October 2021

Research data management practices and services in South African academic libraries

Tlou Maggie Masenya

Tlou Maggie Masenya
Durban University of Technology, tm.masenya@webmail.co.za

Research data management practices and services in South African academic libraries

Tlou Maggie Masenya

Durban University of Technology, South Africa

tm.masenya@webmail.co.za

Abstract

Research data is being produced at a rapid rate in a wide variety of digital forms in academic and research institutions, however, this data is most prone to loss due to mismanagement. Proper management and preservation of this research data is essential for productivity, securing grant funding, enabling collaboration, increases data sharing, ensuring accessibility and the future use of data. Although academic libraries have recognised a need for effective management of research data, however, the management of their fast-growing number of research data poses major challenge to academic librarianship. The purpose of this study was to investigate the research data management practices and services within academic libraries in South Africa, in order to suggest solutions for effective research data management. Review of literature revealed that academic libraries are experiencing difficulties in managing their research data because of the absence of established policies and standards, inadequate standardised storage infrastructure, time constraint to organise data, limited funding, inadequate resources, lack of skills and training in managing research data and lack of incentives for researchers to share their data. All these challenges have created the dire need for best practices and solutions in ensuring proper management and long-term preservation of research data of enduring value in the academic libraries. Effective research data management strategies are thus needed to protect the enormous financial and time investments that have been made by mitigating data loss and avoiding the need for duplication of efforts to recreate lost data. The study suggests the need for implementation of research data management policies and strategies, provision of adequate resources, sufficient funding, collaborative approach and capacitating research data managers and administrators.

Introduction

The rapid growth of research data is the driver in the introduction of research data management practices and services in academic and research institutions worldwide. Research data is the data which is generated when the researchers undertake or execute any research activity, and it differs across all the disciplines. It is any organised data which academic researchers can use in their research as an evidence record. Research data may be textual, quantitative, qualitative, images recordings, musical compositions, verbal communication, experimental readings, simulations,codes and so forth (Mark, Brackett & Whyte, 2011). Mark, Brackett, Whyte (2011) describe research data management as the organisation of data from its entry to the research cycle through the dissemination and archiving of valuable results. Research data management entails all activities and processes which are undertaken to ensure that research data is properly documented, organised, stored, archived and curated so that it is available for access, use and reuse whenever the need arises (Tripathi, Shukla & Sonkar, 2017). It is an umbrella term for activities related to the creation, organisation, structuring and naming of data to their backup, storage, conservation and sharing, and to all actions that guarantee data security (Joachim, Ferrant, André & Fabre, 2018). Kristin (2015) further describe research data management as the care and maintenance of the data that is produced during the course of a data lifecycle that encompasses project and data managementplanning, data acquisition, data analysis, publication and data sharing, data preservation and data reuse.

The process of research data management consists of creating data and planning its use, arranging data structure and name, keeping data secure, accessible, stored and backed up, finding information resources and sharing with collaborators and other stakeholders, publishing and getting the citation, as stated by Gunjal and Gaitanou (2016). The Research Council of Norway (2015) also outlines the processes of research data sets components, namely: output data, storage, archiving with identifiers and preservation with metadata and access to data. Academic libraries play a proactive role in providing research data management services and have been actively involved in managing, preserving and providing access to information, as noted by Ng'éno (2018). These libraries are increasingly becoming sources of infrastructure and research support in the area of data stewardship (Katherine & Doty, 2013). Academic libraries are a key part of the scholarly communication cycle that focuses on the creation of new knowledge through research and scholarship and making the new knowledge available to the next community of researchers. Tenopir, Brirch and Allard (2012) also describe academic

libraries as the ideal centres for research data management and services, and therefore its involvement throughout the data lifecycle is vital to knowledge creation, which is also one of its core missions. Surkis (2015) concur that librarians now provide a range of services such as research data management, assisting researchers to improve their data management practices, creating data management subject guides and assisting in supporting funding agency. Proper data management enables the location, increased sharing and reuse of data and reducesthe duplication of data, costs and efforts in generating data. However, academic libraries are facing enormous challenges in managing their research data including the absence of established policies and standards, limited infrastructure, time constraint to organise data, limited funding, copyright and intellectual property rights, and lack of skills and knowledgeable staff in managing research data. Ashiq et al. (2020) pointed out that although research data management has gained increasing importance since the past two decades, however, the library professionals are far behind to equip and enhance skills on research data management servicesespecially in developing countries. Tenopir (2014) observed that there has been increasing need for academic librarians to play a leading role in research data management as data curation managers. Some academic institutions have recognized the need for research data management education and are promoting best practices for the preservation of scientific data, by developing formal learning opportunities on data management issues (Piorun et al., 2012). The aim of the paper was to examine the research data management practices and services in South African academic libraries, in order tosuggest best solutions and practices for effective research data management.

