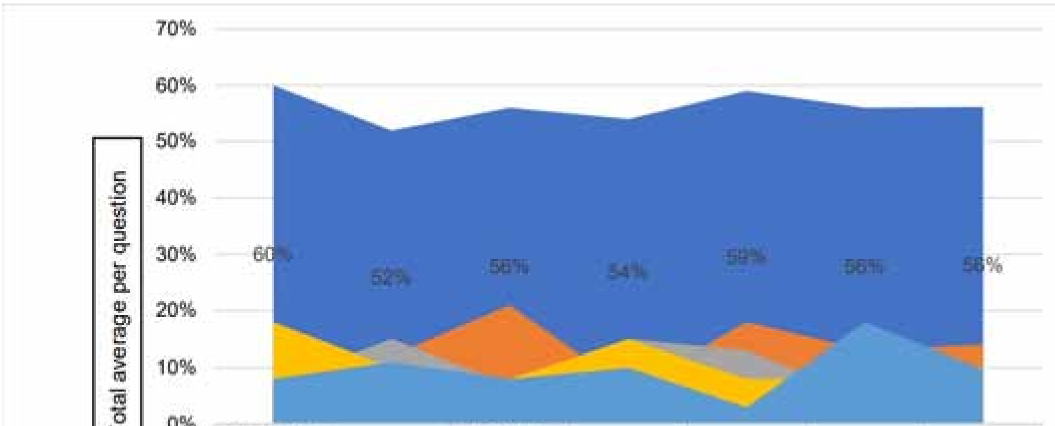


in education to facilitate teaching and learning at higher education institutions in South Africa according to their job specifications. Eighteen percent (18%) indicated a qualification in Information Science. Fifty-eight percent (58%) indicated a qualification in Library and Information Science whilst seventeen percent (17%) indicated a qualification in Library and Information Studies. Information Science, Library Information Science and Library Information Studies are all library-related qualifications. Thus, a large majority of ninety-three percent (93%) of academic librarians at UOT in South Africa only have library qualifications whilst a very small minority of seven percent (7%) have a qualification in education.

The purpose of this question was to explore and ascertain if academic librarians at UOT in South Africa did take a course to prepare for their role as online teachers, facilitators or mediators. This question comprehensively covers aspects such as 21st-century pedagogical practices, online curriculum design, teaching with technology and digital skills required for teaching. A Likert scale was used for this question with the weight-scoring being - Not a priority =1; Low priority =2; Medium priority =3; High priority =4; Essential =5. A total average of fifty-six percent (56%) of academic librarians indicated taking a course that focused on emerging technologies and learning theories, designing an online curriculum, teaching with technology using diagnostic tools, integrating online assessments, 21st-century pedagogical theories, digital skills and teaching was not a priority for their online role as teachers. A significant combined majority of seventy percent (70%) total average indicated taking a course in teaching with technology is either not a priority or a low priority. The remaining small minority of thirty percent (30%) indicated taking a course was a medium, high or essential priority.

The findings as per Figure 4 suggest academic librarians are unprepared to teach using technology in an online environment although it is the ‘new norm’. Therefore, there is a greater need for academic librarians to learn, design, apply and reflect upon emerging technologies and learning theories, design online curricula, teach with technology using diagnostic tools, integrate online assessments, 21st-century

Figure 4. Digital pedagogies and academic librarians at UOT in South Africa – [N=62]



	Emerging technologies and learning theories for online teaching	Designing online curriculum for teaching	Teaching with technology using diagnostic tools	Integrating online assessments	21st century pedagogical theories	Digital skills and teaching	Total Average
1 - Not a priority	60%	52%	56%	54%	59%	56%	56%
2- Low priority	7%	12%	21%	6%	18%	13%	14%
3 - Medium priority	7%	15%	7%	15%	13%	5%	10%
4 - High priority	18%	10%	8%	15%	8%	8%	10%
5- Essential	8%	11%	8%	10%	3%	18%	10%

pedagogical theories, digital skills and teaching (McTavish, 2020). The other findings as per Figure 4, reveal a lack of digital skills linked to academic librarians and online library instruction in a digital environment. Worldwide, there are limited findings that connect teaching with digital skills as part of online library instruction (Khan, 2020). Thus, this is an emergent topic that needs exploring to understand the online teaching role of academic librarians.

In Figure 5 content knowledge for academic librarians at UOT in South Africa is represented on the x-axis and percentages per library topic are represented on the y-axis. The labels for the x-axis are namely:-1. Topic analysis; 2. Search strategies using discovery tool and library catalogue; 3. Search strategies using Google; 4. Search strategies and online information sources e.g. databases, eBooks and eJournals; 5. Evaluation of information; 6. Referencing; 7. Academic integrity e.g. plagiarism; 8. Referencing management software e.g. EndNote and Mendeley; 9. Fake news and 10. Total Average. A Likert scale was used for this question with the weight-scoring being - Always =1; Very Often =2; Sometimes =3; Rarely =4; Never =5. A combined total average of fifty-five percent (55%) for content knowledge of academic librarians indicated as 'Always-1' being covered in their online library instruction. It can be assumed from Figure 5 that the teaching of referencing management software e.g. EndNote as being low when compared to the other library topics. Referencing management software appeared as twenty-six percent (26%) whilst other library topics ranged between forty-one (41%) and seventy-four percent (74%) under the same category of Always -1 on the Likert scale. Table 1 clearly shows the differences and relationships in the scope of pedagogical, content and technological knowledge in teaching when compared to Figures 3, 4, and 5.

Figure 5. Content knowledge of academic librarians at UOT in South Africa - [N=62]

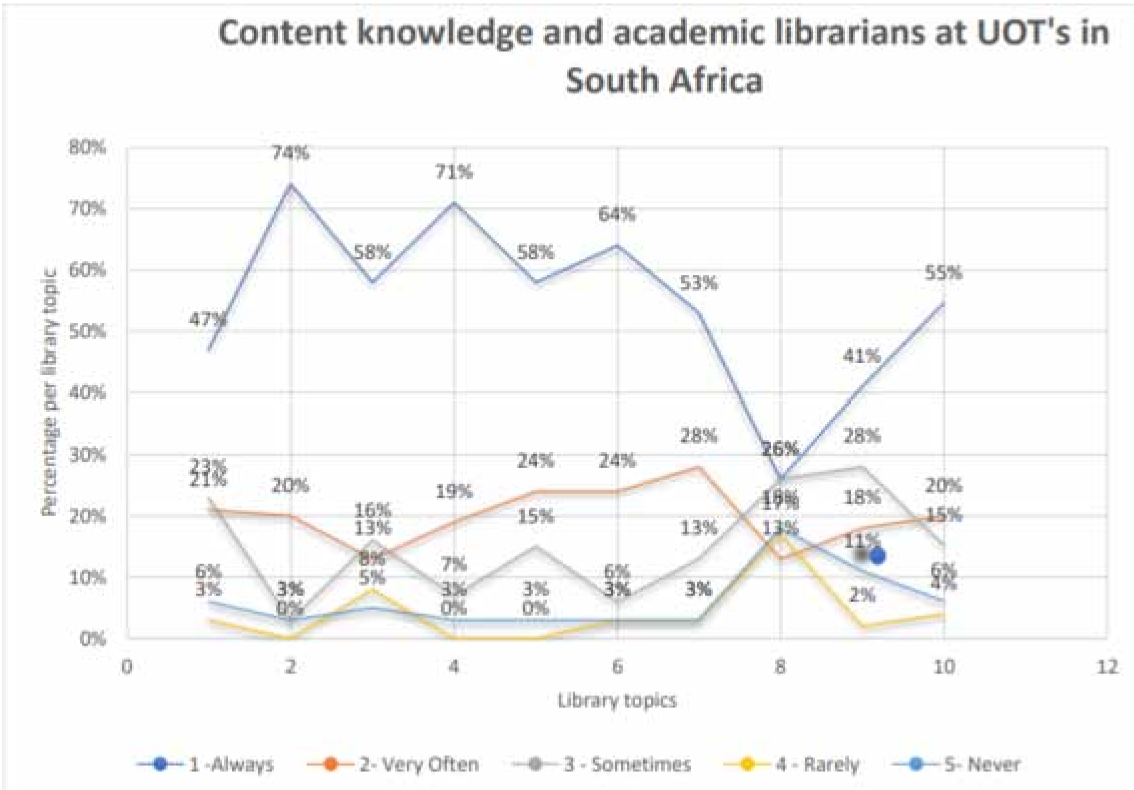


Figure 3 expressed that a large majority of ninety-three percent (93%) of academic librarians at UOT in South Africa only have library qualifications whilst a very small minority of seven percent (7%) have a qualification in education. This pointed to a lack of grounding in education to teach in a multimodal environment (Hallis, 2017). Juxtapose, Figure 5 indicates academic librarians do have the content knowledge and are teaching various library topics in an online environment. Thus, one can assume although academic librarians do not have pedagogical and technological knowledge as illustrated in Figures 3, 4 and Table 1 there is a presence of content knowledge that academic librarians take ownership of as demonstrated in Figure 5 at UOT in South Africa.

However, it is concerning as shown in Figure 4, a significant combined majority of seventy percent (70%) total average indicated it is either not a priority or a low priority to take a course in teaching with technology. This indicated there is a lack of knowledge to critically reflect on teaching methods and digital skills by academic librarians to improve their delivery of online library instruction. Ultimately, teaching should be guided by pedagogical knowledge and influenced by technological knowledge in an online environment. Thus, there is a significant correlation between Figures 3, 4 and Table 1 demonstrating a lack of pedagogical, technological and digital skills of academic librarians who teach at UOT in South Africa.

The lack of technological knowledge is further demonstrated in Table 1 asserting the application of digital and educational tools for online library instruction is not a priority. The category of 'Never -5' in Table 1 clearly indicates a lack of purposeful use of digital tools to facilitate teaching by academic

Table 1. Digital skills and teaching tools [N=62]

Digital teaching tools	1 -Always	2- Very Often	3 - Sometimes	4 - Rarely	5- Never
Presentation software e.g., Sway and Whiteboard	13%	8%	14%	5%	60%
Video production software e.g., Wondershare, Flimora and Doodly	10%	3%	11%	11%	65%
Screen capturing software e.g., Camtasia and Droplr	13%	5%	5%	11%	66%
Online author tools e.g., Storyline and Adobe Captivate	5%	2%	11%	9%	73%
Web authoring tools e.g., Content Management systems and Library Online Guides	63%	21%	8%	3%	5%
Learning management systems e.g., Blackboard and Moodle	45%	18%	6%	6%	25%
Educational/learning technologies e.g., EdPuzzle and Peardeck	13%	10%	11%	8%	58%
Video conferencing platforms to teach e.g., MS Teams and Zoom	68%	23%	2%	2%	5%
Gamification e.g., Kahoots	6%	3%	8%	10%	73%
Total average	26%	10%	8%	7%	48%

librarians. The extremely low use of presentation software (60%), video production software (65%), screen capturing software (66%), online author tools (73%), educational/learning technologies (58%), gamification (73%) under the category 'Never -5' in Table 1 indicates academic librarians at UOT in South Africa are lacking in the use of digital tools in their online library instruction.

In Table 1 the use of video conferencing platforms such as Zoom and MS Teams shows a combined ninety-one percent (91%) usage under the categories of 'Always -1' and 'Very Often 2'. This indicates very high usage, however, these are merely multimodal platforms for delivery of instruction such as face to face. Multimodal platforms are environments where teaching is facilitated. This can be virtual e.g. Zoom and MS Team or physical e.g. face to face in a classroom setting. These environments provide the settings for teaching to be facilitated and mediated. However, although the environment is important it does not direct the teaching whether virtual or physical. The teaching is directed by the pedagogical and content knowledge combined with an intuitive understanding of how to design the curriculum linked to the learning outcomes (Hall, 2017). Further, a succinct understanding of technological knowledge in a multimodal environment coupled with pedagogical and content knowledge can unlock innovative and stimulating teaching methods. These types of interconnectedness, interrelatedness and interdependence between pedagogy, content and technology is missing as indicated in Figure 3, 4 and Table 1.

In Table 1 learning management systems (Blackboard, Moodle) sixty-three percent (63%) and web authoring tools (online library guides) eighty-four percent (84%) under the categories of 'Always -1' and 'Very Often 2' showed a high combined usage. However, this can be linked to a recording of library lectures on multimodal platforms such as MS Teams and Zoom and uploading these into learning management systems for students to access. Mpungose and Khoza (2020) agree the reality is that online facilitators frequently use a passive rather than an active style of instruction such as recording of videos for students to access in their own time and space. Further, web authoring tools such as online library guides are used to access library information resources such as databases, Ebooks and Ejournals and not to actively engage students through online library instruction. These online resources such as video recordings from a library lecture, library tutorials, and web authoring tools such as online library guides should supplement, not substitute, online library instruction in a digital environment. Thus, this alludes to learning management systems and online library guides being used for passive rather than active engagement by academic librarians in their teaching, learning and research support.

DISCUSSIONS

Historically, literature has questioned the role of academic librarians as teachers in higher education institutions (Hess, 2020). This debate also exists within academic circles with 'lecturers' teaching mainstream subject matter in higher education (Kaynardag, 2019). Recently, the influence of technology on pedagogy has added a new dimension for librarians in higher education involved in online teaching and learning. The impact of technology on pedagogy cannot be ignored as higher education institutions grapple with finding their role within the 4IR. Globally, the importance of technology on pedagogy in online teaching and learning at higher education institutions is echoed in research publications. However, the literature scanned does not provide conclusive evidence in relation to digital pedagogies and academic librarians at higher education institutions. Therefore the purpose of this study was to probe, explore and ascertain the readiness of academic librarians for online teaching at UOT in South Africa, as higher education institutions worldwide chart a path into the fourth industrial revolution.

The data demonstrated a significant gap in the pedagogical knowledge of academic librarians at UOT in South Africa. The Library and Information Science qualifications in South Africa do not prepare librarians for teaching. Raju (2017) agrees that 'the curricula lack fundamental pedagogical grounding in teaching and learning which seems to be part of a global disconnect between the increasing teaching responsibilities of academic librarians and a sluggish response from Library and Information Science schools to this demand.' Therefore this issue is not limited to South Africa. However, globally, there are opportunities at higher education institutions through workshops, short courses, centres of teaching and learning in excellence, Scholarship of Teaching and Learning (SOTL) progammes that support the development of academic librarians involved in teaching.

In North America a sequential explanatory mixed-methods study Hays (2019) revealed that programmes in SOTL significantly influenced academic librarians 'teacher indentity'. The SOTL programme supported academic librarians in their instructional practices and professional development. Similarly in their emerging themes O'Neil and Pegrum (2018) findings indicated that teacher-related professional development opportunities at higher education institutions provide the necessary support in developing academic librarians 'teacher profile.' These types of initiatives can help academic librarians understand learning theories, teaching frameworks, curriculum design, educational technologies and assessments leading to well-prepared lessons for their online library instruction. Hence, academic librarians can ultimately decide how best to make pedagogical use of technology in teaching and learning. However, programmes of this nature are a 'quick fix' and not a replacement for formal training in education. Within the Swedish context, Odalen (2019) states short teaching programmes should become compulsory as a criterion for employees who teach at higher education institutions. According to Spowart et al. (2017) if pedagogical training courses are ascribed such importance it has to be of a very high standard not limited to staff satisfaction surveys. Nevertheless, whether through formal programmes in education or SOTL's initiatives this can be key for academic librarians at UOT in South Africa to improve their pedagogical knowledge for online teaching. This will help academic librarians take their place as the 'guide on the side' and not a 'sage on the stage' when facilitating online library instruction in the digital environment.

The 'writing is on the wall' for academic librarians at UOT in South Africa. The influence of technology on pedagogy in online library instruction cannot be understated. The findings in Table 1 clearly demonstrated a lack of digital skills by academic librarians in their online library instruction. The dearth of digital skills (technological knowledge) and inadequate pedagogical knowledge aligned to online teaching in the 4IR is negatively influencing the online 'teacher identity' of academic librarians at UOT in South Africa – Figure 3, 4 and Table 1. Similar patterns exist with some differences in developed knowledge countries such as Australia, Canada and America (Ciccone & Hounslow, 2019; Llewellyn, 2019; Julien *et al*, 2018).

The key findings in these countries reveal academic librarians are designing online curricula, using online instructional strategies for active learning, integrating digital educational and content management tools in their online library instruction. Likewise, within UOT in South Africa, the same opportunities are present; however, academic librarians lack pedagogical and technological preparedness – Figure 3, 4 and Table 1, minimally exploring the influence of technology on teaching practices. However, the studies in developed knowledge economies probing how to teach in a digital environment are a key indicator that academic librarians have recognized and accepted the influence of technology on pedagogy. Thus, developed knowledge economies have begun to conceptualize online library instruction as driven by the 4IR and the internet in comparison to the South African context (McTavish, 2019; Raju, 2017).

In developing economies such as Pakistan, Chile and Botswana studies indicate low-level digital skills by academic librarians (Khan, 2019; Marzal & Suarina, 2015; Chanetsa & Ngulube, 2017). However, these digital skills are linked to a lack of soft skills. These soft skills include using Microsoft applications e.g., Excel spreadsheets, creating or using presentations and limited access to web-based content e.g., library databases. The main reason for this is a lack of Information, Communication and Technologies (ICTs) connected to the digital divide. This has compromised the academic librarian's personal and organizational readiness for the digital environment. Hence, within the context of developing knowledge economies, academic librarians are grappling with ICTs whilst engaging in acquiring digital skills in preparation and navigation of the digital environment. Therefore, critically reflecting upon pedagogy and the impact of technology on online library instruction in the digital environment is secondary in these types of economies. Ultimately, these disparities and differences are a reality in developed and developing economies.

CONCLUSION AND RECOMMENDATIONS

This chapter aimed at probing, exploring and ascertaining the digital and pedagogical skills of academic librarians at UOT in South Africa. It sought to address the research objectives as outlined in this chapter. The findings reveal at UOT in South Africa academic librarians are lacking in pedagogical and digital skills. The opportunity to explore, design and implement digital pedagogies in online library instruction can take shape with a systematically processed approach. However, the support of key stakeholders within the Library and Information Sector in South Africa is important. This is achievable through Library and Information Schools redesigning their curriculum to include key aspects of pedagogy, Scholarship of Teaching and Learning initiatives, formal education qualifications, teaching with technology short courses, on-the-job mentorship programmes and professional development workshops.

The TPACK framework used in this study unpacked the relationships, differences and similarities between the three main components – Pedagogy, Content and Technology Knowledge of academic librarians at UOTs in South Africa using a quantitative design method. Future research in this area aims to use the quantitative findings and formulate relevant questions thereby designing an interview schedule. The interview schedule will be used to collect data in the qualitative phase by interviewing academic librarians at UOT in South Africa. The Community of Inquiry and TPACK frameworks will guide the qualitative phase. This will provide a deep individual perspective of academic librarians in their online role as a teacher in a synchronous and asynchronous environment. The purpose is to provide a succinct picture of digital pedagogies and academic librarians at UOT in South Africa. Therefore, a sequential explanatory mixed-method design through a two-step phase will determine the outcomes. The quantitative results of this study followed by the qualitative phase will provide a complete understanding of digital pedagogies and academic librarians at UOT in South Africa.

REFERENCES

Acharya, A. S., Prakash, A., Saxena, P., & Nigam, A. (2013). Sampling: Why and how of it. *Indian Journal of Medical Specialties*, *4*(2), 330–333.

ALA. (2017). *ACRL Standards for Proficiencies for Instruction Librarians and Coordinators*. https://www.ala.org/acrl/standards/teachinglibrarians

Albrahim, F. A. (2020). Online teaching skills and competencies. *Turkish Online Journal of Educational Technology-TOJET*, *19*(1), 9–20.

Ananga, P. (2020). Pedagogical Considerations of E-Learning in Education for Development in the Face of COVID-19. *International Journal of Technology in Education and Science*, *4*(4), 310–321. doi:10.46328/ijtes.v4i4.123

Babbie, E. R., & Mouton, J. (2001). *The practice of social research*. Oxford University Press.

Beer, N. (2022). Blended professionals: The problem of legitimacy for UK librarians as teachers in Higher Education. *Library and Information Research*. Advance online publication. doi:10.29173/lirg784

Beetham, H., & Sharpe, R. (2019). *Rethinking pedagogy for a digital age: Principles and practices of design*. Routledge. doi:10.4324/9781351252805

Bell, S., & Shank, J. D. (2004). *The blended librarian: A blueprint for redefining the teaching and learning role of academic librarians*. Temple University Libraries.

Bertram, C., & Christiansen, I. (2020). *Understanding research: An introduction to reading research*. Van Schaik.

Brieger, E., Arghode, V., & McLean, G. (2020). Connecting theory and practice: Reviewing six learning theories to inform online instruction. *European Journal of Training and Development*, *44*(4/5), 321–339. doi:10.1108/EJTD-07-2019-0116

Burke, E. A. (2021). *Technological Pedagogical Content Knowledge and Classroom Technology Use: A Mixed Methods Study*. Concordia University Chicago.

Chanetsa, B., & Ngulube, P. (2017). Qualifications and Skills of Subject Librarians in Selected African Countries. *The International Information & Library Review*, *49*(3), 187–200. doi:10.1080/10572317.2016.1278195

Chen, R. H. (2022). Effects of Deliberate Practice on Blended Learning Sustainability: A Community of Inquiry Perspective. *Sustainability*, *14*(3), 1785. doi:10.3390u14031785

Chiles, R. M., Broad, G., Gagnon, M., Negowetti, N., Glenna, L., Griffin, M. A., Tami-Barrera, L., Baker, S., & Beck, K. (2021). Democratizing ownership and participation in the 4th Industrial Revolution: Challenges and opportunities in cellular agriculture. *Agriculture and Human Values*, *38*(4), 943–961. doi:10.100710460-021-10237-7 PMID:34456466

Chisita, C. T., Chiparausha, B., Tsabedze, V., Olugbara, C. T., & Letseka, M. (2022). Remaking academic library services in Zimbabwe in the wake of COVID-19 pandemic. *Journal of Academic Librarianship*, *48*(3), 102521. doi:10.1016/j.acalib.2022.102521 PMID:35310789

Christensen, C. M. (2013). *The innovator's dilemma: When new technologies cause great firms to fail*. Harvard Business Review Press.