Problem Statement

Managing and providing access to research data can involve depositing the data into the Institutional Repositories (IRs) so that it can be made accessible to other researchers and for data re-use. The majority of academic libraries developed IRs in an attempt to collect, manage and preserve all their research data and scholarly outputs and maintaining access to these data over the long-term. However, some of these libraries are suffering from inability to store the data sets in a form that can be managed, having in mind the fragile, vulnerable and sensitive characteristics of the data sets. Academic libraries are thus faced with the major challenge of making sure that users can access the research data that has been ingested into their IRs and other archives. Corti (2011) observed that research data management is not an easy task and data centres may not accept all data submitted to them, and as a result IRs may not afford long-

term maintenance of data. More complex research data may therefore be difficult to store and manage. A study by Ng'éno (2018) also found that researchers and librarians in Kenya were inadequately supported and not well trained to effectively improve data management, appraisal, preservation, access, sharing and reuse. These circumstances have resulted in incomplete and inaccurate data, along with loss of research data consequently hampering access, sharing, use and reuse of research data, as stated by Ng'eno (2018). Research data management consider technical capabilities, ethical considerations, legalissues and governance frameworks, and it requires adherence or compliance to the standards and protocols of the field. However, there is lack of technical capabilities, the absence of established policies, frameworks and standards to guide research data management practices. Some of the researchers and academics are also not aware of the importance of managing and preserving research data for future access and sharing, and as a result this data is vulnerable to loss. Other issues like sustainability, costing, planning and policy, training and education, and raising awareness need to be dwelt upon, as noted by Poole(2015). The objectives which guided this study were to:

- Determine research data management practices and services in academic libraries;
- Establish the barriers to effective research data management in academic libraries; and
- Determine the strategies to effective research data sharing within academic libraries.

Research methodology

The study critically reviewed literature in order to investigate research data management practices in academic libraries, based on qualitative document analysis. Document analysis is a form of qualitative research in which documents are interpreted by the researcher to give voice and meaning around an assessment topic (Bowen, 2009). It is a systematic procedure for reviewing or evaluating documents both printed and electronic materials. Like other analytical methods in qualitative research, document analysis requires that data be examined and interpreted in order to elicit meaning, gain understanding and develop empiricalknowledge (Corbin & Strauss, 2008). Whereas document analysis has served mostly as a complement to other research methods, it has also been used as a stand-alone method and there are some specialised forms of qualitative research that rely solely on the analysis of documents (Bowen, 2009). Wild et. al (2010) concur that even though document analysis has traditionally been used to supplement other qualitative techniques, contemporary research has used this technique as the sole method for research. Document analysis from empirical studies, national and international research journals on research data management practices and services, challenges

and best practices, policy documents as well as articles on previous studies reporting on research data management practices was performed to address research objectives.

Overview of literature Review

Academic institutions worldwide are focusing on research activities, which have tremendously enhanced the production of research data. The availability of huge amounts of research data can result in development of new research data e-infrastructure aimed at harnessing the accumulating data and knowledge produced by research communities through data curation, open access, shared and reused research data. Whyte (2011) refers to research data management as to the early creation and organisation of research data sets, through to the management of preserved data sets in order to ensure that data can be easily retrieved for reuse. Academic libraries have a long history of curating and preserving research data, which makes them key players in research data management. These institutions have thus stepped in to provide research data management services to their researchers and user communities.

The benefits of research data management to both academic and research institutions as summarized by Lewis (2010), include: ensuring research integrity and replication, ensuring research data and records are accurate, complete, authentic and reliable, increasing research efficiency, saving time and resources in the long run; enhancing data security and minimize the risk of data loss and preventing duplication of effort by enabling others to use data. Research data management thus entails that data and related metadata are created, preserved and organized in a manner in which ensures that data remain accessible and reliable, and ensure that data protection and security are maintainedover the whole data lifecycle (Manu & Gala, 2019). However, proper data management is fundamental to all stages of research data life cycle and should be established at the outset. Figure 1 shows all the stages of research data lifecycle (UK Data Archive, 2013).
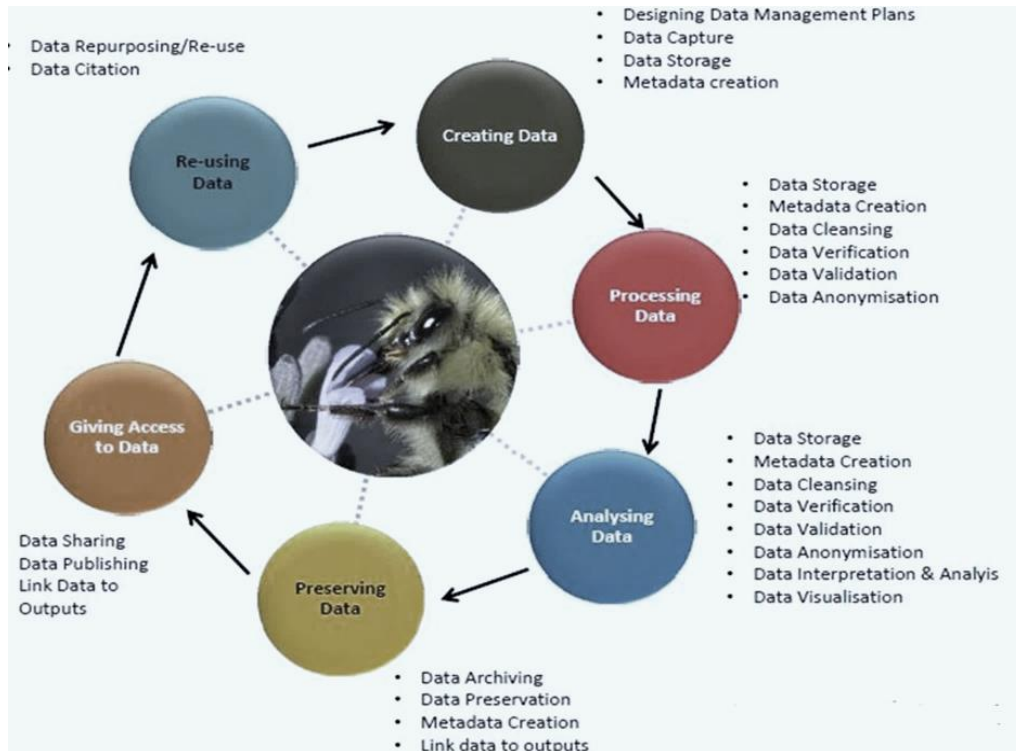
Figure 1: Research Data lifecycle (UK Data Archive, 2013)

The first three stages in the research data lifecycle ensure how researchers create data and metadata, how data management plan is designed, how data is stored and transformed from raw to processed, how data is analysed and interpreted in a way that is understandable. Therefore, if the data is understandable, it can be used by other researchers to test the validity of the original results or to reanalyse the originaldata in an entirely different way. Marlina and Purwandari (2019) stated that the storage facilities have an important role in research data management, especially at the data analysis stage and the preservation stage, in Figure 1. Data preservation enables long-term verification of research and it allows data reuse to produce new findings from existing information (Marlina& Purwandari, 2019). The last three stages of the research data lifecycle involve preserving data for the long term, by ensuring that it is stored on a stable medium, providing access or sharing data with others and finally reusing the data to conduct new studies or to test the reproducibility ofthe original results. It is important to note that the decisions made at each stage of the data lifecycle determine what data is available at the next stage, how it is handled and the purposes for which it is useful.