Ciccone, A., & Hounslow, L. (2019). Re-envisioning the role of academic librarians for the digital learning environment: The case of Unisa Online. *Journal of University Teaching & Learning Practice*, *16*(1), 11. doi:10.53761/1.16.1.11

Corrall, S., & Jolly, L. (2019). Innovations in learning and teaching in academic libraries: Alignment, collaboration, and the social turn. *New Review of Academic Librarianship*, *25*(2-4), 113–128. doi:10.1080/13614533.2019.1697099

Corrall, S., & Jolly, L. (2019). Innovations in Learning and Teaching in Academic Libraries: Alignment, Collaboration, and the Social Turn. *New Review of Academic Librarianship*, *25*(2-4), 113–128. doi:10.1080/13614533.2019.1697099

Crawford, J., Butler-Henderson, K., Rudolph, J., Malkawi, B., Glowatz, M., Burton, R., Magni, P., & Lam, S. (2020). COVID-19: 20 countries' higher education intra-period digital pedagogy responses. *Journal of Applied Learning & Teaching*, *3*(1), 1–20.

Davidson-Shivers, G. V., Rasmussen, K. L., & Lowenthal, P. R. (2018). Overview of online instruction and learning environments and communities. In *Web-based learning* (pp. 3–41). Springer. doi:10.1007/978-3-319-67840-5_1

Davies-Hoffman, K., Alvarez, B., Costello, M., & Emerson, D. (2013). Keeping pace with information literacy instruction for the real world: When will MLS programs wake up and smell the lilacs? *Communications in Information Literacy*, *7*(1), 9–23. doi:10.15760/comminfolit.2013.7.1.131

De Jager, K., & Nassimbeni, M. (2005). Information literacy and quality assurance in South African higher education institutions. *Libri*, *55*(1), 31–38. doi:10.1515/LIBR.2005.31

Digital Learning Collaborative (Organization). (2013). *TPACK Assessment* [Digital Image]. https://www.thinglink.com/scene/418834748178169856

English, M., West, P., & Jackson, J. (2019). Building a Community of Inquiry in online Library instruction: The CoI Framework applied. *Journal of Library & Information Services in Distance Learning*, 1–11. doi:10.1080/1533290X.2019.1575319

Fernández-Ramos, A. (2019). Online information literacy instruction in Mexican university libraries: The librarians' point of view. *Journal of Academic Librarianship*, *45*(3), 242–251. doi:10.1016/j.acalib.2019.03.008

Hall, J. (2017). Developing teaching best practice—Pedagogy, preferences, and professional development. *The International Information & Library Review*, *49*(1), 59–64. doi:10.1080/10572317.2017.1270692

Hall, R. A. (2013). Beyond the job ad: Employers and library instruction. *College & Research Libraries*, *74*(1), 24–38. doi:10.5860/crl-236

Hallis, R. (2017). Internet outfitters: Librarians in the twenty-first century. *Library Management*, *38*(6/7), 369–379. doi:10.1108/LM-02-2017-0012

Hartwell, A. (2020). TPACK as a Framework to Facilitate Co-Planning, Teaching and Assessing. *Canadian School Libraries Journal, 4*(1).

Hays, L., & Studebaker, B. (2019). Academic instruction librarians' teacher identity development through participation in the scholarship of teaching and learning. *International Journal for the Scholarship of Teaching and Learning*, *13*(2). Advance online publication. doi:10.20429/ijsotl.2019.130204

Henriksen, D., Keenan, S., Richardson, C., & Mishra, P. (2015). Rethinking Technology & Creativity in the 21st Century Modeling as a trans-disciplinary formative skill and practice. *TechTrends*, *59*(3), 5–10. doi:10.100711528-015-0845-y

Hensley, M. K. (2015). Improving LIS education in teaching librarians to teach. In D. Mueller (Ed.), *Creating Sustainable Community: The Proceedings of the ACRL 2015 Conference* (pp. 315-322). Association of College and Research Libraries.

Howell, J. (2012). *Teaching with ICT: Digital pedagogies for collaboration and creativity*. Oxford University Press.

Julien, H., Gross, M., & Latham, D. (2018). Survey of information literacy instructional practices in U.S. academic libraries. *College & Research Libraries*, *79*(2), 179–199. doi:10.5860/crl.79.2.179

Kaplon-Schilis, A., & Lyublinskaya, I. (2020). Analysis of relationship between five domains of TPACK framework: TK, PK, CK math, CK science, and TPACK of pre-service special education teachers. *Technology, Knowledge and Learning, 25*(1), 25-43.

Kelly, N., & Antonio, A. (2016). Teacher peer support in social network sites. *Teaching and Teacher Education*, *56*, 138–149. doi:10.1016/j.tate.2016.02.007

Khan, A. (2020). Digital information literacy skills of Pakistani librarians: Exploring supply-demand mismatches, adoption strategies and acquisition barriers. *Digital Library Perspectives*, *36*(2), 167–189. doi:10.1108/DLP-01-2020-0003

Kim, G.-C., & Gurvitch, R. (2020). Online education research adopting the community of inquiry framework: A systematic review. *Quest*, *72*(4), 395–409. doi:10.1080/00336297.2020.1761843

King, N., Horrocks, C., & Brooks, J. (2018). Interviews in qualitative research. *Sage (Atlanta, Ga.)*.

Koehler, M., & Mishra, P. (2009). What is technological pedagogical content knowledge (TPACK)? *Contemporary Issues in Technology & Teacher Education*, *9*(1), 60–70.

Lewitzky, R. A. (2020). Educating, learning, and growing: A review of the teaching role in academic librarianship. *College & Undergraduate Libraries*, *27*(1), 32–40. doi:10.1080/10691316.2020.1714526

Llewellyn, A. (2019). Innovations in learning and teaching in academic libraries: A literature review. *New Review of Academic Librarianship*, *25*(2-4), 129–149. doi:10.1080/13614533.2019.1678494

Maddison, T., Doi, C., Lucky, S., & Kumaran, M. (2017). Literature review of online learning in academic libraries. *Distributed Learning*, 13-46.

Maree, J. G. (2019). Group career construction counseling: A mixed-methods intervention study with high school students. *The Career Development Quarterly*, *67*(1), 47–61. doi:10.1002/cdq.12162

Marshall, C., & Rossman, G. B. (2014). *Designing qualitative research*. Sage publications.

Martzoukou, K. (2020). Academic libraries in COVID-19: A renewed mission for digital literacy. *Library Management*.

Marzal, M. Á., & Saurina, E. (2015). Diagnosis of the state of information literacy in Chilean universities. *Perspectivas em Ciência da Informação*, *20*(2), 58–78. doi:10.1590/1981-5344/2070

McGuinness, C. (2011). *Becoming confident teachers: A guide for academic librarians*. Elsevier. doi:10.1533/9781780632711

McTavish, H. (2019). *Emerging online roles for academic librarians in Canada* (Master's thesis). Ontario Tech University.

McTavish, H., & Robertson, L. (2020). Canadian academic librarians as online teachers. *Learning*, *4*, 10.

Michael, V., & Evangelia, L.-V. (2016). Digital pedagogy from the perspective of early childhood education. In A. R. Elena, W. Gabriela, E. Atilla, & J. Liz (Eds.), Handbook of Research on Applied Learning Theory and Design in Modern Education (pp. 93-114). IGI Global.

Mofijur, M., Fattah, I. R., Alam, M. A., Islam, A. S., Ong, H. C., Rahman, S. A., & Mahlia, T. M. I. (2021). Impact of COVID-19 on the social, economic, environmental and energy domains: Lessons learnt from a global pandemic. *Sustainable Production and Consumption, 26*, 343-359.

Mpungose, C. B., & Khoza, S. B. (2020). Postgraduate students' experiences on the use of Moodle and Canvas learning management system. *Technology, Knowledge and Learning*, 1-16.

Nichols Hess, A. (2020). Academic Librarians' Teaching Identities and Work Experiences: Exploring Relationships to Support Perspective Transformation in Information Literacy Instruction. *Journal of Library Administration*, *60*(4), 331–353. doi:10.1080/01930826.2020.1721939

O'Neil, F., & Pegrum, M. (2018). Keeping up the momentum: A longitudinal evaluation of professional development in digital technologies for academic librarians at an Australian university. *Journal of Academic Librarianship*, *44*(4), 439–445. doi:10.1016/j.acalib.2018.05.009

Ödalen, J., Brommesson, D., Erlingsson, G. Ó., Schaffer, J. K., & Fogelgren, M. (2019). Teaching university teachers to become better teachers: The effects of pedagogical training courses at six Swedish universities. *Higher Education Research & Development*, *38*(2), 339–353. doi:10.1080/07294360.2018.1512955

Okunlaya, R. O., Abdullah, N. S., & Alias, R. A. (2022). Artificial intelligence (AI) library services innovative conceptual framework for the digital transformation of university education. *Library Hi Tech*. Advance online publication. doi:10.1108/LHT-07-2021-0242

Omar Saib, M., Rajkoomar, M., Naicker, N., & Olugbara, C. T. (2022). Digital pedagogies for librarians in higher education: a systematic review of the literature. *Information Discovery and Delivery*.

Panda, S. K., Mohapatra, R. K., Panda, S., & Balamurugan, S. (2022). *The New Advanced Society: Artificial Intelligence and Industrial Internet of Things Paradigm*. John Wiley & Sons. doi:10.1002/9781119884392

Parramore, S. (2019). Online active-learning: Information literacy instruction for graduate students. *RSR. Reference Services Review*, *47*(4), 476–486. doi:10.1108/RSR-03-2019-0022

Picciano, A. G. (2017). Theories and frameworks for online education: Seeking an integrated model. *Online Learning*, *21*(3), 166–190. doi:10.24059/olj.v21i3.1225

Raju, J. (2017). To teach or not to teach? The question of the academic librarian & pedagogical competencies in the digital age. *South African Journal of Higher Education*, *31*(2), 251–269. doi:10.20853/31-2-1096

Reed, K. N., Kester, B., Kaufmann, K. F., Homol, L., & Crampsie, C. (2022). Crisis Librarianship: An Examination of Online Librarianship Roles in the Wake of the COVID-19 Pandemic. *Journal of Academic Librarianship*, *48*(4), 102530. doi:10.1016/j.acalib.2022.102530 PMID:35431354

Sappington, J., & Bedford, D. A. (2017). Assessment of intellectual capital of library and information professionals. *Proceedings of the Association for Information Science and Technology*, *54*(1), 798–799. doi:10.1002/pra2.2017.14505401161

Scott, L. (2019). *Technology Integration with Teacher Educators*. Academic Press.

Shahbazi, R., & Hedayati, A. (2016). Identifying digital librarian competencies according to the analysis of newly emerging IT-based LIS jobs in 2013. *Journal of Academic Librarianship*, *42*(5), 542–550. doi:10.1016/j.acalib.2016.06.014

Shank, J. D., Bell, S., & Zabel, D. (2011). Blended librarianship: [Re] envisioning the role of librarian as educator in the digital information age. *Reference and User Services Quarterly*, *51*(2), 105–110. doi:10.5860/rusq.51n2.105

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, *15*(2), 4–14. doi:10.3102/0013189X015002004

Sobel, K., & Grotti, M. G. (2013). Using the TPACK Framework to facilitate decision-making on instructional technologies. *Journal of Electronic Resources Librarianship*, *25*(4), 255–262. doi:10.1080/1941126X.2013.847671

Spowart, L., Winter, J., Turner, R., Muneer, R., McKenna, C., & Kneale, P. (2017). Evidencing the impact of teaching-related CPD: Beyond the 'happy sheets'. *The International Journal for Academic Development*, *22*(4), 360–372. doi:10.1080/1360144X.2017.1340294

Stiwinter, K. (2013). Using an interactive online tutorial to expand library instruction. *Internet Reference Services Quarterly*, *18*(1), 15–41. doi:10.1080/10875301.2013.777010

Turnbull, D., Chugh, R., & Luck, J. (2021). Transitioning to E-Learning during the COVID-19 pandemic: How have Higher Education Institutions responded to the challenge? *Education and Information Technologies*, *26*(5), 6401–6419. doi:10.100710639-021-10633-w PMID:34177349

Uzwyshyn, R. (2018). Academic libraries and technology: an environmental scan towards future possibility. In G. J. Holbrook (Ed.), *Academic and Digital Libraries: Emerging Directions and Trends* (pp. 63–86). Nova Publishers.

Walter, S. (2008). Librarians as teachers: A qualitative inquiry into professional identity. *College & Research Libraries*, *69*(1), 51–71. doi:10.5860/crl.69.1.51

Watermeyer, R., Crick, T., Knight, C., & Goodall, J. (2020). COVID-19 and digital disruption in UK universities: Afflictions and affordances of emergency online migration. *Higher Education*, 1–19. PMID:32836334

Watson, J. H., & Rockinson-Szapkiw, A. (2021). Predicting preservice teachers' intention to use technology-enabled learning. *Computers & Education*, *168*, 104207. doi:10.1016/j.compedu.2021.104207

Weideman, M., & Hofmeyr, K. B. (2020). The influence of flexible work arrangements on employee engagement: An exploratory study. *SA Journal of Human Resource Management*, *18*(1), 1–18. doi:10.4102ajhrm.v18i0.1209

Xu, M., David, J. M., & Kim, S. H. (2018). The fourth industrial revolution: Opportunities and challenges. *International Journal of Financial Research, 9*(2), 90-95.

Yürekli Kaynardağ, A. (2019). Pedagogy in HE: Does it matter? *Studies in Higher Education*, *44*(1), 111–119. doi:10.1080/03075079.2017.1340444

ADDITIONAL READING

Andreula, N. (2021). Smart Working is the Way Ahead. *From Alpha Century to Viral*, 113.

Corfe, S. (2018). *4IR in the workplace: Ensuring employers and employees benefit*. The Social Market Foundation.

Dholakia, N., & Firat, A. F. (2019). Markets, consumers and society in the age of heteromation. *European Journal of Marketing*, *53*(8), 1504–1520. doi:10.1108/EJM-11-2017-0916

Hirschi, A. (2018). The fourth industrial revolution: Issues and implications for career research and practice. *The Career Development Quarterly*, *66*(3), 192–204. doi:10.1002/cdq.12142

Paul, M., Upadhyay, P., & Dwivedi, Y. K. (2020). *Roadmap to digitalisation of an emerging economy: a viewpoint. Transforming Government: People*. Process and Policy.

Schwab, K. (2017). *The fourth industrial revolution*. Crown Business.

Stankovic, M., Hasanbeigi, A., Neftenov, N., Ventures, T. I., Basani, M., Núñez, A., & Ortiz, R. (2020). *Use of 4IR technologies in water and sanitation in Latin America and the Caribbean*. Inter-American Development Bank. doi:10.18235/0002343

Tella, A. (2020). *Handbook of Research on Digital Devices for Inclusivity and Engagement in Libraries*. IGI Global. doi:10.4018/978-1-5225-9034-7

KEY TERMS AND DEFINITIONS

Digital Learning Environment: An environment that provides a virtual space for teaching and learning to be experienced.

Digital Pedagogies: The use of germane technologies to support teaching and learning in multimodal environments.

Digital Skills: An individual's ability to use digital devices and applications to enhance teaching and learning in multimodal environments.

Digital Teaching Tools: The use of educational platforms such as learning management systems to improve the teaching and learning process synchronously or asynchronously.

Digital Technologies: Systems and devices that allow access, use and storage of learning resources for teaching.

Digital Tools: The access to and effective use of relevant software such as Microsoft Teams to improve teaching and learning in a digital environment.

Online Teaching: The delivery of instruction experienced in a virtual classroom supported by technology and the internet.

Pedagogy: The use of diverse teaching methods and practices influenced by the context of social, political including psychological factors during the learning process.

Compilation of References

AbbottP.AppiahK.OaiyaO. (2020). *Barriers and enablers to open access repository (OAR) development in African HLIs: Research from the LIBSENSE OAR workshop in UA, WACREN and ASREN regions*. doi:10.5281/zenodo.3884974

Abd Aziz, M. F. (2011). Challenges in developing and implementing institutional repositories in higher educational institutions. *Jurnal PPM: Journal of Malaysian Librarians*, *5*, 1–14.

Abdulkadir, A. (2014). *The use of DSpace software in the preservation and management of library resources: conference paper*. 10.13140/2.1.3718.2088

Abdulla, R. (2020). Intelligent Return and Sorter System using Internet of Things. *Solid State Technology*, *63*(1).

Abdulqadir, I. A., & Asongu, S. A. (2022). The asymmetric effect of internet access on economic growth in sub-Saharan Africa. *Economic Analysis and Policy*, *73*, 44–61. doi:10.1016/j.eap.2021.10.014

Abid, H. (2021). Uses of blockchain technologies in library services. *Library Hi Tech News*, *38*(8), 9–11. doi:10.1108/LHTN-08-2020-0079

Aboalsamh, H. A. (2008). A novel Boolean algebraic framework for association and pattern mining. *WSEAS Transactions on Computers*, *7*(8), 1352–1361. https://dl.acm.org/doi/abs/10.5555/1457999.1458022

Abrahams, L., Burke, M., & Mouton, J. (2010). Research productivity-visibility-accessibility and scholarly communication in Southern African universities. *The African Journal of Information and Communication*, (10), 20–36. doi:10.23962/10539/19768

Abram, S., & Luther, J. (2004). Born with the chip: The next generation will profoundly impact both library service and the culture within the profession. *Library Journal*, *129*(8), 34–45.

Acharya, A. S., Prakash, A., Saxena, P., & Nigam, A. (2013). Sampling: Why and how of it. *Indian Journal of Medical Specialties*, *4*(2), 330–333.

Acharya, S., Hiremath, S., & Lalasangi, S. (2019). Technological trends in modern libraries. *Indian Journal of Library Science and Information Technology*, *4*(2), 63–65. doi:10.18231/j.ijlsit.2019.018

Adams, J., King, C., & Hooks, D. (2010). *Global Research Report: Africa*. http://sciencewatch.com/sites/sw/files/sw-article/media/globalresearchreport-africa.pdf

Adebayo, O. (2013). Challenges Associated with Cataloguing Electronic Resources in Selected University Libraries in Southwest Nigeria. *Chinese Librarianship*, (36).

Adebayo, O., Iwu-james, J., Olawoyin, O., Fagbohun, M., Esse, U., Yusuf, F., Segun-adeniran, C., Izuagbe, R., & Owolabi, S. (2019). Blended learning in higher education: implication and strategies for academic library support. *13th International Technology, Education and Development Conference*.

Adegbore, A. M. (2018). Adoption factors of integrated library management system (ILMS) in selected Nigerian university libraries. *Library Philosophy and Practice (e-journal).* http://digitalcommons.unl.edu/libphilprachttp://digitalcommons.unl.edu/libphilprac/1994

Adejo, A. A., & Babatunde, K. A. (2021). Creation and utilization of maker spaces in academic libraries: Bridging the gap between theory and practice. *International Journal of Library and Information*, *13*(2), 34–40. doi:10.5897/IJLIS2021.0981

Aderibigbe, N. A., & Ajiboye, B. A. (2013). User Education Program as Determinant of Electronic Information Resources Usage in Nimbe Adedipe University Library, Nigeria. *The Electronic Library*, *31*(2), 244–255. doi:10.1108/02640471311312410

Adetoro, N., & Ayeni, P.O. (2020). The library in the cloud: Examining the realities of cloud computing adoption and application in Nigerian libraries and information centers. *Media resources and information and communication technology use*, 225-235.

Adetunji, O. A., & Oladokun, T. A. (2020). Effective Strategies for Sustainable Library Automation in Nigerian Academic Libraries: Preparing for 'The New Normal' Caused by the COVID-19 Pandemic. *Nigerian Library Association (NLA) Scholarly Conference on Library and Information Services during and after COVID-19 Pandemic*.

Adjei, E., Mensah, M., & Amoaful, E. A. (2019). The story so far-digital preservation in institutional repositories: The case of academic libraries in Ghana. *Digital Library Perspectives*, *35*(2), 80–96. doi:10.1108/DLP-12-2018-0039

Affandy, H. B., & Ismail, A. (2017). *Conceptual paper: Digital preservation strategies in archival institution*. Academic Press.

African Journals Online (AJOL). (n.d.). https://www.ajol.info/index.php/ajol

Agim Eliezer Chukwuyere, O. I. (2020). Librarians' Use of Social Media in Disseminating Health Information on COVID-19. *International Journal of Research and Review*, *7*(7), 443–454.

Agrawal, T. K., Kumar, V., Pal, R., Wang, L., & Chen, Y. (2021). Blockchain-based framework for supply chain traceability: A case example of textile and clothing industry. *Computers & Industrial Engineering*, *154*, 107130. doi:10.1016/j.cie.2021.107130

Ahmat, M. A., Adauwiyah, R., & Hanipah, A. (2018). Preparing the libraries for the fourth Industrial Revolution (4th IR). *Journal of Malaysian Libraries*, *12*, 53–64. https://www.researchgate.net/publication/332319225_Preparing_the_Libraries_for_the_Fourth_Industrial_Revolution_4th_IR

Ajibade, P., & Khayundi, E. F. (2017). The Role of Records Management in Small Micro and Medium Enterprises (SMMEs) in South Africa and Its Implications for Business Sustainability. *African Journal of Library Archives and Information Science*, *27*(2), 175–188.

Aju, D. T., & Foti, S. T. (2020). Undergraduates' awareness, utilization and satisfaction with online public access catalogue (OPAC) in public university libraries in Nasarawa State, Nigeria. *Library and Information Perspectives and Research*, *2*(1), 18–29. doi:10.47524/liprv2i1.2

Akanbi, M. L., Adekanbi, R. O., & Bankole, Q. A. (2021). Perception and use of OPAC by users in academic libraries in Kwara State, Nigeria. *Record and Library Journal*, *7*(2), 228–233. doi:10.20473/rlj.v7i2.205

Akparobore, D., Omosekejimi, A. F., & Nweke, A. C. (2020). Librarians' Awareness, Positive Attitude and ICT Skills: A Panacea for Effective Services Delivery in the Fourth Industrial Revolution (4th IR) Era in Academic Libraries in Southern Nigeria. *Library Progress (International)*, *40*(2), 184–194. doi:10.5958/2320-317X.2020.00021.5

ALA Libraries Transform. (2022). *Unplugged*. https://bit.ly/354x0mm

ALA. (2017). *ACRL Standards for Proficiencies for Instruction Librarians and Coordinators*. https://www.ala.org/acrl/standards/teachinglibrarians

Al-Barashdi, H., & Al-Karousi, R. (2019). Big Data in academic libraries: Literature review and future research directions. *Journal of Information Studies & Technology*, *2*(2), 13. Advance online publication. doi:10.5339/jist.2018.13

Albatros Adventure Marathons. (n.d.). *Map of Southern Africa*. Retrieved 16 December 2021 from: http://new.big-five-marathon.com/map-southern-africa

Albrahim, F. A. (2020). Online teaching skills and competencies. *Turkish Online Journal of Educational Technology-TOJET*, *19*(1), 9–20.