Research data management practices and services in academic libraries

Research data management practices and services are increasingly offered by university libraries, research offices and data intensive centers worldwide to support researchers in meeting funders' requirements for data management planning and to promote access to open research data (Matusiak & Sposito, 2017). National funding agencies in several countries require researchers to prepare Data Management Plans (DMPs) and to provide open access to data and scholarly publications (Research Councils UK, 2015; European Research Council, 2017). Academic libraries have now been compelled to implement research data management policies and programmes as they have been involved in storing, managing and archiving data. Increased reliance on technology and the establishment of data management and data sharing mandates by many research funding bodies have thus motivated academic libraries to take action with regard to the shifting needs of their faculty and consider how best to engage in e-science through the development of library-based research data management system (Tenopir, 2014). As noted by Manorama (2017) a research data management system may be based on three-tier architecture, namely: file-based data storage, a database of metadata and a web interface to facilitate access and use of data. Jones et al (2015) also outlined the capability elements that institutions need to consider when planning research data management programme, namely:

- Research data management policy, strategy, governance and sustainability;
- Research data management support services and skills development; and
- Technical infrastructure to facilitate storage, preservation and sharing of research data.

With the growth in research data management services, several studies have attempted to understand research data management practices within academic libraries in Africa. In South Africa, the National Research Foundation (NRF) (2015) has released a statement on open access for data retention to enforce the retention of research data for research that has been funded. Mathe (2015) conducted a study on the requirements for setting up research data management services at the Cape Peninsula University of Technology (CPUT) library in South Africa. The findings reveal that there was a great need for structured research data management programme and tools for setting up research data management platforms that include technology, staff and policies within the institution. The study by Ndhlovu (2018) on the preparedness for digital curation and preservation of research data at the National University of Science and Technology in Zimbabwe, found that there were inconsistencies in digital curation and Information and Communication Technology (ICT) competences were low among some of library staff. Chigwada and Kasiroori (2017) further explored research data

management practices in Higher Education Institutions in Zimbabwe and found that there was a general lack of policy and guidelines on research data management, limited financial and human resources, lack of robust and secure technological infrastructure and lack of management and institutional support. Chiware and Becker (2018) conducted a study to determine the readiness of Higher Education Institutions (HEIs) in Southern Africa to lead and participate in institutional research data management development. The study reveals that most institutions were not fully ready to comprehensively support research data management in their institutions due to inadequate resources, lack of proper infrastructure and human capacity constraints. Institutional repositories were also not fully harnessed to manage datasets and their metadata. Chiware and Becker (2018) further recommended training for librarians and organizational restructuring to align existing library research services to research data management.

Other studies have also attempted to understand data management practices, services and needs in an international context. These studies provide the understanding of the current status of research data management and highlight importance of strategic data management planning in academic libraries. Adam (2015) explored the academic libraries' readiness for research data management from Hungary and Estonia academic libraries which revealed that libraries in these areas were indeed at the beginning of addressing the issue, as only small amount of the participating institutions had services in place for supporting research data management at their institutions. Tenopir et al. (2017) conducted a survey of research data services in European academic libraries and indicated that more European libraries currently offer consultative services than technical services while also managing infrastructure for data storage and collaborate with other units on campus. The study by Briney, Goben and Zilinski (2015) focused specifically on data policy in order to understand how this policy is implemented and how it impacts data services at academic institutions. The findings reveal that the place of library data services within the larger framework of research data support at the institutional level and in shaping emerging policies is often unclear and although major funding agency policies have received wide recognition, institutional level data policies are less well known, if they even exist. As a result, researchers may misunderstand their home institutional policies with regard to research data and this, in turn, leads to difficulties when the researcher wishes to or is required to share data, attempting to coordinate policies in advance of a collaboration with researchers

at another institution or needs guidance in setting policy for the department or institution (Briney, Goben & Zilinski, 2015). Although Markauskaite and Kennan (2015) reported that there were inadequate human resources to manage data, however, a study conducted by Allard (2014) revealed that 78% of the respondents for whom research data services was regarded as core of their duties indicated that they had the necessary skills, knowledge and training on research data management. Tenopir et al. (2016) concur that libraries offer opportunities for staff for research data services skills development by way of conferences, workshops, research data services related courses, professional development working groups and in-house workshops and presentations. Allard, Birch, Sandusky and Tenopir (2012) conducted a survey among 223 librarians of the Association of Research Libraries (ARL) on the preparation and attitude of librarians towardsresearch data services. The findings reveal that there was very low percentage of libraries involved in research data management services, however the librarians believed that research data management is an important service for academic research libraries to render.