Alemu, G., Stevens, B., Ross, P., & Chandler, J. (2012). Linked data for libraries: Benefits of a conceptual shift from library-specific record structures to RDF-based data models. *New Library World*, *113*(11/12), 549–570. doi:10.1108/03074801211282920

Alexander, B., Ashford-Rowe, K., Barajas-Murphy, N., Dobbin, G., Knott, J., McCormack, M., & Weber, N. (2019). EDUCAUSE horizon report: 2019 higher education edition. *EDUCAUSE*. https://library.educause.edu/resources/2019/4/2019-horizon-report

Allemang, D., & Hendler, J. (2008). *Semantic Web for the Working Ontologist: Modeling in RDF, RDFS and OWL*. Morgan Kaufmann Publishers.

Altadonna, N. (2021). *Digital adoption challenges and solutions to overcome them*. Apty. https://www.apty.io/blog/digital-adoption-challenges

Alt, R., & Zimmerman, H. (2001). Preface: Introduction to special section business models. *Electronic Markets*, *11*, 3–9.

Ambika, Z., & Amrik, S. (2005). Integrated management system: the experiences of three Australian Organisations. *Journal of Manufacturing Technology Management, 16*(2), 211 – 232.

Ananga, P. (2020). Pedagogical Considerations of E-Learning in Education for Development in the Face of COVID-19. *International Journal of Technology in Education and Science*, *4*(4), 310–321. doi:10.46328/ijtes.v4i4.123

Anaraki, N. L., & Babalhavaeji, F. (2013). Investigating the Awareness and Ability of Medical Students in Using Electronic Resources of the Integrated Digital Library Portal of Iran. *The Electronic Library*, *31*(1), 70–83. doi:10.1108/02640471311299146

Andoh, K. P. R., & Attafuah, A. (2021). *Access control of human resource records: case of the University of Cape Coast*. Collection and Curation. doi:10.1108/CC-06-2020-0025

Andoni, M., Robu, V., Flynn, D., Abram, S., Geach, D., Jenkins, D., McCallum, P., & Peacock, A. (2019). Blockchain technology in the energy sector: A systematic review of challenges and opportunities. *Renewable & Sustainable Energy Reviews*, *100*, 143–174. doi:10.1016/j.rser.2018.10.014

Andro, M., Asselin, E., & Maisonneuve, M. (2012). Digital libraries: Comparison of 10 software. *Library Collections, Acquisitions & Technical Services*, *36*(3), 79–83. doi:10.1016/j.lcats.2012.05.002

Anuradha, P. (2017). *The impact of digital technologies on academic libraries: Challenges and opportunities*. https://www.ipinnovative.com/journal-article-file/5255

Anuradha, J. (2015). A brief introduction on Big Data 5Vs characteristics and Hadoop technology. *Procedia Computer Science*, *48*, 319–324. doi:10.1016/j.procs.2015.04.188

Anuradha, P. (2018). Digital transformation of academic libraries: Opportunities and challenges. *IP Indian Journal of Library Science and Information Technology*, *3*(1), 8–10. doi:10.18231/2456-9623.2018.0002

An, X., Bai, W., Deng, H., Sun, S., Zhng, W., & Dong, Y. (2017). A knowledge management framework for effective integration of national archives resources in China. *The Journal of Documentation*, *73*(1), 18–24. doi:10.1108/JD-04-2016-0040

Aoga, J. O., Nijssen, S., & Schaus, P. (2019). Modelling pattern set mining using boolean circuits. In T. Schiex & S. de Givry (Eds.), *Principles and practice of constraint programming* (pp. 621–638). Springer. doi:10.1007/978-3-030-30048-7_36

Arlitsch, K., & Newell, B. (2017). Thriving in the age of accelerations: A brief look at the societal effects of artificial intelligence and the opportunities for libraries. *Journal of Library Administration*, *57*(7), 789–798. doi:10.1080/01930826.2017.1362912

Arockia, P. S., Varnekha, S. S., & Veneshia, K. A. (2017). The 17 V's of Big data. *International Research Journal of Engineering and Technology*, *4*(9), 329–333.

Arshad, A., & Ameen, K. (2017). Scholarly communication in the age of Google: Exploring academics' use patterns of e-journals at the University of the Punjab. *The Electronic Library*, *35*(1), 167–184. doi:10.1108/EL-09-2015-0171

Artuso, N. J. (2021). Civil Society's Response to Coronavirus Disease 2019: Patterns from Two Hundred Case Studies of Emergent Agency. *Journal of Creative Communications*.

Arya, U. (2021). Reshaping the Paradox of Information Power and Overload: Data Mining Strategies for Knowledge Workers. *IUP Journal of Information Technology*, *17*(1), 33–52. doi:10.1007/3-540-44801-2_3

Asadi, S., Abdullah, R., Yah, Y., & Nazir, S. (2019). Understanding institutional repository in higher learning institutions: A systematic literature review and directions for future research. *IEEE Access: Practical Innovations, Open Solutions*, *7*, 35242–35263. doi:10.1109/ACCESS.2019.2897729

Ashiq, M., Rehman, S. U., & Mujtaba, G. (2021). Future challenges and emerging role of academic libraries in Pakistan: A phenomenology approach. *Information Development*, *37*(1), 158–173. doi:10.1177/0266666919897410

Asogwa, B. E., Ugwu, C. I., & Idoko, A. N. (2016). Internet Services in Academic Libraries. *The Electronic Library*, *34*(5), 757–771. doi:10.1108/EL-04-2015-0066

Asogwa, E. B. (2012). The challenge of managing electronic records in developing countries: Implications for records managers in sub-Saharan Africa. *Records Management Journal*, *22*(3), 198–211. doi:10.1108/09565691211283156

Asogwa, E. B., & Ezema, J. I. (2017). Freedom of access to government information in Africa: Trends, status and challenges. *Records Management Journal*, *27*(3), 318–338. doi:10.1108/RMJ-08-2015-0029

Association for the Development of Education in Africa (ADEA). (2021). *School reopening in Africa.* Association for the Development of Education in Africa (ADEA).

Association of African Universities (AAU). (2021). *Database of African Theses and Dissertations- Research (DATAD-R*). https://aau.org/current-projects/database-of-african-theses-and-dissertations-research-datad-r/

Association of College and Research Libraries. (2020). A review of the trends and issues affecting academic libraries in higher education. *Research Planning Review, 81*(6). https://crln.acrl.org/index.php/crlnews/article/view/24478/32315

Ateka, A., & Kwanya, T. (2019). Using QR codes to Promote Information Services and Products in Academic Libraries in Kenya. *Digital Technologies for Information and Knowledge Management*. http://repository.tukenya.ac.ke:8080/bitstream/handle/123456789/1767/Using%20QR%20codes%20to%20Promote%20Information%20Services%20and%20Products%20in%20Academic%20Libraries%20in%20Kenya.pdf?sequence=1&isAllowed=y

Atkinson, J. (2020). *Technology, Change and the Academic Library Case Studies, Trends and Reflections*. https://www.elsevier.com/books/technology-change-and-the-academic-library/atkinson/978-0-12-822807-4

Atkinson, J. (2020). Reflections on technology, change and academic libraries. In J. Atkinson (Ed.), *Technology, change and the academic library: Case studies, trends and reflections* (pp. 185–193). Chandos Publishing.

Atua-Ntow, C. (2016). *Staff assessment of the success of the integrated library system: the case of the University of Ghana Library System* (Thesis). University of Pretoria, Cape Town. Available at: https://repository.up.ac.za/handle/2263/59625

Avram, H. D. (1968). *The MARC pilot project: final report on a project sponsored by the Council on Library Resources, Inc.* Library of Congress. Available at https://babel.hathitrust.org/cgi/pt:id=uiug.3011201862679

Axiell Group AB. (2016). *Top 7 digital trends for libraries to follow in 2016.* https://www.axiell.co.uk/top-digital-trends-for-libraries-to-follow-in-2016

Ayanso, A., Cho, D. I., & Lertwachara, K. (2010). The digital divide: Global and regional ICT leaders and followers. *Information Technology for Development*, *16*(4), 304–319. doi:10.1080/02681102.2010.504698

Ayo-Olafare, F. R. (2020). Global trends and emerging technologies in libraries and information science. *Library Philosophy and Practice (e-journal),* Article 3835. https://digitalcommons.unl.edu/libphilprac/3835

Azmee, N. N., Kassim, A. N., & Abdullah, Z. C. (2017). DIensions of Knowledge Management Maturity; Top Management Support and Leadership, People, and Information Technology. *Journal of Information and Knowledge Management*, *7*(2), 1–7.

Baada, F. N. A., Ayoung, A. D., Bekoe, S., & Azindow, F. B. (2020). Resource constraints and quality public library service delivery in Ghana. *The International Information & Library Review*, *52*(1), 10–31. doi:10.1080/10572317.2019.1607697

Babbie, E. R., & Mouton, J. (2001). *The practice of social research*. Oxford University Press.

Babu, R., & O'Brien, A. (2000). Web OPAC interfaces: An overview. *The Electronic Library*, *18*(5), 316–327. doi:10.1108/02640470010354572

Backhaus, J., Huth, K., Entwistle, A., Homayounfar, K., & Koenig, S. (2019). Digital affinity in medical students influences learning outcome: A cluster analytical design comparing vodcast with traditional lecture. *Journal of Surgical Education*, *76*(3), 711–719. doi:10.1016/j.jsurg.2018.12.001 PMID:30833205

Bajpai, B. K., & Margam, M. (2019). ICT skills and competencies of library and information science professionals working in college libraries, University of Delhi: A study. *Library Philosophy and Practice (e-journal), 2275.* https://www.researchgate.net/publication/332552909_ICT_Skills_and_Competencies_of_Library_and_Information_Science_Professionals_working_in_College_Libraries_University_of_Delhi_A_study

Baker, T., Coyle, K., & Petiya, S. (2014). Multi-entity models of resource description in the semantic web: A comparison of FRBR, RDA and BIBFRAME. *Library Hi Tech*, *32*(4), 562–582. doi:10.1108/LHT-08-2014-0081

Balaji, B. P., Vinay, M. S., Anitha, K. V., Khan, M. R., Edwin, E., & Shalini, B. G. (2021). A review of integrated library systems and web-scale discovery services in India. *Library Hi Tech News*, *38*(7), 14–18. https://www.emerald.com/insight/content/doi/10.1108/LHTN-09-2021-0061/full/pdf?title=a-review-of-integrated-library-systems-and-web-scale-discovery-services-in-india

Bala, M., & Ojha, D. B. (2012). Study of applications of data mining techniques in education. *International Journal of Research in Science and Technology*, *1*(4), 1–10. https://bit.ly/3pd81Ee

Ball, R. (2019). Big data and its impact on libraries. *American Journal of Information Science and Technology*, *3*(1), 1–9. doi:10.11648/j.ajist.20190301.11

Bangani, S. (2018). The history, deployment, and future of institutional repositories in public universities in South Africa. *Journal of Academic Librarianship*, *44*(1), 39–51. doi:10.1016/j.acalib.2017.12.003

Bansode, N. N., & Shinde, M. G. (2019). Impact of new technologies in the digital libraries. *Journal of Advancements in Library Sciences*, *6*(1), 279–283. https://www.researchgate.net/publication/337209596

Barbieri, D. F., Braga, D., Ceri, S., Della Valle, E., & Grossniklaus, M. (2009). C-SPARQL: SPARQL for continuous querying. *Proceedings of the 18th international conference on World Wide Web*, 1061-1062. 10.1145/1526709.1526856

Barrueco, J.M., & Termens, M. (2021). Digital preservation institutional repositories: a systematic literature review. Digital Library Perspectives, 37(1).

Bashir, B., Nasreen, N., & Loan, F. A. (2019). National digital library of India: An overview. *Library Philosophy and Practice (e-journal),* Article 6462. https://digitalcommons.unl.edu/libphilprac/6462

Bashir, S., Gul, S., Bashir, S., Nisa, N. T., & Ganaie, S. A. (2021). Evolution of institutional repositories: Managing institutional research output to remove the gap of academic elitism. *Journal of Librarianship and Information Science*. Advance online publication. doi:10.1177/09610006211009592

Bassey, B. A., & Owan, V. J. (2019). Ethical Issues in Educational Research. In P. N. Ololube & G. U. Nwiyi (Eds.), *Encyclopedia of institutional leadership, policy, and management: A handbook of research in honour of Professor Ozo-Mekuri Ndimele* (Vol. 2, pp. 1287–1301). Pearl Publishers International Ltd. doi:10.13140/RG.2.2.11785.88161

Bearman, D. (2007). Digital libraries. *Annual Review of Information Science & Technology*, *41*(1), 223–272. doi:10.1002/aris.2007.1440410112

Beer, N. (2022). Blended professionals: The problem of legitimacy for UK librarians as teachers in Higher Education. *Library and Information Research*. Advance online publication. doi:10.29173/lirg784

Beetham, H., & Sharpe, R. (2019). *Rethinking pedagogy for a digital age: Principles and practices of design*. Routledge. doi:10.4324/9781351252805

Bekele, T. A., & Ofoyuru, D. T. (2021). Emerging university-society engagements in Africa: An analysis of strategic plans. *Journal of Comparative & International Higher Education*, *13*(1), 151–180. doi:10.32674/jcihe.v13i1.1690

Belleflamme, P., & Neyse, N. (2020). *A multisided value proposition canvas for digital platforms*. Available:https://alfresco.uclouvain.be/alfresco/service/guest/streamDownload/workspace/SpacesStore/.pdf

Bell, S. (2005). Commentary-backtalk: Don't surrender library values. *Library Journal*, *130*(9), 79–79.

Bell, S., & Shank, J. D. (2004). *The blended librarian: A blueprint for redefining the teaching and learning role of academic librarians*. Temple University Libraries.

Benedetti, A., Boehme, G., Caswell, T. R., Denlinger, K., Li, Y., McAllister, A. D., & Wesolek, A. J. (2020). *Top Trends in Academic Libraries*. https://digitalcommons.unf.edu/cgi/viewcontent

Benniche, S. (2019). Using blockchain technology to recycle cancer drugs. *The Lancet. Oncology*, *20*(6), e300. Advance online publication. doi:10.1016/S1470-2045(19)30291-8 PMID:31085048

Benson, O. V., Anyanwu, E. U., Co, O., & Nwauwa, E. B. (2016). Priorities and challenges of actualizing sustainable development goals: Perspectives of library and information professionals in Owerri, Nigeria. *Journal of Applied Information Science and Technology*, *9*(2), 40–46.

Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities. (2003). https://openaccess.mpg.de/67605/berlin_declaration_engl.pdf

Bermes, E. (2011). Convergence and interoperability: a Linked Data perspective. In *World Library and Information Congress: 77th IFLA General Conference and Assembly* (pp. 13-18). Available at https://www.ifla.org/past-wlic/2011/149-bermes-en.pdf

Berners-Lee, T., Fielding, R., & Masinter, L. (1998). *RFC2396: Uniform resource identifiers (URI): generic syntax.* Available at: https://www.hjp.at/doc/rfc/rfc3986.html

Berry, J. W. (1996). *Digital libraries: new initiatives with worldwide implications*. IFLANET. https://origin-archive.ifla.org/IV/ifla61/61-berjo.htm

Bertram, C., & Christiansen, I. (2020). *Understanding research: An introduction to reading research*. Van Schaik.

Bhardwaj, R. K. (2017). Academic social networking sites: Comparative analysis of ResearchGate, Academia. edu, Mendeley and Zotero. *Information and Learning Science*, *118*(5/6), 298–316. doi:10.1108/ILS-03-2017-0012

Bharti, K. L., & Verma, S. (2021). Use of Emerging Technologies in the University Libraries: A study of Review of Literature. *Library Philosophy and Practice (e-journal),* 6134. https://digitalcommons.unl.edu/libphilprac/6134

Bichan, G. (2020). New Zealand school libraries respond to COVID-19. Schools Catalogue Information Service, (114).

Binder, A. T. C. (2020). *What we know about the gender digital divide for girls: A literature review*. UNICEF.

Bloch, L. C. (2018). A reading project to improve literacy in the foundation phase: A case study in the Eastern Cape. *Reading & Writing - Journal of the Reading Association of South Africa, 9*(1), 1-7.

Boamah, E., Dorner, G. D., & Oliver, G. (2015). Using Theory to understand Digital Preservation Management in Ghana. *PDT&C.*, *44*(2), 46–61. doi:10.1515/pdtc-2015-0011

Boamah, E., & Liew, C. L. (2017). Conceptualising the digitisation and preservation of indigenous knowledge: The importance of attitudes. *International Conference on Asian Digital Libraries*. 10.1007/978-3-319-70232-2_6

Bollmann-Sdorra, P., Hafez, A., & Raghavan, V. V. (2003). A theoretical framework for association mining based on the Boolean retrieval model. In Y. Kambayashi & W. Winiwarter (Eds.), *Proceedings of the Third International Conference on Data Warehousing and Knowledge Discovery* (pp. 21–30). Springer-Verlag Berlin. https://dl.acm.org/doi/abs/10.5555/646110.679436

Bolu, C. A., & Egbo, K. (2014). The Role of Higher Education Institutions in the Development of ICT Professionals for Innovation in Nigeria. *International Journal of Engineering Innovations and Research*, *3*(1), 1.

Bountouri, L. (2017). *Archives in the Digital Age: Standards, Policies and Tools*. Elsevier.

Breeding, M. (2016). Strategic technology strengthens the capacity of libraries to serve their communities. *Proceedings of the 82nd IFLA General Conference and Assembly*. http://library.ifla.org/id/eprint/1320/1/137-breeding-en.pdf

Brieger, E., Arghode, V., & McLean, G. (2020). Connecting theory and practice: Reviewing six learning theories to inform online instruction. *European Journal of Training and Development*, *44*(4/5), 321–339. doi:10.1108/EJTD-07-2019-0116

Buchholz, I. M. (2011). *Provision of access to information in academic libraries in Southern Africa: Two case studies* [Master's Thesis]. University of South Africa.

Burke, E. A. (2021). *Technological Pedagogical Content Knowledge and Classroom Technology Use: A Mixed Methods Study*. Concordia University Chicago.

Bushey, J., Demoulin, M., & Mclelland, R. (2015). Cloud Service Contracts: An Issue of Trust. *Canadian Journal of Information and Library Science*, *39*(2), 128–153. doi:10.1353/ils.2015.0009

Cabello, J., Janßen, G., & Mühle, A. (2017). *Distributed library management system based on the blockchain technology*. Technische Universitat. https://bit.ly/3pgzJ2T

Cabonero, D. A., Austria, R. M., Bayang, J. M. L., & Bumanghat, R. P. (2020). Knowledge, satisfaction and challenges on online public access catalog in an academic library in Northern Philippines. *Library Philosophy and Practice (e-Journal).*

Calhoun, K. (2007). Being a librarian: Metadata and metadata specialists in the twenty-first century. *Library Hi Tech*, *25*(2), 174–187. doi:10.1108/07378830710754947

Calibraint. (2021). *Technology Adoption Challenges – More Attention to Digital Tech*. Calibraint. https://www.calibraint.com/blog/technology-adoption-challenges

Calvert, S. (2020). Research libraries, emerging technologies-and a pandemic. *EDUCAUSE Review*, *2*, 74–75. https://digitalcommons.unl.edu/libraryscience

Canadian Association of Research Libraries. (2010). *Core competencies for 21st Century CARL librarians. Librarians as researchers and writers: Research priorities for Canada's Research Public Libraries*. https://www.carl-abrc.ca/strengthening-capacity/human-resource-management/core-competencies-21st-century-carl-librarians/?cn-reloaded=1

Candela, L., Castelli, D., & Pagano, P. (2011). History, Evolution, and Impact of Digital Libraries. In I. Iglezakis, T. Synodinou, & S. Kapidakis (Eds.), *E-publishing and digital libraries: Legal and organizational issues* (pp. 1–30). IGI Global. doi:10.4018/978-1-60960-031-0.ch001

Castagné, M. (2013). *Institutional repository software comparison: DSpace, EPrints, Digital Commons, Islandora and Hydra*. Available at: http://hdl.handle.net/2429/44812

Catalano, A. J., Glasser, S., Caniano, L., Caniano, W., & Paretta, L. (2018). An analysis of academic libraries' participation in 21st century library trends. *Evidence Based Library and Information Practice*, *13*(3), 4–16. doi:10.18438/eblip29450

Cautela, C., Mortati, M., Dell'Era, C., & Gastaldi, L. (2019). The impact of Artificial Intelligence on Design Thinking practice: Insights from the Ecosystem of Startups. *Strategy*, *12*(1), 114–134. doi:10.4013drj.2019.121.08

Cervone, H. F., & Svensson, L. G. (2016). Linked Data and User Interaction: The Road Ahead. *Webology*, *13*(2), 54–57.

Chachage, B., & Ngulube, P. (2006). Management of business records in Tanzania: An exploratory case study of selected companies. *South African Journal of Information Management*, *8*(3). Advance online publication. doi:10.4102ajim.v8i3.227

Chandrappa, C., & Sunil, M. V. (2017). Next generation catalogues: A comparative analysis of OPAC's of university libraries in India. *Journal of Library Development*, *3*(1), 25–37.

Chanetsa, B., & Ngulube, P. (2017). Qualifications and Skills of Subject Librarians in Selected African Countries. *The International Information & Library Review*, *49*(3), 187–200. doi:10.1080/10572317.2016.1278195

Chan, L., Kirsop, B., & Arunachalam, S. (2011). Towards open and equitable access to research and knowledge for development. *PLoS Medicine*, *8*(3), e1001016. doi:10.1371/journal.pmed.1001016 PMID:21483470

Chelsa. (2021). *State of South African academic libraries report embracing new frontiers*. Available: https://chelsa.ac.za/wp-content/uploads/2021/08/StateOfSouthAfricanLibrariesReport.pdf

Cheng, Y., & Liu, Q. (2019). Process and application of data mining in the university library. In *2019 IEEE 4th International Conference on Big Data Analytics (ICBDA)* (pp. 123-127). IEEE. 10.1109/ICBDA.2019.8713202

Chen, G., Xu, B., Lu, M., & Chen, N. S. (2018). Exploring blockchain technology and its potential applications for education. *Smart Learning Environments*, *5*(1), 1–10. doi:10.118640561-017-0050-x

Cheng, C. K. E. (2018). Managing records and archives in a Hong Kong School: A case study. *Records Management Journal*, *28*(2), 204–215. doi:10.1108/RMJ-02-2017-0004

Chen, Han, & Yu. (1996). Data mining: An overview from a database perspective. *IEEE Transactions on Knowledge and Data Engineering*, *8*(6), 866–883. doi:10.1109/69.553155

Chen, R. H. (2022). Effects of Deliberate Practice on Blended Learning Sustainability: A Community of Inquiry Perspective. *Sustainability*, *14*(3), 1785. doi:10.3390u14031785

Chen, W., Xu, Z., Shi, S., Zhao, Y., & Zhao, J. (2018). A survey of blockchain applications in different domains. *International Conference on Blockchain Technology and Applications (ICBTA)*. arXiv Preprint. 10.1145/3301403.3301407

Cherukodan, S., Kumar, G. S., & Kabir, S. H. (2011). Using open source software for digital libraries: A case study of CUSAT. *Emerald*, *31*(2), 217–225.

Chesbrough, H., & Rosenbloom, R. S. (2002). The role of the business model in capturing value from innovation: Evidence from Xerox Corporation's technology spin-off companies. *Industrial and Corporate Change*, *11*(3), 529–555. doi:10.1093/icc/11.3.529

Chiles, R. M., Broad, G., Gagnon, M., Negowetti, N., Glenna, L., Griffin, M. A., Tami-Barrera, L., Baker, S., & Beck, K. (2021). Democratizing ownership and participation in the 4th Industrial Revolution: Challenges and opportunities in cellular agriculture. *Agriculture and Human Values*, *38*(4), 943–961. doi:10.100710460-021-10237-7 PMID:34456466

Chingath, V. (2020). *Technology Trends in Libraries. Transforming libraries: Smart users, smart services and smart resources*. https://www.researchgate.net/publication/346975783

Chisita, C. T., Enakrire, R. T., Muziringa, M. C., & Chikonzo, A. (2021). Development of Transferable Knowledge: Electronic Theses and Dissertation (ETDs) Publications in Academic Libraries in Zimbabwe. In *E-Collaboration Technologies and Strategies for Competitive Advantage Amid Challenging Times* (pp. 266-281). IGI Global.

Chisita, C. T., & Chiparausha, B. (2019). Open Access initiatives in Zimbabwe: Case of academic libraries. *Journal of Academic Librarianship*, *45*(5), 102047. doi:10.1016/j.acalib.2019.102047

Chisita, C. T., Chiparausha, B., Tsabedze, V., Olugbara, C. T., & Letseka, M. (2022). Remaking academic library services in Zimbabwe in the wake of COVID-19 pandemic. *Journal of Academic Librarianship*, *48*(3), 102521. doi:10.1016/j.acalib.2022.102521 PMID:35310789

Chisita, C. T., & Fombad, M. (2021). Spatial configuring for wider access to public library services at the Harare city library: Towards a new strategy for inclusivity. *Public Library Quarterly*, *40*(3), 221–243. doi:10.1080/01616846.2020.1771936

Chiu, T. K. F. (2017). Introducing electronic textbooks as daily-use technology in schools: A top-down adoption process. *British Journal of Educational Technology*, *48*(2), 524–537. doi:10.1111/bjet.12432

Chiu, T. K. F., & Churchill, D. (2015). Exploring the characteristics of an optimal design of digital materials for concept learning in mathematics: Multimedia learning and variation theory.`. *Computers & Education*, *82*, 280–291. doi:10.1016/j.compedu.2014.12.001

Chiu, T. K. F., & Churchill, D. (2016). Adoption of mobile devices in teaching: Changes in teacher beliefs, attitudes and anxiety. *Interactive Learning Environments*, *24*(2), 317–327. doi:10.1080/10494820.2015.1113709

Chiu, T. K., Jong, M. S. Y., & Mok, I. A. (2020). Does learner expertise matter when designing emotional multimedia for learners of primary school mathematics? *Educational Technology Research and Development*, *68*(5), 2305–2320. doi:10.100711423-020-09775-4

Chiu, W. Y., Meng, W., & Li, W. (2021). LibBlock: Towards decentralised library system based on blockchain and IPFS. *18th International Conference on Privacy, Security and Trust (PST)*, 1-9. 10.1109/PST52912.2021.9647821

Cho, J. (2019). *Exploratory analysis of the operation of institutional repositories in Asian countries.* Academic Press.

Cho, A. (2013). YouTube and academic libraries: Building a digital collection. *Journal of Electronic Resources Librarianship*, *25*(1), 39–50. doi:10.1080/1941126X.2013.761521

Chowdhury, G. (2014). Sustainability of digital libraries: A conceptual model and a research framework. *International Journal on Digital Libraries*, *14*(3-4), 181–195. doi:10.100700799-014-0116-0

Christensen, C. M. (2013). *The innovator's dilemma: When new technologies cause great firms to fail*. Harvard Business Review Press.

Christian, R. W. (1975). *The Electronic Library: Bibliographic Data Bases 1975-76*. Academic Press.

Chukwusa, J. (2019). Awareness of the Usefulness of ICTs as Correlate of Attitude towards Use in collection development by Librarians. *Library Philosophy and Practice (e-journal),* 2930. https://digitalcommons.unl.edu/libphilprac/2930

Chung, K. J. (2020). Preprints: What is their role in medical journals? *Archives of Plastic Surgery*, *47*(02), 115–117. doi:10.5999/aps.2020.00262 PMID:32203987

Ciccone, A., & Hounslow, L. (2019). Re-envisioning the role of academic librarians for the digital learning environment: The case of Unisa Online. *Journal of University Teaching & Learning Practice*, *16*(1), 11. doi:10.53761/1.16.1.11

Combs, J. P. (2016). What School Principals Need to Know about Libraries: Implications for Practice and Preparation. *NCPEA Education Leadership Review*, *17*(2), 2.

Corbin, J., & Strauss, A. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. Sage Publications. doi:10.4135/9781452230153

Cordón-García, J.-A., Alonso-Arévalo, J., Gómez-Díaz, R., & Linder, D. (2013). Open access eBooks. In *Social Reading* (pp. 121–141). Elsevier. doi:10.1016/B978-1-84334-726-2.50004-5

Corradini, E. (2006). Teenagers analyse their public library. *New Library World*, *107*(11/12), 481–498. Advance online publication. doi:10.1108/03074800610713307

Corrall, S., & Jolly, L. (2019). Innovations in learning and teaching in academic libraries: Alignment, collaboration, and the social turn. *New Review of Academic Librarianship*, *25*(2-4), 113–128. doi:10.1080/13614533.2019.1697099

Council of Canadians Academies. (2015). *Leading in the digital world: Opportunities for Canada's memory institutions. The expert panel on memory institutions in the digital revolution.* Author.

Cox, J. (2019). Technology and the Positioning of the Library on Campus: Challenges and Opportunities. *Proceedings of the IATUL Conferences*, Paper 1. https://docs.lib.purdue.edu/iatul/2019/strategic/

Cox, A., Pinfield, S., & Rutter, S. (2019). Academic libraries' stance toward the future. *Portal (Baltimore, Md.)*, *19*(3), 485–509.

Coyle, K., Dyla, J., Han, M. J., Folsom, S., Schreur, P., Thompson, T., & Current, P. C. C. (2017). *Linked data infrastructure models: areas of focus for PCC strategies*. Available at: hhtps://www.loc.gov/aba/pcc/documents/LinkedDataInfrastructureModels.pdf

Coyle, K. (2010). Library data in the web world. *Library Technology Reports*, *46*(2), 5–11.

Cragin, M. H., Palmer, C. L., Carlson, J. R., & Witt, M. (2010). Data sharing, small science and institutional repositories. Philosophical Transactions. *Series A, Mathematical, Physical, and Engineering Sciences, 368*(1926), 4023-4038. . doi:10.1098/rsta.2010.0165

Crawford, J., Butler-Henderson, K., Rudolph, J., Malkawi, B., Glowatz, M., Burton, R., Magni, P., & Lam, S. (2020). COVID-19: 20 countries' higher education intra-period digital pedagogy responses. *Journal of Applied Learning & Teaching*, *3*(1), 1–20.

Creswell, J. W. (2014). *A concise introduction to mixed methods research*. SAGE publications.

Crosby, M., Pattanayak, P., Verma, S., & Kalyanaraman, V. (2016). Blockchain technology: Beyond bitcoin. *Applied Innovation, 2*, 6-18. https://j2-capital.com/wp-content/uploads/2017/11/AIR-2016-Blockchain.pdf

Czachorowski, K., Solesvik, M., & Kondratenko, Y. (2019). The application of blockchain technology in the maritime industry. In V. Kharchenko, Y. Kondratenko, & J. Kacprzyk (Eds.), *Green IT engineering: Social, business and Industrial applications* (pp. 561–577). Springer. doi:10.1007/978-3-030-00253-4_24

da Silva, J. A. T. (2017). The preprint wars. *AME Medical Journal*, *2*(74), 74. Advance online publication. doi:10.21037/amj.2017.05.23

Darnton, R. (2009). Google & the future of books. *The New York Review of Books*, *55*(2), 27–3. https://bit.ly/3vccUBf4

Davidson-Shivers, G. V., Rasmussen, K. L., & Lowenthal, P. R. (2018). Overview of online instruction and learning environments and communities. In *Web-based learning* (pp. 3–41). Springer. doi:10.1007/978-3-319-67840-5_1

Davies-Hoffman, K., Alvarez, B., Costello, M., & Emerson, D. (2013). Keeping pace with information literacy instruction for the real world: When will MLS programs wake up and smell the lilacs? *Communications in Information Literacy*, *7*(1), 9–23. doi:10.15760/comminfolit.2013.7.1.131

Davis, A. M. L. (2018). Current trends and goals in the development of makerspaces at New England college and research libraries. *Information Technology and Libraries*, *37*(2), 94–117. doi:10.6017/ital.v37i2.9825

Davis, J. R., & Lagoze, C. (2000). NCSTRL: Design and deployment of a globally distributed digital library. *Journal of the American Society for Information Science*, *51*(3), 273–280. doi:10.1002/(SICI)1097-4571(2000)51:3<273::AID-ASI6>3.0.CO;2-6

De Jager, K., & Nassimbeni, M. (2005). Information literacy and quality assurance in South African higher education institutions. *Libri*, *55*(1), 31–38. doi:10.1515/LIBR.2005.31

De Mutiis, A., & Kitchen, S. (2016). *African digital research repositories: survey report. Africa Bibliography*. doi:10.1017/S0266673116000027

Dellaca, M. (2018). Leading Libraries in a VUCA World. *Austl. L. Libr.*, *26*, 134.

Dempsey, L., & Malpas, C. (2018). Academic library futures in a diversified university system. In N. Gleason (Ed.), *Higher Education in the Era of the Fourth Industrial Revolution* (pp. 65–89). Palgrave Macmillan. doi:10.1007/978-981-13-0194-0_4

Digital Learning Collaborative (Organization). (2013). *TPACK Assessment* [Digital Image]. https://www.thinglink.com/scene/418834748178169856

Diyaolu, A. M., & Oso, O. O. (2019). Challenges of integrated library system (ILS) migration in selected academic libraries in Oyo State, Nigeria. *Library Philosophy and Practice (e-journal), 2535*. https://digitalcommons.edu/libphilprac/2535

Dlamini, N. N., & Snyman, M. (2017). Institutional repositories in Africa: Obstacles and challenges. *Library Review*, *66*(6/7), 535–548. doi:10.1108/LR-03-2017-0021

Dongxing, J., Xulei, Y., Qixin, L., Fang, Y., & Xiaolong, F. (2011). Exploration of university information architecture. *Shiyan Jishu Yu Guanli*, *28*(5), 7–11.

Dorner, D. (2000). Cataloguing in the 21st century, part 2: Digitization and information standards. *Library Collections, Acquisitions & Technical Services*, *24*(2), 73–87.

Dowlin, K. E. (1984). *The electronic library: The promise and the process*. Neal-Schuman Publishers.

Drake, M. A. (2004). Institutional repository: hidden treasure. *Inf Today, 12*(5), 1-7. https://www.infotoday.com/searcher/may04/drake.shtml

Du preez, P., Verhoef, A. H., & Simmonds, S. (2016). Rethinking and researching transformation in higher education: A meta-study of South African trends. *Transformation in Higher Education, 1*, 1-7.

Duranti, L. (2010). Concepts and principles for the management of electronic records, or records management theory is archival diplomatics. *Records Management Journal*, *20*(1), 78–95. doi:10.1108/09565691011039852

Early, S. (2016). *Getting more from SharePoint-Part 3. Metrics, Content Processes, and Governance policies*. Information Today Inc.

Ebele, N. A., Anthonia, U. N. E., & Ebikabowei, E. B. (2019). Digital preservation practices in university libraries: An investigation of institutional repositories in Africa. *Digital Library Perspectives*, *35*(1), 41–64. doi:10.1108/DLP-10-2017-0041

Eggleston, J. (2018). *School-Based Curriculum Development in Britain: A Collection of Case Studies*. Routledge. doi:10.4324/9780429454622

Egwunyenga, J. E. (2009). Record Keeping in Universities: Associated Problems and Management Options in South West Geo-Political Zone of Nigeria. *International Journal of Educational Sciences*, *1*(2), 109–113. doi:10.1080/09751122.2009.11889983

Elbert, M., Fuegi, D., & Lipeikaite, U. (2012). Public libraries in Africa – agents for development and innovation? Current perceptions of local stakeholders. *IFLA Journal*, *38*(2), 148–165. doi:10.1177/0340035212444512

English, M., West, P., & Jackson, J. (2019). Building a Community of Inquiry in online Library instruction: The CoI Framework applied. *Journal of Library & Information Services in Distance Learning*, 1–11. doi:10.1080/1533290X.2019.1575319

Eserada, R. E., & Okolo, S. E. (2019). Use of Online Public Access Catalogue (OPAC) in selected university libraries in South-South Nigeria. *Library Philosophy and Practice (e-Journal)*.

Eserada, R. E., Okolo, S. E., & Ideh, P. N. (2019). Computer self-efficacy as determinant to the use of online public access catalogue: A case study of selected universities in Niger delta region. *The Computer Journal*.

European Commission. (2020). *Horizon 2020 online manual: Open access*. https://ec.europa.eu/research/participants/docs/h2020-funding-guide/cross-cutting-issues/open-access-data-management/open-access_en.htm

Ex Libris. (2019). Ex Libris Signs Definitive Agreement to Acquire Innovative. *Ex Libris Library Technology Reports*, *55*(1). Advance online publication. doi:10.5860/ltr.55n1

Fabumni, O. M., & Asubiojo, B. O. (2013). Awareness and Use of Online Public Access Catalogue by Students of Obafemi Awolowo University, Ile-Ife, Nigeria. *Library Philosophy and Practice (e-journal).* https://www.librarianshipstudies.com/2017/09/functional-requirements-for-bibliographic-records-frbr.html

Fabunmi, O. M., & Asubiojo, B. O. (2013). Awareness and use of online public access catalogue by students of ObafemiAwolowo University, Ile-Ife, Nigeria. *Library Philosophy and Practice (e-journal*), 922. Available at: https://digitalcommons.unl.edu/libphilprac/92

Fahmy, S. F. (2018). *Blockchain and its uses*. https://www.sheriffadelfahmy.org/wp-content/uploads/2018/01/doc-1.pdf

Fati, O. I., & Adetimirin, A. (2015). OPAC awareness as a factor affecting OPAC use by undergraduates in two Nigerian libraries. *International Journal of Academic Library and Information Science*, *3*(3), 72–80.

Feng, X., & Pan, W. (2016). Determinants of Acceptance of Electronic Recordkeeping Systems: A User-Focused Empirical Study of System Characteristics. *Canadian Journal of Information and Library Science*, *40*(2), 125–151.

Ferdinand, O. A. (2020). Undergraduates' awareness, ICT skills and use of OPAC in federal universities in South West, Nigeria. Library of Progress-Library Science. *Information Technology & Computer*, *40*(2), 257–269.

Ferguson-Boucher, K., & Convey, N. (2011). Storing Information in the Cloud- A Research Project. *Journal of the Society of Archivists*, *32*(2), 221–237. doi:10.1080/00379816.2011.619693

Fernandez-Morales, M., & Bonilla-Carrión, R. (2020). Bibliomining, data, and the decision-making process. *Revista Interamericana de Bibliotecología (Inter-American Journal of Library Science)*, *43*(2), Article e4. doi:10.17533/udea.rib.v43n2eI8

Fernández-Ramos, A. (2019). Online information literacy instruction in Mexican university libraries: The librarians' point of view. *Journal of Academic Librarianship*, *45*(3), 242–251. doi:10.1016/j.acalib.2019.03.008

Fitzpatrick, K. (2012). Giving it away: Sharing and the future of scholarly communication. *Journal of Scholarly Publishing*, *43*(4), 347–362. doi:10.3138/jsp.43.4.347

Fonseca, P., & Picoto, W. N. (2020). The competencies needed for digital transformation. *Online Journal of Applied Knowledge Management*, *8*(2), 53–70. doi:10.36965/OJAKM.2020.8(2)53-70

Formenton, D., & de Souza Gracioso, L. (n.d.). *Digital Preservation challenges, requirements, strategies and scientific output*. Academic Press.

Fox, E. A., Akscyn, R. M., Furuta, R. K., & Leggett, J. J. (1995). Digital libraries. *Communications of the ACM*, *38*(4), 22–28. doi:10.1145/205323.205325

Francke, H., Gamalielsson, J., & Lundell, B. (2017). Institutional repositories as infrastructures for long-term preservation. *Information Research*, *22*(2).

Frankenfield, J. (2021). *Artificial Intelligence (AI).* Retrieved from https://www.investopedia.com/terms/a/artificial-intelligence-ai.asp

Frankland, J., & Ray, M. A. (2017). Traditional versus open access scholarly publishing: An economic perspective. *Journal of Scholarly Publishing*, *49*(1), 5–25. doi:10.3138/jsp.49.1.5

Friday, J. E., & Eze, M. E. (2021). Digital Preservation of Electronic Theses and Dissertations in Public University Libraries in South-East Nigeria. *Library Philosophy and Practice*, 1-21.

Gao, J. H. (2017). Advantages and Disadvantages for Nurses of Using Social Media. *Journal of Primary Health Care and General Practice*.

Garaba, F. (2018). The neglected fond in university archives: The case of sport club records at the University of Kwazulu-Natal (UKZN), Pietermaritzburg Campus, South Africa. *Records Management Journal*, *28*(2), 143–158. doi:10.1108/RMJ-11-2016-0043

Garoufallou, E., & Gaitanou, P. (2021). Big data: Opportunities and challenges in libraries, a systematic literature review. *College & Research Libraries*, *82*(3), 410. Advance online publication. doi:10.5860/crl.82.3.410

Garrett, L., Gramstadt, M., & Silva, C. (2013). Identifying and selecting the infrastructure required to support the curation and preservation of visual arts research data. *International Journal of Digital Curation*, *8*(2), 68–88. doi:10.2218/ijdc.v8i2.273

Gartner. (2017). *Gartner insights on how and why leaders must implement cloud computing.* Available at: https://www.gartner.com/imagesrv/books/cloud/cloud_strategy_leadership.pdf

Gatteschi, V., Lamberti, F., Paravati, G., Sanna, A., Demartini, C., Lisanti, A., & Venezia, G. (2015). New frontiers of delivery services using drones: A prototype system exploiting a quadcopter for autonomous drug shipments. In *2015 IEEE 39th Annual Computer Software and Applications Conference* (Vol. 2, pp. 920-927). IEEE. 10.1109/COMPSAC.2015.52

Gbaje, E. S., & Mohammed, M. H. (2017). *Long-term accessibility and re-use of institutional repository contents of some selected academic institutions in Nigeria*. Paper presented at IFLA SOCRS satellite meeting 2017.

Gilliland, A. J. (2014). *Conceptualizing Twenty-First Century Archives*. Society of American Archivists.

Glatthorn, A. A., Boschee, F., Whitehead, B. M., & Boschee, B. F. (2018). *Curriculum Leadership: Strategies for Development and Implementation*. Sage.

Godly, C. J., & Smith-Yoshimura, K. (2017). From records to things: Managing the transition from legacy library metadata to linked data. *Bulletin of the Association for Information Science and Technology*, *43*(2), 18–23. doi:10.1002/bul2.2017.1720430209

Gohain, A., & Saikia, M. (2013). Use and user's satisfaction on Online Public Access Catalogue (OPAC) services among BTech. Students of School of Engineering in Tezpur University: A survey. *Library Philosophy and Practice (e-journal)*.

Goldner, M. (2011). Winds of change: Libraries and cloud computing. *Multimedia Information and Technology*, *37*(3), 1–8.

Gomba, C. (2016). Transforming rural secondary schools in Zimbabwe through technology: Lived experiences of student computer users. *International Online Journal of Education & Teaching*, *3*(2), 108–120.

Gonçalves, M. A., Moreira, B. L., Fox, E. A., & Watson, L. T. (2007). What is a good digital library?" A quality model for digital libraries. *Information Processing & Management*, *43*(5), 1416–1437. doi:10.1016/j.ipm.2006.11.010

Gonzales, B. M. (2014). Linking libraries to the web: Linked data and the future of the bibliographic record. *Information Technology and Libraries*, *33*(4), 10–22. doi:10.6017/ital.v33i4.5631

Gopalaswamy, M., & Kumar, S. N. (2012). Cloud computing technology: A boon for Library and Information Services. *Indian Journal of Library and Information Science.*, *6*(3).

Gordijin, J., & Akkermans, H. (2006). *Early requirement determination for networked value constellations: A business model ontology approach*. Free University Amsterdam VUA.

Goundar, M. S., & Kumar, B. A. (2021). The use of mobile learning applications in higher education institutes. *Education and Information Technologies*, 1–24. doi:10.100710639-021-10611-2

Graham, M. (2019). *Robots in the libraries*. www.soutron.com/robots-libraries/

Grammenis, E., & Mourikis, A. (2020). Migrating from integrated library systems to library services platforms: An exploratory qualitative study for the implications on academic libraries' workflows. *Qualitative and Quantitative Methods in Libraries (QQML), 9,* 343–357. http://lnu.diva-portal.org/smash/get/diva2:1234039/FULLTEXT01.pdf

Greeff, W. J., & Barker, R. (2012). Exploring vodcasts as a supportive learning tool. *Progressio*, *34*(1), 170–185.

Gross, J., & Sheridan, L. (2011). Web scale discovery: The user experience. *New Library World*, *112*(5/6), 236–247. doi:10.1108/03074801111136275

Guerrini, M., & Possemato, T. (2016). From record management to data management: RDA and new application models BIBFRAME, RIMMF, and OliSuite/WeCat. *Cataloging & Classification Quarterly*, *54*(3), 179–199. doi:10.1080/01639374.2016.1144667

Guion, D. (2021, June 26). *A brief history of the internet and digital libraries*. Reading, Writing, Research. https://www.allpurposeguru.com/2021/06/a-brief-history-of-the-internet-and-digital-libraries

Hallis, R. (2017). Internet outfitters: Librarians in the twenty-first century. *Library Management*, *38*(6/7), 369–379. doi:10.1108/LM-02-2017-0012

Hall, J. (2017). Developing teaching best practice—Pedagogy, preferences, and professional development. *The International Information & Library Review*, *49*(1), 59–64. doi:10.1080/10572317.2017.1270692

Hall, R. A. (2013). Beyond the job ad: Employers and library instruction. *College & Research Libraries*, *74*(1), 24–38. doi:10.5860/crl-236

Han, Y. (2006). A RDF-based digital library system. *Library Hi Tech*, *24*(2), 234–240. doi:10.1108/07378830610669600

Harada, T. (2017). *Robotics and artificial intelligence technology in Japanese libraries*. Paper presented at IFLA WLIC 2019 - Athens, Greece - Libraries: dialogue for change in Session S08 - Information Technology. In: Robots in libraries: challenge or opportunity? Wildau, Germany. http://library.ifla.org/id/eprint/2695

Hartwell, A. (2020). TPACK as a Framework to Facilitate Co-Planning, Teaching and Assessing. *Canadian School Libraries Journal, 4*(1).