The study conducted by Manorama (2017) on the analysis of the role of research data management found that the academic libraries have developed data management plans and tools, provided links for case studies, training material, guides, research data consultation group. This help the researchers in maintaining and preserving data life cycles, published and deposited data torepositories as per their requirements and describe their data with metadata and saved their data in appropriate file formats preferably in non-proprietary formats. The study by Henty, et al (2008) on examining post-graduate research behaviour in the Australian context, focused on two broad-based surveys of capabilities and skills within institutions, seeking to understand current practices and training requirements. Avuglah and Underwood (2019) conducted the study on assessing research data management capabilities at the University of Ghana (UG) focusing on four key capability elements: policy framework, technological infrastructure, skills and knowledge, and support services. The study explored the extent to which research data management is embedded in research practices at UG and provides insight into the preparedness of UG to develop research data management. The study recommends that a clear and comprehensive policy framework for research data management should be developed to articulate research data management aspirations and express management's commitment. It also recommends that research support staff should be supported to build their capacity for research data management promotion and support.

Takeda et al. (2010) also used the AIDA self-assessment tool to benchmark the level of data management capability at the University of Southampton. The findings of the assessment revealed among others, limited research data management guidance and incoherent policy framework, a lack of formal training around data management, limited support andguidance for researchers, varied capabilities across campus with pockets of best practices and limited

awareness about existing capabilities and resources. Jones et al., (2015) reported on how four institutions in the UK (University of East London, University of Edinburgh, University of Leeds, and University of St. Andrews) complied with the EPSRC mandate on research data management practices. Using the CARDIO Matrix framework, they report that three of the four universities adopted a policy-first approach, while University of St. Andrews started their research data management practices implementation with a strategy document (roadmap) instead and developed a policy later on. Technical infrastructure was focused on storage solutions in the form of data repositories. University of Edinburgh also had a high-performance computing infrastructure in place. Research data management support services included guidance on writing data management plans and training, which were generally done by embedding research data management trainings into graduate programmes. Guidance on research data management practices was also provided through library websites and links to relevant resources on the web such as the University of Edinburgh's online management training resource. The study further reveal that librarians play a critical role in developing research data management programmes and it is absolutely important that investments are made into their capacity development for them to be effective. The study also helps to understand which capability elements need to be emphasised and prortized such as the development of policy framework, implementation of technological infrastructure, skills development and support services.

Barriers to effective research data management

Effective research data management allows other researchers to validate existing research and to create new knowledge by accessing and building on the work of others (Doucette & Fyfe, 2013). However, developing research data management program and providing research data management services has been difficult for many academic libraries due to lack of institutional support, lack of funding and technological infrastructure (Yoon & Schultz, 2017). Although strategies to overcome these challenges, have been developed by some of academic libraries, however, other areas of support such as professional training and collaboration with other institutions to develop more skills are needed. The study by Tenopir, Birch and Allard (2012) reveals that a number of librarians did not have required skills to provide data management services and their libraries do not prioritize research data management services. As stated by Erway and Rinehart (2016) research data management services are often more expensive and require more personnel than simply running an institutional repository. Corti, Van den Eynden, Bishop and Woollard (2011) observed that institutional repositories may not afford long-term maintenance of data, more complex research data may be difficult to store and manage. Harvey (2010) further identified the challenges associated with research data management, namely: technology obsolescence and fragility, lack of guidelines on good practice, inadequate financial and human resources to manage data well and lack of evidence about best infrastructures.