Hartzell, G. (2012). The Principal's Perceptions of School libraries and Teacher-Librarians. *School Libraries Worldwide*, *8*(1), 92–110.

Haslhofer, B., & Isaac, A. (2011). Data Europeana. EU: The Europeana linked open data pilot. *International Conference on Dublin Core and Metadata Applications*, 94-104.

Hastut, I. K., Muslih, M., Syarif, A. M., & Mulyana, A. R. (2021). A Conceptual Digital Library Model for Validated Content-based Preservation of Traditional Javanese Songs. In *4th International Seminar on Research of Information Technology and Intelligent Systems (ISRITI).* IEEE.

Hayes, C. T. (2015). Social Media: Defining, Developing, and Divining. *Atlantic Journal of Communication*, *23*(1).

Hays, L., & Studebaker, B. (2019). Academic instruction librarians' teacher identity development through participation in the scholarship of teaching and learning. *International Journal for the Scholarship of Teaching and Learning*, *13*(2). Advance online publication. doi:10.20429/ijsotl.2019.130204

Hedman, J., & Kalling, T. (2003). The business model concept: Theoretical underpinnings and empirical illustrations. *European Journal of Information Systems*, *12*(1), 49–59. doi:10.1057/palgrave.ejis.3000446

Hendler, J., Gandon, F., & Allemang, D. (2020). *Semantic web for the working ontologist: effective modeling for linked data, RDFS, and OWL*. Morgan & Claypool.

Henriksen, D., Keenan, S., Richardson, C., & Mishra, P. (2015). Rethinking Technology & Creativity in the 21st Century Modeling as a trans-disciplinary formative skill and practice. *TechTrends*, *59*(3), 5–10. doi:10.100711528-015-0845-y

Hensley, M. K. (2015). Improving LIS education in teaching librarians to teach. In D. Mueller (Ed.), *Creating Sustainable Community: The Proceedings of the ACRL 2015 Conference* (pp. 315-322). Association of College and Research Libraries.

Hicks, A. (2011). "Mendeley": A review. *Collaborative Librarianship*, *3*(2), 10. Advance online publication. doi:10.29087/2011.3.2.10

Higgins, S. (2008). *The DCC curation lifecycle model*. Academic Press.

Hildreth, C. H. (1991). Advancing toward the E3OPAC: the imperative and the path. In *Think tank on the present and future of the online catalog. Proceedings of ALA Midwinter Meeting*. American Library Assoc.

Hinterhuber, A., & Liozu, S. (2012). Is it time to rethink your pricing strategy. *MIT Sloan Management Review*, *53*, 69–78.

Hobohm, H. C. (2012). Can Digital Libraries Generate Knowledge? *Historical Social Research. Historische Sozial-forschung*, *37*(3), 218–229.

Holotescu, C. (2018). Understanding blockchain opportunities and challenges. In *Proceedings of the 14th International Scientific Conference "eLearning and Software for Education"* (pp. 275-283). National Defence University Publishing House. https://proceedings.elseconference.eu/index.php?r=site/index&year=2018

Horton, S. (2006). Social Capital, government policy and public value: Implications for archive service delivery. *Aslib Proceedings*, *58*(6), 502–512. doi:10.1108/00012530610713588

Howell, J. (2012). *Teaching with ICT: Digital pedagogies for collaboration and creativity*. Oxford University Press.

Hoy, M. B. (2017). An introduction to the blockchain and its implications for libraries and medicine. *Medical Reference Services Quarterly*, *36*(3), 273–279. doi:10.1080/02763869.2017.1332261 PMID:28714815

Hu, J., & Zhang, Y. (2016). Chinese Students' Behavior Intention to Use Mobile Library Apps and Effects of Education Level and Discipline. *Library Hi Tech*, *34*(4), 639–656. doi:10.1108/LHT-06-2016-0061

Hussain, A., & Nisha, F. (2017). Awareness and use of library makerspaces among library professionals in India: A study. *DESIDOC Journal of Library and Information Technology*, *37*(2), 84–90.

Hyun, H. K., & Yong, H. K. (2008). Usability study of digital institutional repositories. *The Electronic Library*, *26*(6), 863–881. doi:10.1108/02640470810921637

Idika, E. O., Eneogu, N. D., Ede, M. O., Obiorah, N. J., Nji, I. A., Okolie, O. M., & Tom, B. (2021). Availability and Utilization of Digital Technologies in the Teaching and Learning of Economics at the University of Nigeria, Nsukka. *Journal of Critical Reviews*, *8*(2). https://www.bibliomed.org/fulltextpdf.php?mno=73239

IFLA Study Group. (1998). *Functional requirements for bibliographic records: final report.* Technical report. IFLA. https://www.ifla.org/VII/s13/frbr/frbr.p

IFLA Study Group. (2009). *Functional requirements for authority data – a conceptual model. Working Group on Functional Requirements and Numbering of Authority Records*. Author.

IFLA Study Group. (2010). *Functional requirements for subject authority data (FRSAD) – a conceptual model.* IFLA Working Group on the Functional Requirements for Subject Authority Records (FRSAR).

Igbudu, M. T., & Ver, A. (2020). Undergraduates' awareness, use and satisfaction with online public access catalogue (OPAC) of Benue State University Library, Makurdi, Nigeria. *Journal of Library Services and Technologies*, *2*(1), 58–68.

Ingram, J., & Lord, K. M. (2019). *Global development disrupted: Findings from a survey of 93 leaders*. Brookings Institution. https://www.brookings.edu/wp-content/ uploads/2019/03/Global-Development-Disrupted.pdf

Institute of Development and Management (IDM). (2021). *Diploma in Archives and Records Management*. Retrieved from https://www.idmbls.com/course-overview/DIPLOMA

International Africa Institute (IAI). (2021). *African digital research repositories*. https://www.internationalafricaninstitute.org/repositories

International Federation of Library Associations-IFLA. (2021). *COVID-19 and the Global Library Field*. Retrieved October 15, 2021, from https://www.ifla.org/covid-19-and-the-global-library-field/#services

Irving, G., & Holden, J. (2016). How blockchain-timestamped protocols could improve the trustworthiness of medical science. *F1000Research*, *5*, Article 222. doi:10.12688/f1000research.8114.2

Iskandar, I., & Patak, A. A. (2019). The significance of Mendeley usage on the accuracy of citation and references. *International Journal of Humanities and Innovation*, *2*(4), 108–114. doi:10.33750/ijhi.v2i4.51

Ivey, C., & Crum, J. (2018). Choosing the right citation management tool: Endnote, Mendeley, RefWorks, or Zotero. *Journal of the Medical Library Association: JMLA*, *106*(3), 399. Advance online publication. doi:10.5195/jmla.2018.468

Iwu, C. G., Musikavanhu, T. B., Ukandu, H., & Dassah, M. (2019). Administering postgraduate education for success: The necessity for postgraduate orientation. *Academia (Caracas)*, *16-17*, 185–210.

Jacksi, K., Zeebaree, S. R., & Dimililer, N. (2018). LOD explorer: Presenting the web of data. *(IJACSA). International Journal of Advanced Computer Science and Applications*, *9*(1), 45–51. doi:10.14569/IJACSA.2018.090107

Jadhav, U. S., & Alur, S. (2021). Impact of COVID-19 on Academic Library Services. In G. Rathinasabapathy, K. Veeranjaneyulu, & V. Srinivasa (Eds.), *Management of knowledge resource centres in the networked digital environment*. BS Publications.

Jagatap, S. W., & Shaikh, I. (2018). Mapping of Literature on digital library by J-Gate Database. *Knowledge Librarian An International Peer Reviewed Bilingual E-Journal of Library and Information Science*, *5*, 2.

Jalal, S. K. (2019). Emerging roles of librarians in academic libraries: A great leap forward. *Library Herald*, *57*(2), 183–194. doi:10.5958/0976-2469.2019.00010.1

James Friday, C. O. (2020). Social Media and Library Services: A Case of COVID-19 Pandemic Era. *International Journal of Research and Review*, *7*(10), 230–237.

Jetty, S., Anbu, K. J. P., Jain, P. K., & Hopkinson, A. (2011). OPAC 2.0 towards the next generation of online library catalogues. *International Conference of Asian Special Libraries*. units.sla.org/chapter/cas/CoASL%202011.pdf

Jiang, T., Chi, Y., & Gao, H. (2017). A clickstream data analysis of Chinese academic library OPAC users' information behavior. *Library & Information Science Research*, *39*(3), 213–223. doi:10.1016/j.lisr.2017.07.004

Johnson, R., Watkinson, A., & Mabe, M. (2018). *The STM report: An overview of scientific and scholarly publishing* (5th ed.). International Association of Scientific, Technical and Medical Publishers. https://www.stm-assoc.org/2018_10_04_STM_Report_2018.pdf

Johnson, W. M., Christensen, M. C., & Kagermann, H. (2008). Reinventing your business model. *Harvard Business Review*, *86*, 59–67.

Jones, M., & Vines, R. (2016). Cultivating Capability The Socio-technical challenges of integrating approaches to records and Knowledge Management. *Records Management Journal*, *26*(3), 242–258. doi:10.1108/RMJ-11-2015-0035

Joo, S., Hofman, D., & Kim, Y. (2018). Investigation of challenges in academic institutional repositories: A survey of academic librarians. *Emerald*, *37*(3), 527–548.

Joudrey, D. N., Taylor, A. G., & Miller, D. P. (2015). *Introduction to cataloguing and classification* (11th ed.). Libraries Unlimited.

Julien, H., Gross, M., & Latham, D. (2018). Survey of information literacy instructional practices in U.S. academic libraries. *College & Research Libraries*, *79*(2), 179–199. doi:10.5860/crl.79.2.179

Kadli, J. H. (2020). QR Codes: Academic Library Perspective in Digital Age. *Library Philosophy and Practice (e-journal)*, 3916. https://digitalcommons.unl.edu/libphilprac/3916

Kamatula, G., & Kemoni, H. (2018). A framework for E-Records in Support of E-Government Implementation in the Tanzanian Public Service. *ESARBICA Journal*, *37*, 70–88.

Kamupunga, W., & Chunting, Y. (2019). Application of big data in libraries. *International Journal of Computers and Applications*, *178*(16), 34–38. doi:10.5120/ijca2019918955

Kansanen, A. & Mantykangas, A. (2014). The challenge of organizing future libraries. *International Journal of Advanced Statistics and IT&C for Economics and Life Sciences, 4*, 42-48.

Kanyengo, C. W. (2006). *Managing digital information resources in Africa: Preserving the integrity of scholarship.* Paper presented at the Bridging the North-South Divide in Scholarly Communication on Africa: Threats and Opportunities in the Digital era, Leiden, The Netherlands.

Kapasule, A., & Chawinga, W. (2016). *Revolutionising Scholarly Communications Through Institutional Repositories: Empirical Findings from a University (College) in Malawi.* Paper presented at the 22nd Standing Conference of Eastern Central and Southern African Libraries Association (SCECSAL), Royal Swazi Sun eZulwini, Swaziland. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3004463

Kaplon-Schilis, A., & Lyublinskaya, I. (2020). Analysis of relationship between five domains of TPACK framework: TK, PK, CK math, CK science, and TPACK of pre-service special education teachers. *Technology, Knowledge and Learning, 25*(1), 25-43.

KardanMoghaddam, H., Rajael, A., & Jafari. (2022). Determining effects factors in cloud computing acceptance using Rogers Diffusion of Innovation Model and David' Technology Adoption Model. *Journal of Electrical and Computer Engineering Innovations, 10*(1), 175-194. Available at: https://jecei.sru.ac.ir/article_1603_f5ca4190f95fa37bb6a530ab-062c3b60.pdf

Kari, K.H., & Baro, E.E. (2016). Digital preservation practices in university libraries. *De Gruyter, 45*(3), 134–144. doi:10.1515/pdtc-2016-0006

Katuu, S. (2016). Overview of the InterPares Trust Project in Africa: Trusting Records in an Increasingly Networked Environment. *New Review of Information Networking*, *21*(2), 117–128. doi:10.1080/13614576.2016.1247743

Kawaguchi, N. (2019). Application of blockchain to supply chain: Flexible blockchain technology. *Procedia Computer Science*, *164*, 143–148. doi:10.1016/j.procs.2019.12.166

Keller, C. M. (2020). *Foreword*. Johns Hopkins University Press.

Kelly, A. V. (2009). *The Curriculum: Theory and Practice*. Sage.

Kelly, N., & Antonio, A. (2016). Teacher peer support in social network sites. *Teaching and Teacher Education*, *56*, 138–149. doi:10.1016/j.tate.2016.02.007

Ketenci, A., & Gol, E. A. (2019). Synthesis of monitoring rules via data mining. In *2019 American Control Conference (ACC)* (pp. 1684-1689). IEEE. 10.23919/ACC.2019.8815002

Khalid, J., Ram, B. R., Soliman, M., Ali, A. J., Khalee, M., & Islam, M. S. (2018). Promising digital university: A pivotal need for higher education transformation. *International Journal of Management Education*, *12*, 264–275.

Khalid, S., Maqbool, A., Rana, T., & Naheed, A. (2020). A blockchain-based solution to control power losses in Pakistan. *Arabian Journal for Science and Engineering*, *45*(8), 6051–6061. doi:10.100713369-020-04464-z

Khan, A. (2020). Digital information literacy skills of Pakistani librarians: Exploring supply-demand mismatches, adoption strategies and acquisition barriers. *Digital Library Perspectives*, *36*(2), 167–189. doi:10.1108/DLP-01-2020-0003

Khan, S. I., & Hoque, A. S. M. L. (2010). A new technique for database fragmentation in distributed systems. *International Journal of Computers and Applications*, *5*(9), 20–24. doi:10.5120/940-1318

Khiste, G. P., Avinash, A., & Deshmukh, R. K. (2018). Literature audit of ‘digital library’: An overview. *Vidyawarta*, (Special Issue), 403–411.

Khumalo, B. N., & Masuku, M. (2018). The Self-Worth of Records and Archives Management Students at the National University of Science and Technology, Bulawayo, Zimbabwe. *African Journal of Library Archives and Information Science*, *28*(1), 49–59.

KICD. (2017). *Basic Education Curriculum Framework*. Kenya Institute of Curriculum Development.

Kieth, T. (2019). *Technology adoption challenges: 3 hurdles and how to get over them*. Introhive. https://www.introhive.com/blog/technology-adoption-challenges

Kim, G.-C., & Gurvitch, R. (2020). Online education research adopting the community of inquiry framework: A systematic review. *Quest*, *72*(4), 395–409. doi:10.1080/00336297.2020.1761843

Kim, K. (2003). Recent work in cataloguing and classification, 2000-2002. *Library Resources & Technical Services*, *47*(3), 96–108. doi:10.5860/lrts.47n3.96

King, N., Horrocks, C., & Brooks, J. (2018). Interviews in qualitative research. *Sage (Atlanta, Ga.)*.

Koedinger, K., Cunningham, K., Skogsholm, A., & Leber, B. (2008). An open repository and analysis tools for fine-grained, longitudinal learner data. In R. S. J. de Baker, T. Barnes, & J. E. Beck (Eds.), *Educational data mining: The 1st International Conference on Educational Data Mining* (pp. 157–166). Computer Science Bibliography. https://dblp.uni-trier.de/db/conf/edm/edm2008.html#KoedingerCSL08

Koehler, M., & Mishra, P. (2009). What is technological pedagogical content knowledge (TPACK)? *Contemporary Issues in Technology & Teacher Education*, *9*(1), 60–70.

Kolahi, J., Khazaei, S., Dunning, D. G., & Rossomando, E. F. (2020). Do open-access dental articles enjoy higher altmetric attention scores, Twitter, Facebook, news, Wikipedia, blog mentions, Mendeley readers and citations? *Dental Hypotheses*, *11*(1), 1–3. doi:10.4103/denthyp.denthyp_17_20

Kolbitsch, J., & Maurer, H. A. (2006). The transformation of the Web: How emerging communities shape the information we consume. *Journal of Universal Computer Science*, *12*(2), 187–213.

Kondor, D., Po'sfai, M., Csabai, I., & Vattay, G. (2014). Do the rich get richer? An empirical analysis of the Bitcoin transaction network. *PLoS One*, *9*(2), 86197–86207. doi:10.1371/journal.pone.0086197 PMID:24505257

Kopcha, T. J., Neumann, K. L., Ottenbreit-Leftwich, A., & Pitman, E. (2020). Process over product: The next evolution of our quest for technology integration. *Educational Technology Research and Development*, *68*(2), 729–749. doi:10.100711423-020-09735-y

Kotecha, P., & Perold, H. (2010). Rebuilding higher education in Zimbabwe: a needs analysis. Rebuilding higher education in Zimbabwe: implications for regional collaboration. *SARUA Leadership Dialogue Series, 2*(1).

Kouis, D., Kyprianos, K., Efthymiou, F., Koulouris, A., & Karabela, A. (2021). Migrating to a shared Library Management System: Evaluation from the perspective of librarians and lessons learned. *Library Management*, *42*(6–7), 448–458. https://www.emerald.com/insight/content/doi/10.1 108/LM-12-2020-0177/full/html

Kratochvíl, J. (2017). Comparison of the accuracy of bibliographical references generated for medical citation styles by EndNote, Mendeley, RefWorks and Zotero. *Journal of Academic Librarianship*, *43*(1), 57–66. doi:10.1016/j.acalib.2016.09.001

Król, K. (2020). Evolution of online mapping: from Web 1.0 to Web 6.0. *Geomatics, Land management and Landscape*. https://gll.urk.edu.pl/zasoby/74/GLL-1-3-2020.pdf

Kronke, M. (2020). *AfricaPortal*. Retrieved September 14, 2021, from https://www.africaportal.org/publications/africas-digital-divide-and-promise-e-learning/

Kumar, P. B. (2020). Role of Library Professionals in a Pandemic Situation Like COVID-19. *International Journal of Library and Information Studies*, *10*(2), 33–48.

Kumar, R. (2011). *Research methodology: A step-by-step guide for beginners* (3rd ed.). Sage.

Kumar, S., & Vohra, R. (2013). User perception and use of OPAC: A comparison of three universities in the Punjab region of India. *The Electronic Library*, *31*(1), 36–54. doi:10.1108/02640471311299128

Lalnunpuii, E., Nurtinkhuma, R. K., & Verma, M. K. (2018). Use and users' satisfaction with on-line public access catalogue (OPAC) services of Mizoram University Library: A survey. *ISST Journal of Advances in Librarianship*, *9*(1), 68–73.

Lashkari, A. H., Mahdavi, F., & Ghomi, V. (2009). A Boolean model in information retrieval for search engines. In *2009 International Conference on Information Management and Engineering* (pp. 385-389). IEEE. 10.1109/ICIME.2009.101

Lawrence, S., Koob, A., & Mutima, N. (2015). *U.S. foundation funding for Africa*. Foundation Centre. https://grantcraft.org/content/curated-content/u-s-foundation-funding-for-africa-2015-edition/

Lee, D. (2006). iPod, you-pod, we-pod: Podcasting and marketing library services. *Library Administrator and Management, 20*, 206-208. https://bit.ly/33MloDZ

Lewis, C., Wolff, K., & Bekker, B. (2021). Supporting project-based education through a community of practice: A case of postgraduate renewable energy students. *World Transactions on Engineering and Technology Education*, *19*, 35–40.

Lewitzky, R. A. (2020). Educating, learning, and growing: A review of the teaching role in academic librarianship. *College & Undergraduate Libraries*, *27*(1), 32–40. doi:10.1080/10691316.2020.1714526

Library of the Future. (2018). *Data everywhere*. https://www.ala.org/tools/future/trends/data

Li, S., Hao, Z., Ding, L., & Xu, X. (2019). Research on the application of information technology of Big Data in Chinese digital library. *Library Management*, *40*(8/9), 518–531. doi:10.1108/LM-04-2019-0021

Liu, X. L. (2015). Analysis and management platform construction of library's big data based on Internet of Things. In G. Lee (Ed.), Advances in education research. Information Engineering Research Institute. Academic Press.

Liu, G., & Fu, P. (2018). Shared Next Generation ILSs, and Academic Library Consortia: Trends, Opportunities and Challenges. *International Journal of Librarianship*, *3*(2), 53–71.

Liu, M., Wan, C., & Wang, L. (2004). A fuzzy logic approach for content-based audio classification and Boolean retrieval. In *Fuzzy Logic and the Internet* (pp. 135–156). Springer. doi:10.1007/978-3-540-39988-9_7

Liu, Y. (2018). Data mining of university library management based on improved collaborative filtering association rules algorithm. *Wireless Personal Communications*, *102*(4), 3781–3790. doi:10.100711277-018-5409-y

Li, Y., & Banach, M. (2011). Institutional repositories and digital preservation: Assessing current practices at research libraries. *D-Lib Magazine*, *17*(5). Advance online publication. doi:10.1045/may2011-yuanli

Llewellyn, A. (2019). Innovations in learning and teaching in academic libraries: A literature review. *New Review of Academic Librarianship*, *25*(2-4), 129–149. doi:10.1080/13614533.2019.1678494

Lown, C., Sierra, T., & Boyer, J. (2013). How users search the library from a single search box. *College & Research Libraries*, *74*(3), 227–241. doi:10.5860/crl-321

Lu, L. L. (2018). Analysis of the Present Situation and Strategy of the Informatization construction of College Student Archives in China. *International Journal for Research in Educational Studies*, *4*(3), 11–15.

Luyombya, D., & Sennabulya, S. (2012). *An analysis of the public archive's infrastructure in Uganda.* Comma-2012_1_07_ luyombya _sennabulya.inddd

Lv, S. (2020). Construction of marine ship automatic identification system data mining platform based on big data. *Journal of Intelligent & Fuzzy Systems*, *38*(2), 1249–1255. doi:10.3233/JIFS-179487

Lynch, R., Young, J. C., Jowaisas, C., Boakye-Achampong, S., & Sam, J. (2020). African Libraries in Development: Perceptions and Possibilities. *The International Information & Library Review*. Advance online publication. doi:10.10 80/10572317.2020.1840002

Macgregor, G., & McCulloch, E. (2006). Collaborative tagging as a knowledge organisation and resource discovery tool. *Library Review*, *55*(5), 291–300. doi:10.1108/00242530610667558

MacMillan, D. (2012). Mendeley: Teaching scholarly communication and collaboration through social networking. *Library Management*, *33*(8/9), 561–569. doi:10.1108/01435121211279902

Madalli, D. P., Barve, S., & Amin, S. (2012). Digital preservation in open-source digital library software. *Journal of Academic Librarianship*, *38*(3), 161–164. doi:10.1016/j.acalib.2012.02.004

Maddison, T., Doi, C., Lucky, S., & Kumaran, M. (2017). Literature review of online learning in academic libraries. *Distributed Learning*, 13-46.

Madge, O. L., & Robu, I. (2019). Medical academic libraries in Romania–breaking with the past and turning towards the future. *Health Information and Libraries Journal*, *36*(1), 96–100. doi:10.1111/hir.12245 PMID:30811885

Madhusudhan, M., & Aggarwal, S. (2011). Web-based online public access catalogues of IIT libraries in India: An evaluative study. *Program*, *45*(4), 415–438. doi:10.1108/00330331111182102

Maesaroh, I., & Genoni, P. (2010). An investigation of the continuing professional development practices of Indonesian academic libraries. *Library Management*, *31*(8/9), 621–634. doi:10.1108/01435121011093397

Maflahi, N., & Thelwall, M. (2018). How quickly do publications get read? The evolution of Mendeley reader counts for new articles. *Journal of the Association for Information Science and Technology*, *69*(1), 158–167. doi:10.1002/asi.23909

Majore, S. A., Yoo, H., & Shon, T. (2014). Secure and Reliable electronic records management system using digital forensic technologies. *Supercomputer*, *70*(1), 149–165. doi:10.100711227-014-1137-6

Maker Spaces in Libraries. (n.d.). *An expert takes us through the how, why and why not*. https://bit.ly/3LTVVtn

Makori, E. O., & Mauti, N. O. (2016). Digital Technology Acceptance in Transformation of University Libraries and Higher Education Institutions in Kenya. *Library Philosophy and Practice (e-journal),* 1379. https://digitalcommons.unl.edu/libphilprac/1379

Malapela, T., & De Jager, K. (2018). Theories of value and demonstrating their practical implementation in academic library services. *Journal of Academic Librarianship*, *44*(6), 775–780. doi:10.1016/j.acalib.2018.09.018

Manduca, C. A., Fox, S., & Iverson, E. R. (2006). Digital library as network and community center. *D-Lib Magazine: the Magazine of the Digital Library Forum*, *12*(12), 12. doi:10.1045/december2006-manduca

Marchionini, G., & Maurer, H. (1995). The roles of digital libraries in teaching and learning. *Communications of the ACM*, *38*(4), 67–75. doi:10.1145/205323.205345

Maree, J. G. (2019). Group career construction counseling: A mixed-methods intervention study with high school students. *The Career Development Quarterly*, *67*(1), 47–61. doi:10.1002/cdq.12162

Marginea, E., & Kifor, C. V. (2021). Academic Libraries as user-centered organizations. Case study: Quality of services provided by LBUS Library. In *MATEC Web of Conferences.* EDP Sciences.

Marshall, C., & Rossman, G. B. (2014). *Designing qualitative research*. Sage publications.

Martzoukou, K. (2020). Academic libraries in COVID-19: A renewed mission for digital literacy. *Library Management*.

Maryati, I., Purwandari, B., Santoso, H. B., Budi, I., Solichah, I., & Gani, F. (2022). Research Support Services in Indonesian Academic Digital Libraries A Proposed Business Model and Prototype Design. *DESIDOC Journal of Library and Information Technology*, *42*(1), 18–29. doi:10.14429/djlit.42.1.17108

Marzal, M. Á., & Saurina, E. (2015). Diagnosis of the state of information literacy in Chilean universities. *Perspectivas em Ciência da Informação*, *20*(2), 58–78. doi:10.1590/1981-5344/2070

Masanes, J. (1998). *Web Archiving*. Springer.

Masenya, T. M., & Ngulube, P. (2020). Adoption and implementation of digital preservation strategies by academic libraries in South Africa. *Mousaion*, *38*(1), 1–21. doi:10.25159/2663-659X/7123

Masenya, T. M., & Ngulube, P. (2020). Factors that influence digital preservation sustainability in academic libraries in South Africa. *South African Journal of Library and Information Science*, *86*(1), 52–63. doi:10.7553/86-1-1860

Masenya, T. M., & Ngulube, P. (2021). Digital preservation systems and technologies in South African academic libraries. *South African Journal of Information Management*, *23*(1), 1–11. doi:10.4102ajim.v23i1.1249

Mavodza, J. (2013). The impact of cloud computing on the future of academic library practices and services. *New Library World*, *114*(3/4), 132–141. doi:10.1108/03074801311304041

Mayega, S. (2008). *Library information services in the digital age*. Academic Press.

Mayega, S. (2008). *Library information services in the digital age.* In Fourth Shanghai International Library Forum (SILF 2008), Shanghai, China. http://eprints.rclis.org/12567

McGillis, L. (2016). The Lights are on but Nobody's Home: The Future of Academic Libraries? *Partnership. The Canadian Journal of Library and Information Practice and Research*, *11*(1). Advance online publication. doi:10.21083/partnership.v11i1.3657

McGuinness, C. (2011). *Becoming confident teachers: A guide for academic librarians*. Elsevier. doi:10.1533/9781780632711

McTavish, H. (2019). *Emerging online roles for academic librarians in Canada* (Master's thesis). Ontario Tech University.

McTavish, H., & Robertson, L. (2020). Canadian academic librarians as online teachers. *Learning*, *4*, 10.

Megwa, C. P. (2022). *The Impact of Technology On Teaching and Learning In Higher Institutions: A Literature*. Available: https://www.researchgate.net/profile/ChukwuemekaMegwa/publication/357824376

Melnik, E. V., Orda-Zhigulina, M. V., & Orda-Zhigulina, D. V. (2021, April). Distributed Library Model Based on Distributed Ledger Technology for Monitoring and Diagnostics System. In *Computer Science On-line Conference* (pp. 501-509). Springer. 10.1007/978-3-030-77442-4_43

Mendeley. (2021). *Release note for Mendeley Desktop*. https://www.mendeley.com/release-notes/

Mensah, M. (2015). Digital preservation in the context of institutional repositories in public universities in Ghana. *International conference on African digital libraries and archives*.

Michael, V., & Evangelia, L.-V. (2016). Digital pedagogy from the perspective of early childhood education. In A. R. Elena, W. Gabriela, E. Atilla, & J. Liz (Eds.), Handbook of Research on Applied Learning Theory and Design in Modern Education (pp. 93-114). IGI Global.

Mierzecka, A. (2018). Students' information needs and digital technologies in the academic libraries. *Przegląd Biblioteczny*, *86*(4), 509–530. doi:10.36702/pb.440

Ministry of Primary and Secondary Education. (2019). *2018 primary and secondary education statistics report*. Ministry of Primary and Secondary Education.

Moahi, K. H. (2009). *Institutional repositories: Towards harnessing knowledge for African development*. Paper presented at the First International Conference on African Digital Libraries and Archives (ICADLA-1), Addis Ababa, Ethiopia. Retrieved September 25, 2021 from: https://wiredspace.wits.ac.za/handle/10539/8950?show=full

Mofijur, M., Fattah, I. R., Alam, M. A., Islam, A. S., Ong, H. C., Rahman, S. A., & Mahlia, T. M. I. (2021). Impact of COVID-19 on the social, economic, environmental and energy domains: Lessons learnt from a global pandemic. *Sustainable Production and Consumption, 26*, 343-359.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & Group, P. (2009). Preferred reporting items for systematic reviews and Meta-analyses: The prisma statement. *Annals of Internal Medicine*, *151*(4), 264–269.

Mohesh, G. (2019). PubMed Data Mining using AI-Based Qinsight Platform. *International Journal of Clinical and Experimental Physiology*, *6*(1), 33–34. doi:10.5530/ijcep.2019.6.1.8

Mojapelo, S. M. (2020). The internet access and use in public libraries in Limpopo Province, South Africa. *Public Library Quarterly*, *39*(3), 265–282. doi:10.1080/01616846.2019.1622980

Molteno, R. (2019). *Why African digital repositories for storing research writings are so important*. https://www.internationalafricaninstitute.org/repositories/why.html

Monyela, M. J. (2014). *Information seeking behaviour of postgraduate students: a study of Rhodes University and University of Fort Hare* [Unpublished MLIS thesis]. Department of Library and Information Science, University of Fort Hare, South Africa.

Monyela, M. J. (2019). *Cataloguing practices from creation to use: a study of Cape Town Metropolitan Public Libraries in Western Cape Province, South Africa [Unpublished PhD]*. Department of Information Studies, University of KwaZulu-Natal.

Mooketsi, B. E. (2020). Factors influencing adoption of institutional repositories in tertiary education institutions: Librarians' perspective. *Mosenodi Journal*, *23*(2), 21–40.

Moroz, M. (2018). Acceleration of digital transformation as a result of launching programs financed from public funds: Assessment of the implementation of the operational program digital Poland. *Foundations of Management*, *10*(1), 59–74. doi:10.2478/fman-2018-0006

Morris, M., Schindehutte, M., & Allen, J. (2005). The entrepreneur's business model: Towards a unified perspective. *Journal of Business Research*, *58*(6), 726–735. doi:10.1016/j.jbusres.2003.11.001

Moruf, H. A., & Dangani, B. U. (2020). Emerging Library Technology Trends in Academic Environment - An Updated Review. *TheScientificWorldJournal*, *15*(3). Advance online publication. doi:10.47514wj/15.03.2020.002

Mostafa, J. (2005). Seeking better web searches. *Scientific American*, *292*(2), 51–57. doi:10.1038cientificamerican0205-66 PMID:15715393

Mostow, J., & Beck, J. (2006). Some useful tactics to modify, map and mine data from intelligent tutors. *Natural Language Engineering*, *12*(2), 195–208. doi:10.1017/S1351324906004153

Motleno, R. (2016). Digital repositories – making Africa's intelligentsia visible? *Bulletin of the National Library of South Africa*, *70*(2). https://www.internationalafricaninstitute.org/downloads/Molteno-Making%20Africa's%20Intelligensia%20Visible.pdf

Moya, M., Musumba, I., & Akodo, R. (2011). Management attitude, support and integration of information communication technologies in higher education in Uganda. *Journal of Modern Accounting and Auditing*. http://ahero.uwc.ac.za/index.php?module=cshe&action=downloadfile&fileid=1840

Mpungose, C. B., & Khoza, S. B. (2020). Postgraduate students' experiences on the use of Moodle and Canvas learning management system. *Technology, Knowledge and Learning*, 1-16.

Msagati, N. (2016). Awareness and use of OPAC by distance learners: the case of the Open University of Tanzania. *Library Philosophy and Practice (e-journal)*, 1482.

Mtebe, J. (2014). *Acceptance and Use of eLearning Solutions in Higher Education in East Africa*. University of Tampere.

Muheidat, F., Patel, D., Tammisetty, S., Lo'ai, A. T., & Tawalbeh, M. (2022). Emerging Concepts Using Blockchain and Big Data. *Procedia Computer Science*, *198*, 15–22. doi:10.1016/j.procs.2021.12.206

Mukalele, R. (2019 October 24). *Manual vs electronic databases: Advantages, disadvantages and features*. https://bit.ly/376AMwx

Muraf, H. A., & Dangani, B. (2020). Emerging library technology trends in academic environment: An updated review. *TheScientificWorldJournal*, *15*(3), 13–18. https://www.researchgate.net/publication/344438404

Murano, F., Beretta, F., Niccoluci, F., & Bruseker, G. (2021). *49th joint meeting of the CIDOC CRM SIG and ISO/TC46/SC4/WG9; 42nd FRBR-CIDOC CRM Harmonization Meeting*. University of Oslo.

Musa, A. I., Gbaje, S. E., & Monsurat, M. F. (2015). Perceived attributes of Diffusion of Innovation Theory as a Theoretical Framework for understanding the non-digital library services. *Information and Knowledge Management*, *5*(9), 82–87. searchgate.net/publication/309479883

Mutsvunguma, G. (2019). *Institutional repositories as platforms for open access in South African universities: The case of University of KwaZulu-Natal* [PhD thesis]. School of Social Sciences, College of Humanities, University of KwaZulu-Natal, Pietermaritzburg, South Africa.

Mutsvunguma, G., & Hoskins, R. G. (2020). Use of the Institutional Repository by Academics at the University of KwaZulu-Natal", *Mousaion*. *South African Journal of Information Studies*, *38*(1).

Mutula, S. (2012). Library automation in sub-Saharan Africa: case study of the University of Botswana. *Programme: Electronic Library and Information Systems, 46*(3), 292-302. https://www.emeraldinsight.com/0033-0337.htm

Nagle, S. B. (2020). Maker Services in Academic Libraries: A Review of Case Studies. *New Review of Academic Librarianship*, 1–17.

Nahotko, M. (2020). OPAC development as the genre transition process, PART 1: OPAC generations historical development. *Annals of Library and Information Studies*, 107-117. http://eprints.rclis.org/40413/1/ALIS%2067%282%29%20107-117.pdf

Nahotko, M. (2020). OPAC development as the genre transition process, PART 1: OPAC generations historical development. *Annals of Library and Information Studies*, *67*(2), 107–117.

Naidu, Y., & Constable, T. (2016, April). Use of vodcasts by the UNISA Library for teaching and learning: Challenges, opportunities and lessons learned about this emerging technology. In *22nd Standing Conference of Eastern, Central and Southern Africa Library and Information Associations (SCECSAL XXII)* (pp. 125-131). Academic Press.

Natarajan, K., Nguyen, T.-H. D., & Mete, M. (2018). Hand Gesture Controlled Drones: An open-source library. *2018 1st International Conference on Data Intelligence and Security (ICDIS)*, 168–175. 10.1109/ICDIS.2018.00035

Nath, F. (2018). Library drone delivery programme: A Study. *DESIDOC Journal of Library and Information Technology*, *38*(5), 349–353. doi:10.14429/djlit.38.5.12892

National Research Foundation. (2015). *Statement on open access to research publications from the National Research Foundation (NRF) funded research*. https://www.nrf.ac.za/media-room/news/statement-open-access-research-publications-national-research-foundation-nrf-funded

Ndumbaro, F., & Kassim, M. (2021). The use of OPAC query logs to support evidence-informed information literacy (IL) training at The University of Dar es Salaam. *Information Development*. doi:10.1177/02666669211021619

Newton, M. P., Miller, C. C., & Bracke, M. S. (2010). Librarian roles in institutional repository data set collecting: Outcomes of a research library task force. *Collection Management*, *36*(1), 53–67. doi:10.1080/01462679.2011.530546

Ngoepe, M., & Katuu, S. (2017). Provision of Records Created in Networked Environments in the Curricula of Institutions of Higher Learning in Africa. *New Review of Information Networking*, *22*(1), 1–12. doi:10.1080/13614576.2017.1297731

Ngozi, A. S. (2020). Library Automation in University: a literature review. *Predestinasi, 13*(2), 115-134. Available at: https://ojs.unm.ac.id/predistinasi/article/view/21934

Ngulube, P. (2015). Trends in research methodological procedures used in knowledge management studies. *African Journal of Library Archives and Information Science*, *25*(2), 125–143.

Ngulube, P. (2018). Overcoming the difficulties associated with using conceptual and theoretical frameworks in heritage studies. In P. Ngulube (Ed.), *Handbook of research on heritage management and preservation*. IGI Global. doi:10.4018/978-1-5225-3137-1.ch001

Nguyen, H. S. (2005, August). Approximate Boolean reasoning approach to rough sets and data mining. In D. Ślęzak, J. T. Yao, J. F. Peters, W. Ziarko, & X. Hu (Eds.), *Rough sets, fuzzy sets, data mining, and granular-soft computing* (pp. 12–22). Springer. doi:10.1007/11548706_2

Nichols Hess, A. (2020). Academic Librarians' Teaching Identities and Work Experiences: Exploring Relationships to Support Perspective Transformation in Information Literacy Instruction. *Journal of Library Administration*, *60*(4), 331–353. doi:10.1080/01930826.2020.1721939

Nicholson, S. (2006). The basis for bibliomining: Frameworks for bringing together usage-based data mining and bibliometrics through data warehousing in digital library services. *Information Processing & Management*, *42*(3), 785–804. doi:10.1016/j.ipm.2005.05.008

Niemiec, C. P., & Ryan, R. M. (2009). Autonomy, competence, and relatedness in the classroom: Applying self-determination theory to educational practice. *Theory and Research in Education*, *2009*(7), 133–144. doi:10.1177/1477878509104318

Nilsson, M. (2010). From interoperability to harmonization in metadata standardization: designing an evolvable framework for metadata harmonization [Unpublished PhD]. School of Computer Science and Communication, KTH, Stockholm.

Nitecki, D. A., Franklin, B., Nitecki, D. A., & Franklin, B. (1999). New measures for research libraries. *Journal of Academic Librarianship*, *25*(6), 484–487. doi:10.1016/S0099-1333(99)00084-1

Niu, J. (2020). Diffusion and adoption of linked data among libraries. *Proceedings of the Association for Information Science and Technology*, *57*(1), 1–9. doi:10.1002/pra2.216

Nordling, L. (2018). *What is Africa's real share of global science?* http://www.sun.ac.za/scistip/news/what-does-africa-contribute

Ntshuntshe-matshaya, P. P. (2019). Investigating the Relevance of Quality Measurement Indicators for South African Higher Education Libraries [Doctor of Philosophy]. University of the Western Cape.

Ntui, A. I., Robert, B. E., & Usang, E. I. (2017). Economic challenges and prospects associated with the utilization of Information and Communication Technology (ICT) for library services in universities in Cross River State Nigeria. *Computing and Information Systems*, *21*(1), 29–39.

Nwagwu, W. E. (2013). Open access initiatives in Africa-structure, incentives and disincentives. *Journal of Academic Librarianship*, *39*(1), 3–10. doi:10.1016/j.acalib.2012.11.024

Nyahodza, L., & Higgs, R. (2017). Towards bridging the digital divide in post-apartheid South Africa: A case of a historically disadvantaged university in Cape Town. *SA JnL Libs & Info Sci*, *83*(1), 39–48. doi:10.7553/83-1-1645

O'Neil, F., & Pegrum, M. (2018). Keeping up the momentum: A longitudinal evaluation of professional development in digital technologies for academic librarians at an Australian university. *Journal of Academic Librarianship*, *44*(4), 439–445. doi:10.1016/j.acalib.2018.05.009

Ocholla, L., & Ocholla, D. (2017). *The changing library and information research landscape: an analysis of Library and Information Science Research in South Africa by LIS academics in the last decade (2007-2016).* Academic Press.

Ocholla, D., & Shongwe, M. (2013). An analysis of the library and information science (LIS) job market in South Africa. *South African Journal of Library and Information Science*, *79*(1), 35–43. https://sajlis.journals.ac.za/pub/article/view/113/122

OCLC. (2017a). *OCLC and linked data*. Available at: https://www.oclc.org/content/dam/oclc/services/brochures/215912_WWAE-OCLC-Linked-Data-Report.pdf

OCLC. (2017b). *WorldCat Work Descriptions* [White paper]. Available at: https://www.oclc.org/developer/develop/linked-data/worldcat-entities/worldcat-work-entity.en.html

Ödalen, J., Brommesson, D., Erlingsson, G. Ó., Schaffer, J. K., & Fogelgren, M. (2019). Teaching university teachers to become better teachers: The effects of pedagogical training courses at six Swedish universities. *Higher Education Research & Development*, *38*(2), 339–353. doi:10.1080/07294360.2018.1512955

Odigwe, F. N., Bassey, B. A., & Owan, V. J. (2020). Data management practices and educational research effectiveness of university lecturers in South-South Nigeria. *Journal of Educational and Social Research*, *10*(3), 24–34. doi:10.36941/jesr-2020-0042

Okello-Obura, C. (2009). Positioning of Records and Archives education in Uganda: An analysis of the trend. *ESARBICA Journal*, *28*, 172–195.

Okon, A. E., & Ubi, I. O. (2021). Awareness and utilisation of *PsyArXiv* for the dissemination of research preprints among psychology scholars in universities. *Library Philosophy and Practice (e-journal),* Article 5870. https://digitalcommons.unl.edu/libphilprac/5870

Okunlaya, R. O., Abdullah, N. S., & Alias, R. A. (2022). Artificial intelligence (AI) library services innovative conceptual framework for the digital transformation of university education. *Library Hi Tech*. Advance online publication. doi:10.1108/LHT-07-2021-0242

Oladokun. (Ed.). (n.d.). *Open Access Implications for Sustainable Social, Political, and Economic Development.* Hershey, PA: IGI Global.

Olson, H. A., Boll, J. J., & Aluri, R. (2001). *Subject analysis in online catalogs*. Libraries Unlimited.

Omame, I. M., & Alex-Nmecha, J.C. (2020). Artificial Intelligence in Libraries In book: Managing and adapting library information services for future users. Hershey, PA: IGI Global.

Omame, I. M., & Alex-Nmecha, J. C. (2020). Artificial intelligence in libraries. In N. E. Osuigwe (Ed.), *Managing and adapting library information services for future users* (pp. 120–144). IGI Global. doi:10.4018/978-1-7998-1116-9.ch008

Omar Saib, M., Rajkoomar, M., Naicker, N., & Olugbara, C. T. (2022). Digital pedagogies for librarians in higher education: a systematic review of the literature. *Information Discovery and Delivery*.

Omeluzor, S. U., & Oyovwe-Tinuoye, G. O. (2016). Assessing the adoption and use of integrated library systems (ILS) for library service provision in academic libraries in Edo and Delta states, Nigeria. *Library Review*, *65*(8–9), 578–592. https://www.emerald.com/insight/content/doi/10.1108

Omosebi, F. E., & Bakare, O. D. (2022). Makerspace: An innovative inclusion in Nigerian libraries. In I. I. Ekoja, E. F. Ogbomo, & O. Okuonghae (Eds.), *Handbook of research on emerging trends and technologies in librarianship* (pp. 143–158). IGI Global. doi:10.4018/978-1-7998-9094-2.ch010

Omotayo, F. O., & Haliru, A. (2020). Perception of task-technology fit of digital library among undergraduates in selected universities in Nigeria. *Journal of Academic Librarianship*, *46*(1), 102097. doi:10.1016/j.acalib.2019.102097

Ong, P. M. (2020). *Covid-19 and the digital divide in virtual learning, fall 2020*. UCLA Centre for Neighborhood Knowledge.

Onyancha, O. B. (2018). Navigating the rising metrics tide in the 21st century: Which way for academic librarians in support of researchers in sub-Saharan Africa? *South African Journal of Library and Information Science*, *84*(2), 1–13. doi:10.7553/84-2-1762

OpenDOAR. (2021). https://v2.sherpa.ac.uk/opendoar

Organisation for Economic Co-operation and Development (OECD). (2019). *Development aid statistics at a glance, Statistics by region, Africa*. https://www.oecd.org/dac/ financing-sustainable-development/development-financedata/Africa-Development-Aid-at-a-Glance-2019.pdf

Orhan, M. S., & Ozkan, T. S. (2014). Writing references and using citation management software. *Türk Üroloji Dergisi. Turkish Journal of Urology*, *39*(1), 25–32. doi:10.5152/tud.2013.050

Orji, S., & Anyira, I. E. (2021). What is "Smart" About Smart Libraries? *International Journal of Research in Library Science*, *7*(4), 265–271. doi:10.26761/IJRLS.7.4.2021.1482

Osterwalder, A. (2004). *The business model ontology a proposition in a design science approach* [PhD]. Lausanne.

Osterwalder, A., & Pigneur, Y. (2010). *Business model generation*. John Wiley & Sons.

Osterwalder, A., Pigneur, Y., & Tucc, I. L. C. (2005). Clarifying business models: Origins, present, and future of the concept. *Communications of the Association for Information Systems*, *16*, 1–25. doi:10.17705/1CAIS.01601

Owan, V. J., Asuquo, M. E., Ekaette, S. O., Aslam, S., Obla, M. E., & Owan, M. V. (2021). Gender, age and staff preparedness to adopt Internet tools for research sharing during Covid-19 in African varsities. *Library Philosophy and Practice (e-Journal),* Article 6133. https://digitalcommons.unl.edu/libphilprac/6133

Owan, V. J., Asuquo, M. E., Makuku, V., & Etudor-Eyo, E. (2021). The extent of online platforms utilisation for scholarly research dissemination: A survey of academic staff in African Universities. *Library Philosophy and Practice (e-Journal),* Article 5585. https://digitalcommons.unl.edu/libphilprac/5585

Owan, V. J., Asuquo, M. E., Makuku, V., & Etudor-Eyo, E. (2021). The extent of online platforms utilization for scholarly research dissemination: A survey of academic staff in African Universities. *Library Philosophy and Practice (e-Journal),* Article 5585. https://digitalcommons.unl.edu/libphilprac/5585

Owan, V. J., Uzoamaka Duruamaku-Dim, J., Nonyelum Odigwe, F., & Owan, M. V. (2022). Dataset of the adoption of digital tools for research sharing among academics in African Varsities during the COVID-19 pandemic in 2020. *F1000Research, 11*, Article 82. doi:10.12688/f1000research.54245.3

Owan, V. J., & Asuquo, M. E. (2021). Assessment of socio-demographic factors and students' satisfaction with the study of ICT in secondary schools. *Pedagogical Research*, *6*(3), em0101. Advance online publication. doi:10.29333/pr/11087

Owan, V. J., & Bassey, B. A. (2019). Data management practices in Educational Research. In P. N. Ololube & G. U. Nwiyi (Eds.), *Encyclopedia of institutional leadership, policy, and management: A handbook of research in honour of Professor Ozo-Mekuri Ndimele* (Vol. 2, pp. 1251–1265). Pearl Publishers International Ltd. doi:10.13140/RG.2.2.16819.04647

Oyedemi, T. (2015). Internet access as citizen's right? Citizenship in the digital age. *Citizenship Studies*, *19*(3-4), 450–464. doi:10.1080/13621025.2014.970441

Oyelude, A. A. (2016). What's trending in libraries from the internet cyber sphere-bookless libraries? *Library Hi Tech News*, *33*(6), 19–20. doi:10.1108/LHTN-06-2016-0027

Padhi, S., & Nahak, B. (2019). *The Role of Smart Library and Smart Librarian for E-Library Services*. INFLIBNET Centre. http://ir.inflibnet.ac.in/handle/1944/2338

Padilla, T. G. (2018). Collections as data: Implications for enclosure. *College & Research Libraries News*, *79*(6), 296. doi:10.5860/crln.79.6.296

Panda, S. (2021). Usefulness and impact of big data in libraries: An opportunity to implement embedded librarianship. *Technological Innovations & Environmental Changes in Modern Libraries*, 45-60. 10.31235/ doi:osf.io/fsau9

Panda, S. K., Mohapatra, R. K., Panda, S., & Balamurugan, S. (2022). *The New Advanced Society: Artificial Intelligence and Industrial Internet of Things Paradigm*. John Wiley & Sons. doi:10.1002/9781119884392

Pandita, R., & Ramesha, B. (2013). Global scenario of open access publishing: A decadal analysis of Directory of Open Access Journals (DOAJ) 2003-2012. *Journal of Information Science Theory and Practice*, *1*(3), 47–59. doi:10.1633/JISTaP.2013.1.3.4

Panitch, J. M., & Michalak, S. (2005). *The serials crisis*. A White Paper for the UNC-Chapel Hill Scholarly Communications Convocation. https://www.unc.edu/scholcomdig/whitepapers/panitch-michalak.html

Park, J. R., Brenza, A., & Richards, L. (2020). BIBFRAME linked data: a conceptual study on the prevailing content standards and data model. In Linked Open Data-Applications, Trends and Future Developments. IntechOpen. doi:10.5772/intechopen.91849

Parramore, S. (2019). Online active-learning: Information literacy instruction for graduate students. *RSR. Reference Services Review*, *47*(4), 476–486. doi:10.1108/RSR-03-2019-0022

Pateli, A., & Giaglis, G. M. (2004). A research framework for analysing e-business models. *European Journal of Information Systems*, *13*(4), 302–314. doi:10.1057/palgrave.ejis.3000513

Paul, K. (2014). Social networking: A powerful tool for the LIS professionals in the digital era. *Asian Journal of Multidisciplinary Studies*, *2*(6), 82–87.

Pazhaniraja, N., Sountharrajan, S., & Sathis Kumar, B. (2020). High utility itemset mining: A Boolean operators-based modified grey wolf optimisation algorithm. *Soft Computing*, *24*(21), 16691–16704. doi:10.100700500-020-05123-z

Pedró, F., Subosa, M., Rivas, A., & Valverde, P. (2019). *Artificial Intelligence in Education: Challenges and Opportunities for Sustainable Development*. UNESCO.

Pérez, J., Arenas, M., & Gutierrez, C. (2009). Semantics and complexity of SPARQL. *ACM Transactions on Database Systems*, *34*(3), 1–45. doi:10.1145/1567274.1567278

Petrovic, O., Kittl, C., & Teksen, R. D. (2001). Developing business models for ebusiness. *International Conference of Electronic Commerce*.

Phillips, L. L. (2010). Coming home: scholarly publishing returns to the university. *Library Publications and Other Works*. https://trace.tennessee.edu/utk_libfpubs/33

Phiri, J. M., & Tough, G. A. (2018). Managing university records in the world of governance. *Records Management Journal*, *28*(1), 47–61. doi:10.1108/RMJ-11-2016-0042

Pho, T. H., & Tambo, T. (2014). Integrated Management Systems and Workflow- Based Electronic Document Management: An Empirical Study. *Journal of Industrial Engineering and Management*, *7*(1), 194–217. doi:10.3926/jiem.846

Picciano, A. G. (2017). Theories and frameworks for online education: Seeking an integrated model. *Online Learning*, *21*(3), 166–190. doi:10.24059/olj.v21i3.1225

Piniel, K., & Csizér, K. (2013). L2 motivation, anxiety and self-efficacy: The interrelationship of individual variables in the secondary school context. *Studies in Second Language Learning and Teaching*, *3*(4), 523–550. doi:10.14746sllt.2013.3.4.5

Pinto, M., & Leite, C. (2020). Digital technologies in support of students learning in Higher Education: Literature review. *Digital Education Review*, *37*(37), 343–360. doi:10.1344/der.2020.37.343-360

Plasmeijer, H. W. (2002). Pricing the serials library: In defense of a market economy. *Journal of Economic Methodology*, *9*(3), 337–357. doi:10.1080/13501780022000015131

Polding, R. (2018, August 31). *Databases: Evolution and change*. https://bit.ly/3E1Oyg7

Ponelis, S. R., & Adoma, P. (2018). Diffusion of open-source integrated library systems in academic libraries in Africa: The case of Uganda. *Library Management*, *39*(6–7), 430–448. https://www.emerald.com/insight/content/doi/10.1108/LM-05-2017-0052/full/pdf?title=diffusion-of-open-source-integrated-library-systems-in-academic-libraries-in-africa-the-case-of-uganda

Potnis, D., Deosthali, K., Cortez, E., & Allard, S. (2016). Skills and Knowledge Needed to Serve as Mobile Technology Consultants for Information Organizations. *Journal of Education for Library and Information Science*, *57*(2), 187–196.

Prabhakar, S. V. R., & Manjula Rani, S. V. (2017). Benefits and perspectives of institutional repositories in academic libraries. *Scholarly Research Journal for Humanity Science & English Language*, *5*(25), 6904–6909.

Prakash, A., & Ambekar, S. (2020). Digital transformation using blockchain technology in the construction industry. *Journal of Information Technology Case and Application Research*, *22*(4), 256–278. doi:10.1080/15228053.2021.1880245

Prasad, S. (2017). *Modern Technologies for Reshaping Libraries in the Digital Era.* GRIN Verlag. https://www.grin.com/document/367578

Priestley, M., & Biesta, G. (2013). *Reinventing the Curriculum: New Trends in Curriculum Policy and Practice*. Bloomsbury Academic. doi:10.5040/9781472553195

Pujar, S. M., & Satyanarayana, K. V. (2015). Internet of Things and libraries. *Annals of Library and Information Studies*, *62*, 186–190.

Qin, J. (2018, May). The research of the library services based on the Internet of things. In *4th International Symposium on Social Science*. Atlantis Press. 10.2991/isss-18.2018.83

Rabatseta, B., Maluleka, J. R., & Onyancha, O. B. (2021). *Adoption and use of social media in academic libraries in South Africa*. https://sajlis.journals.ac.za/pub/article/view/1926/1536

Rahimi, S. K., & Haug, F. S. (2010). *Distributed database management systems: A Practical Approach*. John Wiley & Sons. doi:10.1002/9780470602379

Raju, J. (2014). Knowledge and skills for digital era academic library. *Journal of Academic Librarianship*, *40*(2), 163–170. https://www.sciencedirect.com/science/article/pii/S009913331400024X

Raju, J. (2014). Knowledge and skills for the digital era academic library. *Journal of Academic Librarianship*, *40*(2), 163–170. doi:10.1016/j.acalib.2014.02.007

Raju, J. (2017). To teach or not to teach? The question of the academic librarian & pedagogical competencies in the digital age. *South African Journal of Higher Education*, *31*(2), 251–269. doi:10.20853/31-2-1096

Raju, R., Raju, J., & Claassen, J. (2015). Open scholarship practices reshaping South Africa's scholarly publishing roadmap. *Publications*, *3*(4), 263–284. doi:10.3390/publications3040263

Ranking Web of Repositories. (2021). *Transparent ranking: Institutional repositories by Google Scholar*. https://www.repositories.webometrics.inf/en/node/32

Rasuli, B., Alipour-hafezi, M., & Solaimani, H. (2018). Analyzing national electronic theses and dissertations programs from business model perspective: Cross-case analysis. *Online Information Review*, *42*(2), 250–267. doi:10.1108/OIR-08-2016-0223

Rawat, D. B., Chaudhary, V., & Doku, R. (2021). Blockchain technology: Emerging applications and use cases for secure and trustworthy smart systems. *Journal of Cybersecurity and Privacy*, *1*(1), 4–18. doi:10.3390/jcp1010002

Raza, Z., Mahmood, K., & Warraich, N. F. (2019). Application of linked data technologies in digital libraries: A review of literature. *Library Hi Tech News*, *3*(3), 9–12. doi:10.1108/LHTN-10-2018-0067

RDA Toolkit. (2020). *Resource Description and Access*. Available at: https://access.rdatool kit.org

Reddy, P. R. (2017). Measuring of quality services in the libraries. *International Journal of Library and Information Studies*, *7*, 144–149.

Reed, K. N., Kester, B., Kaufmann, K. F., Homol, L., & Crampsie, C. (2022). Crisis Librarianship: An Examination of Online Librarianship Roles in the Wake of the COVID-19 Pandemic. *Journal of Academic Librarianship*, *48*(4), 102530. doi:10.1016/j.acalib.2022.102530 PMID:35431354

Registry of Open Access Repositories (ROAR). (2021). http://roar.eprints.org/view/geoname

Renold, A. P., & Rani, R. J. (2013). An internet-based RFID library management system. In *Proceedings of 2013 IEEE Conference on Information and Communication Technologies*. IEEE. 10.1109/CICT.2013.6558229

Richardson, J. (2008). The business model: An integrative framework for strategy execution. *Strategic Change*, *17*(5-6), 133–144. doi:10.1002/jsc.821

Ritesh Chugh, R. G. (2021). Social media usage by higher education academics: A scoping review of the literature. *Education and Information Technologies*, *26*(1), 983–999. doi:10.100710639-020-10288-z

Riva, P., & Žumer, M. (2015). *Introducing the FRBR Library Reference Model*. Paper presented at: IFLA WLIC 2015, Cape Town, South Africa.

Riva, P., & Žumer, M. (2018). *FRBRoo, the IFLA Library Reference Model, and now LRMoo: a circle of development.* Paper presented at IFLA WLIC 2018, Kuala Lumpur, Malaysia.

Rof, A., Bikfalvi, A., & Marques, P. (2022). Pandemic-accelerated digital transformation of a born digital Higher Education Institution: Towards a customized multimode Learning strategy. *Journal of Educational Technology & Society*, 25.

Rogers, E. M. (2003). *Diffusion of Innovations* (5th ed.). Free Press.

Roller, M. R., & Lavrakas, P. J. (2015). *Applied qualitative research design: A total quality framework approach*. Guilford Press.

Romero, C., & Ventura, S. (2012). Data mining in education. *Wiley Interdisciplinary Reviews. Data Mining and Knowledge Discovery*, *3*(1), 12–27. doi:10.1002/widm.1075

Romero, C., Ventura, S., Pechenizkiy, M., & Baker, R. S. (Eds.). (2010). *Handbook of educational data mining*. CRC Press. doi:10.1201/b10274

Rosa, C. A., Craveiro, A., & Dominques, P. (2017). Open source software for digital preservation repositories: A survey. *International Journal of Computer Science & Engineering Survey*, *8*(3), 21–39. doi:10.5121/ijcses.2017.8302

Rose, J., Holgersson, J., & Soderstrom, E. (2019). Designing innovative digital services for government: A business model canvas adaptation. In *27th European Conference on Information Systems (ECIS)*. Association for Information Systems.

Rotich, D. C. (2011). The present and future growth of scholarly publishing in Africa. Inkanyiso. *Journal of the Humanities and Social Sciences*, *3*(2).

Rout, R., & Panigrahi, P. (2018). Online Public Access Catalogue (OPAC) usage patterns among the library users of Odisha: A study. *International Journal of Library and Information Science*, *7*(1), 28–34. doi:10.34218/IJLIS.7.1.2018.005

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *The American Psychologist*, *55*(1), 68–78. doi:10.1037/0003-066X.55.1.68 PMID:11392867

Saha, P. (2018). *Top skills required for digital transformation*. HRKatha. https://www.hrkatha.com/special/learn-engage-transform/top-skills-required-for-digitaltransformation

Saibakumo, W. T. (2021). Awareness and acceptance of emerging technologies for extended information service delivery in academic libraries in Nigeria. *Library Philosophy and Practice (e-journal),* 5266. https://digitalcommons.unl.edu/libphilprac/5266

Saloi, A. (2021). Drone in libraries for document delivery: Flying documents. *Library Philosophy and Practice (e-journal),* Article 4599. https://digitalcommons.unl.edu/libphilprac/4599

Saloi, A. (2021). Drone in libraries for document Delivery: Flying documents. *Library Philosophy and Practice (e-journal),* Article 4599. https://digitalcommons.unl.edu/libphilprac/4599

Sambuli, N. (2016). Challenges and opportunities for advancing Internet access in developing countries while upholding net neutrality. *Journal of Cyber Policy*, *1*(1), 61–74. doi:10.1080/23738871.2016.1165715

Sam, C., Naicker, N., & Rajkoomar, M. (2020). Meta-Analysis of Artificial Intelligence Works in Ubiquitous Learning Environments and Technologies. *International Journal of Advanced Computer Science and Applications*, *11*(9). https://thesai.org/Downloads/Volume11No9/Paper_71-Meta_Analysis_of_Artificial_Intelligence_Works.pdf

San, S. M., & Nyunt, K. Z. (2010). *Implementation of library system using vertical fragmentation method in a distributed database*. http://onlineresource.ucsy.edu.mm/handle/123456789/1127

Santos, M. C. (2020). Libraries respond to COVID-19. *Texas Library Journal, 96*(2), 64-70, 72-73.

Sappington, J., & Bedford, D. A. (2017). Assessment of intellectual capital of library and information professionals. *Proceedings of the Association for Information Science and Technology*, *54*(1), 798–799. doi:10.1002/pra2.2017.14505401161

Sarfraz, Z., Sarfraz, A., Iftikar, H. M., & Akhund, R. (2021). Is covid-19 pushing us to the fifth industrial revolution (Society 5.0)? *Pakistan Journal of Medical Sciences*, *37*(2), 591. doi:10.12669/pjms.37.2.3387 PMID:33679956

Sarmah, S. S. (2018). Understanding Blockchain Technology. *Computing in Science & Engineering*, *8*(2), 23–29. doi:10.5923/j.computer.20180802.02

Scale, M. E. (2010). Assessing the Impact of Cloud Computing and Web Collaboration on the Work of Distance Library Services. *Journal of Library Administration*, *50*(7/8), 933–950. doi:10.1080/01930826.2010.488995

Scalzo, C. (2019). *Challenges of implementing new technology and how to address them*. Online Computers. https://www.onlinecomputers.com/2019/01/challenges-of-implementing-new-technology-and-how-to-address-them

Schina, B., & Wells, G. (2002). University Archives and Records Programs in the United States and Canada. *Archival Issues*, *27*(1), 35–51.

Schlak, T. (2020). Futures Thinking and Library Leadership. *Journal of Library Administration*, *60*(8), 945–950. doi:10.1080/01930826.2020.1820280

Scott, L. (2019). *Technology Integration with Teacher Educators*. Academic Press.

Selwyn, N. (2016). *Is technology good for education?* John Wiley & Sons.

SenseTime. (2018). Fundamentals of Artificial Intelligence. East China Normal University.

Shahbazi, R., & Hedayati. (2013). Identifying digital librarian competencies according to the analysis of newly emerged IT-based LIS in 2013. *The Journal of Academic Librarianship, 42*(5), 542-550. https://www.sciencedirect.com/science/article/pii/S0099133316300957

Shahbazi, R., & Hedayati, A. (2016). Identifying digital librarian competencies according to the analysis of newly emerging IT-based LIS jobs in 2013. *Journal of Academic Librarianship*, *42*(5), 542–550. doi:10.1016/j.acalib.2016.06.014

Shahnaz, A., Qamar, U., & Khalid, A. (2019). Using blockchain for electronic health records. *IEEE Access: Practical Innovations, Open Solutions*, *7*, 147782–147795. doi:10.1109/ACCESS.2019.2946373

Shank, J. D., Bell, S., & Zabel, D. (2011). Blended librarianship: [Re] envisioning the role of librarian as educator in the digital information age. *Reference and User Services Quarterly*, *51*(2), 105–110. doi:10.5860/rusq.51n2.105

Sharifabadi, S. R. (2006). How digital libraries can support e-learning. *The Electronic Library*.

Shashikumara, A. A., Manu, T. R., & Panna Chaudhary, V. A. (2019). Emerging technology trends for libraries and library professionals. *Librarianship Development Through the Internet of Things and Customer Service (LDITCS),* 75. https://www.librarianshipstudies.com/2019/08/emerging-trends-technologies-in-library.html

Shastri, D. K., & Chudasma, P. (2021). The perception of ICT skills and challenges of usage of technologies among the library professionals of the Gujarat State during the COVID 19: A comprehensive study. *Quality & Quantity*. Advance online publication. doi:10.100711135-021-01167-x PMID:34054149

Shearer, K. (2015). Comprehensive brief on research data management policies. Academic Press.

Shearer, M.K. (2003). Institutional repositories: towards the identification of critical success factors. *Canadian Journal of Information and Library Science – Revue Canadienne des Sciences de l'Information et de Bibliotheconomie, 27*(3), 89-108.

Sheriff, A., Bouchlaghem, D., El-Hamalawi, A., & Yeomans, S. (2012). Information Management in UK-Based Architecture and Engineering Organisations: Drivers, Constraining Factors and Barriers. *Journal of Management Engineering*, *28*(2), 170–180. doi:10.1061/(ASCE)ME.1943-5479.0000085

Shimray, S. R., & Ramaiah, C. K. (2018). Digital preservation strategies: An overview. *Proceedings of 11th national conference on recent advances in information technology*.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, *15*(2), 4–14. doi:10.3102/0013189X015002004

Si, L., Zeng, Y., Guo, S., & Zhuang, X. (2019). Investigation and analysis of research support services in academic libraries. *The Electronic Library*, *37*(2), 281–301. doi:10.1108/EL-06-2018-0125

Siler, K. (2017). Future challenges and opportunities in academic publishing. *Canadian Journal of Sociology/Cahiers Canadiens de Sociologie, 42*(1), 83-114.

Singh, K., & Nikandia, P. (2017). Role of Mobile Technology and their Application in Library Services in Digital era. *International Research: Journal of Library & Information Science*, *7*(1), 157–166.

Singh, M. P., Lata, N., & Sonkar, S. K. (2022). *Transformative technologies for libraries*. Ess Ess Publication.

Sithole, N. (2012). *Government has a duty to enrich school libraries*. The Standard.

Sleegers, P., den Brok, P., Verbiest, E., Moolenaar, N. M., & Daly, A. J. (2013). Toward conceptual clarity: A multidimensional, multilevel model of professional learning communities in Dutch elementary schools. *The Elementary School Journal*, *2013*(114), 118–137. doi:10.1086/671063

Smith, C. (2021). *Blockchain Reaction: How library professionals are approaching blockchain technology and its potential impact*. Available from https://americanlibrariesmagazine.org/2019/03/01/library-blockchain-reaction/

Snowball, C. (2008). Enticing teenagers into the library. *Library Review*, *57*(1), 25–35. doi:10.1108/00242530810845035

Sobel, K., & Grotti, M. G. (2013). Using the TPACK Framework to facilitate decision-making on instructional technologies. *Journal of Electronic Resources Librarianship*, *25*(4), 255–262. doi:10.1080/1941126X.2013.847671

Sompel, H. V. D., Payette, S., Erickson, J., Lagoze, C., & Warner, S. (2004). Rethinking scholarly communication: Building the system that scholars deserve. *D-Lib Magazine: the Magazine of the Digital Library Forum*, *2004*(10), 9.

Sousa, M. J., & Rocha, Á. (2018). Digital learning: Developing skills for the digital transformation of organisations. *Future Generation Computer Systems*, *91*, 327–334. doi:10.1016/j.future.2018.08.048

South Africa. (2021). Statistics on Post-School Education and Training in South Africa: 2019. Pretoria, South Africa: Department of Higher Education and Training.

Spowart, L., Winter, J., Turner, R., Muneer, R., McKenna, C., & Kneale, P. (2017). Evidencing the impact of teaching-related CPD: Beyond the ‘happy sheets’. *The International Journal for Academic Development*, *22*(4), 360–372. doi:10.1080/1360144X.2017.1340294

Sprochi, A. (2016). Where are we headed? Resource description and access, bibliographic framework, and the functional requirements for bibliographic records library reference model. *The International Information & Library Review*, *48*(2), 129–136. doi:10.1080/10572317.2016.1176455

Stephen, M. M. (2014). Status of digital heritage preservation management in Eastern Africa. *The Electronic Library*, *32*(3), 363–374. doi:10.1108/EL-01-2013-0003

Stewart, M., & Morrison, C. (2016). Breaking ground: Consortia migration to a next-generation ILS and its impact on acquisitions and workflows. *Library Resources & Technical Services*, *60*(4), 259–269. https://journals.ala.org/index.php/lrts/article/view/6137/7932

Stiwinter, K. (2013). Using an interactive online tutorial to expand library instruction. *Internet Reference Services Quarterly*, *18*(1), 15–41. doi:10.1080/10875301.2013.777010

Sugimoto, C. R., Ding, Y., & Thelwall, M. (2012). Library and information science in the Big Data era: Funding, projects, and future. *Proceedings of the American Society for Information Science and Technology*, *49*(1), 1–3. doi:10.1002/meet.14504901187

Suna, J., & Yuanb, B. (2012). Development and characteristics of the digital library as a library branch. *IERI Procedia*, *2*, 12–17. doi:10.1016/j.ieri.2012.06.044

Sutton-Brady, C., Scott, K. M., Taylor, L., Carabetta, G., & Clark, S. (2009). The value of using short-format podcasts to enhance learning and teaching. *ALT-J*, *17*(3), 219–232. doi:10.1080/09687760903247609

Svard, P. (2013). Enterprise Content Management and the Records Continuum Model as strategies for long-term preservation of digital information. *Records Management Journal*, *23*(3), 159–176. doi:10.1108/RMJ-12-2012-0035

Swaminathan, K. S. M. (2017). Use and awareness of Online Public Access Catalogue (OPAC) by students and faculty members of Anna University Regional Campus, Coimbatore, Tamil Nadu-A Case Study. *International Journal of Scientific Research and Management*, *5*(05), 5345–5349. doi:10.18535/ijsrm/v5i5.11

Swan, A. (2008). *The business of digital repositories*. Available: http://citeseerx.ist.psu.edu/viewdoc/download?doi:10.1.1.170.1389&rep=rep1&type=pdf

Swan, A., Willmers, M., & King, T. (2014). *Opening access to Southern African research: recommendations for university managers.* Scholarly Communication in Africa Programme Brief 4. http://openuct.uct.ac.za/sites/default/files/media/SCAP_Brief_4_Swan_et_al_Opening_Access.pdf

Swanson, D. M., & Pashby, K. (2016). Towards critical global citizenship? A comparative analysis of GC education discourses in Scotland and Alberta. *J. Res. Curric. Instr.*, *20*, 184–195.

Szeto, K. (2017). The Mistry of the Schurbet Song: The linked data promise. *Notes*, *74*(1), 9–23. doi:10.1353/not.2017.0071

Tang, Y., & Tseng, H. W. (2013). Distance Learners' Self-Efficacy and Information Literacy Skills. *Journal of Academic Librarianship*, *39*(6), 517–521. doi:10.1016/j.acalib.2013.08.008

Tan, L., Shi, N., Yu, K., Aloqaily, M., & Jararweh, Y. (2021). A Blockchain-empowered access control framework for smart devices in green Internet of things. *ACM Transactions on Internet Technology*, *21*(3), 1–20. doi:10.1145/3433542

Tanner, S. (2009). The economic future for digital libraries: a 2020 vision. *Digital library economics: An academic perspective,* 291-309.

Tapfuma, M. M., & Hoskins, R. G. (2019a). Attitudes of scholars towards self-archiving in institutional repositories of Zimbabwe's public universities. *Mousaion*. *South African Journal of Information Studies*, *37*(4).

Tapfuma, M. M., & Hoskins, R. G. (2019b). Usage of institutional repositories in Zimbabwe's public universities. *South African Journal of Information Management*, *21*(1), a1039. doi:10.4102ajim.v21i1.1039

Tapfuma, M. M., & Hoskins, R. G. (2020). Challenges for establishment of institutional repositories: The case of Zimbabwe's university libraries. In P. Jain, N. Mnjanma, & O. Oladokun (Eds.), *Open access implications for sustainable development*. IGI Global Publishing.

Tella, A., Bajeh, A. O., Titilola, O. O., & Ayodeji, A. Y. (2020). Librarians and Information Professionals Skills Need for Sustainability at the Advanced Information Technology Era. *Proceedings of the 2nd International Conference on ICT for National Development and Its Sustainability, Faculty of Communication and Information Sciences, University of Ilorin, Ilorin, Nigeria - 2021*. https://www.ijipc.com.ng/index.php/ijipc/article/view/513/281

Tella, A. (2020). Repackaging LIS professionals and libraries for the fourth industrial revolution. *Library Hi Tech News*, *37*(8), 1–6. doi:10.1108/LHTN-02-2020-0016

Tennant, J. P., Waldner, F., Jacques, D. C., Masuzzo, P., Collister, L. B., & Hartgerink, C. H. J. (2016). The academic, economic and societal impacts of Open Access: An evidence-based review. *F1000 Research*, *5*, 632. doi:10.12688/f1000research.8460.3 PMID:27158456

Thanos, C. (2017). Research data reusability: Conceptual foundations, barriers and enabling technologies. *Publications*, *5*(1), 2. doi:10.3390/publications5010002

The American Library Association (ALA). (2021). *2021 State of Americas' Libraries: special report: Covid 19*. ALA.

The Elsevier Foundation. (2014, June 24). *National digital repository building project kick-off meeting conducted in Addis Ababa.* The Elsevier Foundation. https://elsevierfoundation.org/national-digital-repository-building-project-kick-off-meeting-conducted-in-addis-ababa

Thelwall, M. (2017). Microsoft Academic: A multidisciplinary comparison of citation counts with Scopus and Mendeley for 29 journals. *Journal of Informetrics*, *11*(4), 1201–1212. doi:10.1016/j.joi.2017.10.006

Thomas, D., & Underwood, P. G. (2015). The use of the intranet of the Durban University of Technology Library as a Knowledge Management tool. *South African Journal of Library and Information Science*, *81*(1), 21–27. doi:10.7553/81-1-1545

Tillet, B. B. (2011). *Keeping libraries relevant with RDA*. Available at: http://web.ebscohost.con/ehost/pdfviewe/pdfviewer

Tokwe, H. (2021). *Bhero in the City by the Black Paparazzi.* Academic Press.

Tongai, I. (2013). South Africa: incentives for researchers drive up publication output. *University World News, Global Edition,* (280). https://www.universityworldnews.com/article.php?story=20130712145949477

Town, J. S. (2011). Value, impact, and the transcendent library: Progress and pressures in performance measurement and evaluation. *The Library Quarterly*, *81*(1), 111–125. doi:10.1086/657445

Tran, Y., Rene, C. G., & Boer, H. (2015). Managing business model innovation risks - lessons for theory and practice. *16th International CINet conference on Pursuing Innovation Leadership*.

Trivedi, M. (2010). Digital libraries: Functionality, usability, and accessibility. *Library Philosophy and Practice (e-journal),* Paper 381. https://digitalcommons.unl.edu/libphilprac/381

Trotter, H., Kell, C., Willmers, M., Gray, E., & King, T. (2014). *Seeking impact and visibility: Scholarly Communication in Southern Africa*. African Minds. http://open.uct.ac.za/bitstream/handle/11427/2310/SCAP_Trotter_SynthesisReport_2014.pdf?sequence=1

Tsabedze, V., & Ngoepe, M. (2020). A framework for quality assurance for archives and records management education in an open distance e-learning environment in Eswatini. *The International Journal of Information and Learning Technology.*, *38*(1), 1–18. doi:10.1108/IJILT-03-2020-0033

Tsekea, S., & Chigwada, J. P. (2021). COVID-19: Strategies for positioning the university library in support of e-learning. *Digital Library Perspectives*, *37*(1), 54–64. doi:10.1108/DLP-06-2020-0058

Tulinayo, F. P., Ssentume, P., & Najjuma, R. (2018). Digital technologies in resource constrained higher institutions of learning: A study on students' acceptance and usability. *International Journal of Educational Technology in Higher Education*, *15*(36), 36. Advance online publication. doi:10.118641239-018-0117-y

Tunga, S. K. (2021). Library services in digital environment: Challenges and strategies in Covid-19 pandemic situation. *Journal of Advances in Library and Information Science*, *10*, 94–101.

Turnbull, D., Chugh, R., & Luck, J. (2021). Transitioning to E-Learning during the COVID-19 pandemic: How have Higher Education Institutions responded to the challenge? *Education and Information Technologies*, *26*(5), 6401–6419. doi:10.100710639-021-10633-w PMID:34177349

Uddin, J., & Hasan, N. (2012). Use of information technology in library service: A study on some selected libraries in northern part of Bangladesh. *International Journal of Library and Information Science*, *4*(3), 34–44.

Ukachi, N. B. (2015). Information Literacy of Students as a Correlate of Their Use of Electronic Resources in University Libraries in Nigeria. *The Electronic Library*, *33*(3), 486–501. doi:10.1108/EL-05-2013-0085

UKEssays. (2018). *The Evolution of Database Management System*. Retrieved from https://www.ukessays.com/essays/information-technology/the-evolution-of-database-management-system-information-technology-essay.php?vref=1

Unal, Y., Chowdhury, G., Kurbanoglu, S., Boustany, J., & Walton, G. (2019). *Research data management and data sharing behaviour of university researchers*. Academic Press.

UNESCO. (2015). *UNESCO Science Report: Towards 2030*. Paris: UNESCO Publishing. https://unesdoc.unesco.org/ark:/48223/pf0000235406

UNICEF. (2021). https://www.unicef.org/zimbabwe/press-releases/zimbabwe-launches-innovative-learning-platform-children-and-teachers

University of Eswatini. (2018). Report of the Vice Chancellor 2018-2019. University of Eswatini.

University of Eswatini. (2021). *Student enrolment.* Retrieved from http://www.uneswa.ac.sz/

University of Lisbon. (n.d.). *ISCTE*. Available https://www.iscte-iul.pt/contents/iscte/quality/accreditations-and-rankings/rankings/1276/scimago-institutions-ranking

University of Pretoria. (2019). *Libby the library robot is on duty at UP.* Retrieved from https://www.up.ac.za/alumni/news/post_2825427-libby-the-library-robot-ison-duty-at-up

Uzwyshyn, R. (2018). Academic libraries and technology: an environmental scan towards future possibility. In G. J. Holbrook (Ed.), *Academic and Digital Libraries: Emerging Directions and Trends* (pp. 63–86). Nova Publishers.

Van Deventer, M., & Pienaar, H. (2008). South African Repositories: Bridging Knowledge Divides. *Ariadne*, (55), 3.

Van Rensburg, R. J. (2017). *Resource Description and Access (RDA): continuity in an ever-fluxing information age with reference to tertiary institutions in the Western Cape* [Unpublished MLIS thesis]. University of Western Cape.

Van Wyk, B., & Mostert, J. (2014). African institutional repositories as contributors to global information: South African case study. *Mousaion: South African Journal of Information Studies*, *32*(1). https://www.upjournals.co.za/index.php/LIS/article/view/1704/858

Van Wyk, B., & Mostert, J. (2014). African institutional repositories as contributors to global information: A South African case study. *Mousaion*, *32*(1), 98–114. doi:10.25159/0027-2639/1704

Varlan, S. E. (2011). Using Semantic Web technologies for knowledge management in e-commerce applications. *Proceedings of the 11th WSEAS international conference on applied computer science*, 194-197.

Verma, L., & Kumarz, N. (2018). Comparative Analysis of Open Source Digital Library Software: A Case Study. *DESIDOC Journal of Library and Information Technology*, *38*(5), 361. doi:10.14429/djlit.38.5.12425

Vistro, D. M., Farooq, M. S., Rehman, A. U., & Khan, M. A. (2021, September). Fraud prevention in taxation system of Pakistan using blockchain technology. *Proceedings of the 3rd International Conference on Integrated Intelligent Computing Communication & Security (ICIIC 2021),* 582-586. 10.2991/ahis.k.210913.074

Voce, J. (2014). Reviewing institutional policies for electronic management of assessment. *Higher Education*, *69*(6), 915–929. doi:10.100710734-014-9813-2

Vysakh, C., & Rajendra, B. H. (2019). Reshaping of librarianship, innovations, and transformation. *International Conference on Reshaping Librarianship: Innovations and Transformations. ICRLIT - 2019: e-Proceedings*, 59-63. https://bit.ly/3shxZIO

W3C. (2004a). *OWL web ontology language overview*. Available at: www.w3.org/TR/owl-features/

W3C. (2004b). *RDF primer. W3C recommendation*. Available at: www.w3.org/TR/2004/REC-rdf-primer-20040210/#basicconcepts

W3C. (2004c). *RDF vocabulary description language 1.0: RDF schema*. Available at: www.w3.org/TR/rdf-schema/

Walter, S. (2008). Librarians as teachers: A qualitative inquiry into professional identity. *College & Research Libraries*, *69*(1), 51–71. doi:10.5860/crl.69.1.51

Wang, Y. Y., & Wang, Y. S. (2019). Development and validation of an artificial intelligence anxiety scale: An initial application in predicting motivated learning behavior. *Interactive Learning Environments*, 1–16.

Wang, Y., & Yang, S. Q. (2018). Linked data technologies and what libraries have accomplished so far. *International Journal of Librarianship*, *3*(1), 3–20. doi:10.23974/ijol.2018.vol3.1.62

Wang, Z. (2021, September). Research on Intrusion Detection Method and Strategy of Industrial Internet Based on Big Data Environment. In *2021 IEEE International Conference on Computer Science, Electronic Information Engineering and Intelligent Control Technology (CEI)* (pp. 560-569). IEEE. 10.1109/CEI52496.2021.9574516

Wani, G. A. (2022). Digital library initiatives: An overview of national and international scenario. *IP Indian Journal of Library Science and Information Technology*, *6*(2), 66–72. doi:10.18231/j.ijlsit.2021.015

Warraich, N. F., & Rorissa, A. (2018). Adoption of linked data technologies among university librarians in Pakistan: Challenges and prospects. *Malaysian Journal of Library and Information Science*, *23*(3), 1–13. doi:10.22452/mjlis.vol23no3.1

Wasike, J. M. (2013). An assessment of the status of open access resources in Kenyan university libraries. *Library Hi Tech News*, *6*(6), 17–21. doi:10.1108/LHTN-12-2012-0074

Watermeyer, R., Crick, T., Knight, C., & Goodall, J. (2020). COVID-19 and digital disruption in UK universities: Afflictions and affordances of emergency online migration. *Higher Education*, 1–19. PMID:32836334

Watson, J. H., & Rockinson-Szapkiw, A. (2021). Predicting preservice teachers' intention to use technology-enabled learning. *Computers & Education*, *168*, 104207. doi:10.1016/j.compedu.2021.104207

Web of Science. (2019). https://incites.clarivate.com/#/explore/0/journal

Weideman, M., & Hofmeyr, K. B. (2020). The influence of flexible work arrangements on employee engagement: An exploratory study. *SA Journal of Human Resource Management*, *18*(1), 1–18. doi:10.4102ajhrm.v18i0.1209

Wei, L., & Deming, Z. (2015). Forward-looking of the Next Decade Library Technology Trends. *Library Journal*, *34*(1), 4–12. http://www.libraryjournal.com.cn/EN/Y2015/V34/I1/4

Wheatley, A., & Hervieux, S. (2019). Artificial intelligence in academic libraries: An environmental scan. *Information Services & Use*, 347–356.

Wilcox, D., & Weinraub, E. (2017). *Supporting Digital Preservation and Access with Fedora*. Available at: http://library.ifla.org/id/eprint/1758

Wilcox, S. D. (2011). Creating a Knowledge Management Culture at the Army Soldier Support Institute. *Army Sustainment*, *43*(2), 52–53.

Williams, R., Park, H. W., & Breazeal, C. A. (2019). Is for Artificial Intelligence: The Impact of Artificial Intelligence Activities on Young Children's Perceptions of Robots. *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. 10.1145/3290605.3300677

Wittmann, R. J., & Reinhalter, L. (2014). The Library: Big Data's Boomtown. *The Serials Librarian: From the Printed Page to the Digital Age*, *67*(4), 363–372. doi:10.1080/0361526X.2014.915605

Wittmann, R., Neatrour, A., Cummings, R., & Myntti, J. (2019). From Digital Library to Open Datasets. *Information Technology and Libraries*, *38*(4), 49–61. doi:10.6017/ital.v38i4.11101

Wojick, M. (2016). Internet of Things – potential for libraries. *Library Hi Tech*, *34*(2), 404–420. doi:10.1108/LHT-10-2015-0100

Wood, D., Zaidman, M., & Ruth, L. (2014). *Linked data: Structured data on the web*. Manning Publications Co.

Woutersen-Windhouwer, S. (2013). The future of open access publishing in the Netherlands: Constant dripping wears away the stone. *Journal of Academic Librarianship*, *39*(1), 105–107. doi:10.1016/j.acalib.2012.11.015

Xie, I., & Matusiak, K. K. (2016). Introduction to digital libraries. In *Discover Digital Libraries* (pp. 1–35). Elsevier. doi:10.1016/B978-0-12-417112-1.00001-6

Xu, M., David, J. M., & Kim, S. H. (2018). The fourth industrial revolution: Opportunities and challenges. *International Journal of Financial Research, 9*(2), 90-95.

Yadav, A. K. S. (2022). Key skills and competencies of LIS professionals in the digital library environment: a content analysis of job advertisement. *Library Management, 43*(1-2), 50-65. https://www.emerald.com/insight/content/doi/10.1108/LM-03-2021-0030/full/html

YALSA Young Adult Library Services Association. (2011, February). *Teens & Social Media in School & Public Libraries: A Toolkit for Librarians & Library Workers.* Retrieved September 13, 2021, from www.ala.org/yalsa

Yang, H., & Tate, M. (2012). A descriptive literature review and classification of cloud computing research. *Communications of the Association for Information Systems*, *31*, 35–60. doi:10.17705/1CAIS.03102

Yassir, A. H., Mohammed, A. A., Alkhazraji, A. A. J., Hameed, M. E., Talib, M. S., & Ali, M. F. (2020). Sentimental classification analysis of polarity multi-view textual data using data mining techniques. *Iranian Journal of Electrical and Computer Engineering*, *10*(5), 5526–5534. doi:10.11591/ijece.v10i5.pp5526-5534

Yeboah, E. B. (2018). *Assessing the role and position of the online public access catalogue at Sam Jonah library, University of Cape Coast*. Available at: http://hdl.handle.net/123456789/3947

Yeganeh, S., & Izadpanah, S. (2021). The Effect of Podcasts and Vodcasts Among Motivated Iranian Learners of English: Different Listening Proficiency Levels. *Journal of Language Horizons*, *5*(1), 51–75.

Yeh, S., & Walter, S. (2016). Critical success factors for integrated library system implementation in academic libraries: A qualitative study. *Information Technology and Libraries*, *35*(3), 27–42. https://ejournals.bc.edu/index.php/ital/article/view/9255

Yli-Huumo, J., Ko, D., Choi, S., Park, S., & Smolander, K. (2016). Where is current research on blockchain technology? A systematic review. *PLoS One*, *11*(10), 163477–163504. doi:10.1371/journal.pone.0163477 PMID:27695049

Yürekli Kaynardağ, A. (2019). Pedagogy in HE: Does it matter? *Studies in Higher Education*, *44*(1), 111–119. doi:10.1080/03075079.2017.1340444

Zaugg, H., West, R. E., Tateishi, I., & Randall, D. L. (2011). *Mendeley: Creating communities of scholarly inquiry through research collaboration*. Faculty Publications, Article Number 1633. https://scholarsarchive.byu.edu/facpub/1633

Zeng, J., Dai, X., Xiao, J., Yang, W., Hao, W., & Jin, H. (2019). BookChain: Library-free book sharing based on blockchain technology. In *Proceedings of the 15th International Conference on Mobile Ad-Hoc and Sensor Networks* (pp. 224-229). IEEE. 10.1109/MSN48538.2019.00051

Zepounidou, S., Sfakakis, M., & Papatheodorou, C. (2017). Representing and integrating bibliographic information into the semantic web: A comparison of four conceptual models. *Journal of Information Science*, *43*(4), 525–553. doi:10.1177/0165551516650410

Zhang, A. B. (2011). The world digital library. In C. Xing, F. Crestani, & A. Rauber (Eds.), *Digital libraries: For cultural heritage, knowledge dissemination, and future creation*. Springer. doi:10.1007/978-3-642-24826-9_47

Zhang, F., Gao, Z., & Ye, Q. (2015). Construction of cloud platform for personalised information services in digital library based on cloud computing data processing technology. *Automatic Control and Computer Sciences*, *49*(6), 373–379. doi:10.3103/S0146411615060127

Zhang, Y. (2012). Comparison of Select Reference Management Tools. *Medical Reference Services Quarterly*, *31*(1), 45–60. doi:10.1080/02763869.2012.641841 PMID:22289095

Zinn, O. O. (2021). The Role of School Libraries in Supporting Inquiry-Based Methods for Teaching Science in Nigerian Schools: Challenges and Possibilities. *Libri, 71*(2).

Zins, C. (2007). Knowledge map of information science. *Journal of the American Society for Information Science and Technology*, *58*(4), 526–535. doi:10.1002/asi.20505

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