The study by Kennan and Markauskaite (2015) on research data management practices reported that there were inadequate skilled human resources to manage data. Academic libraries thus need to offer research data management service skills development to staff through conferences, workshops, professional development and research data services related courses. Boateng (2015) identified other challenges associated with research data management practices such as lack of skills and confidence, lack of support from organization or management, lack of research data policy, unsupported infrastructure and lack of incentives. Although trusted data repositories play a critical role in assuring that data remain accessible and available for future generations of scholars, however, a key challenge may be the cost of archiving data and the lack of sustainable business models for this activity. There is lack of funding to ensure that data are adequately managed and preserved. Some academic libraries are relying on national funding while other data repositories are left to fend for themselves often at the mercy of grant funding cycles which do not assure sustained funding. Aydinoglu, Dogan and Taskin (2017) noted that data is generally managed by researchers with limited access due to the absence of national or institutional policies. Most of the academic institutions do not have data storage facilities and reliable Information Technology (IT) infrastructure for large volumes of data, and as a result data is vulnerable to lose as it is not supported by good hardware and back up (Kruse & Thestrup, 2014). Aydinoglu, Dogan and Taskin (2017) added that researchers as data producers often do not have technical expertise and knowledge in research data management. Privacy and confidentiality of data is another barrier for researchers to publish and share data (Brian, 2018). Other barriers include the time and efforts it takes to make data ready for sharing, and the lack of perceived validation, recognition for researchers and their efforts as well as lack of data sharing policies and framework.

Strategies and initiatives to effective research data sharing within academic libraries

Hate et al (2015) highlighted the benefits of making data available for use, namely: the generation of evidence that might lead to positive interventions for the local populations, increased transparency and accountability, avoidance of duplication of efforts and encouragement of learning. As stated by Corti (2011) research data sharing enables scientific enquiry and debate, promotes innovation, transparency and accountability, examination of research findings, validation of research methods, avoiding duplicating data collection, research visibility, collaborations between and among data users and data creators. Research data sharing benefits scholarship by facilitating new theories to be developed and it also helps in validating science by reproducing already reported findings (Ng'eno, 2018). However, sharing research data and putting transparency principles into practice often appeared daunting. Researchers are unwilling to share data because of personal or confidential information of the participants, which if shared would amount to the breach of privacy. Most of researchers acknowledge the potential for exploitation of the local population and other forms of harm that might affect research participants including loss of privacy (Alter & Vardigan, 2015). Some scholars highlighted issues around informed consent, including questions about the right of research subjects and potential

benefits to the local community (Denny, et al, 2015; Jao et al 2015; Merson et al 2015). Effective data sharing is the key driver for research data management (Rosie & Pinfield, 2015), and it makes research more efficient. Strategies to effective research data sharing are thus needed to address all these challenges, and the best way to increase the benefits from data collection is to make data and thorough documentation available to other researchers. Trifan and Oliveira (2018) concur that research data need to be managed properly so that it can be accessed, integrated, shared and reused to produce inventions. As stated by Dimple (2016) the academic institutions also require to develop standards and privacy tools in assisting researchers to share data safely and trustworthily. Funders of research around the world have also issued a call for Open Access (OA) or data sharing, over the past several years, to extent scientific findings and encourage open sciences or e-science (Alter & Vardigan, 2015). Penev (2017) describe open science as over-encompassing movement to make scientific research more collaborative, data more open and dissemination accessible to all levels of scientific engagement. Open Access to research data is an enabler of high-quality research, a facilitator of innovation and safeguards good research practice. Borglund and Engvail (2014) describe open access as the concept that which should make public information available for others to use. In 2001, the Budapest Open Access Initiative also published a manifesto calling for open access to peer-reviewed journal literature (Open Society Institute, 2002). The basic idea of Open Access was providing online access to scholarly publications and making that access free of charge and without most copyright and licensing restrictions.

The majority of academic libraries globally, and South Africa in particular, have expressed their commitment to openness and have therefore, signed the Berlin Declaration on openness to data in the Sciences and Humanities. Berlin Declaration is a mechanism to commit institutions to promote an Open Access approach to scholarly research outputs or data and this declaration asserted that scholarly research outputs be freely accessible and usable for scientists and the public. The fundamental principle of Open Access is thus to make the research data or outputs more visible, accessible, searchable and useable by any potential user. This is indispensable in the quest for long-term access and delivery of authentic digital information. Open access thus advocates for free scientific output or open data mainly generated with public funds, from the economic barriers and copyright restrictions that prevent it from being freely accessible (Serrrano-Vicente, Melero & Abadal, 2016). The Open Access movement in scholarly communication has grown considerably over the past two decades and it has prompted the initiatives such as developing institutional repositories. Institutional repositories play an important and supporting role as knowledge management system or repositories, and have now becoming a platform for the sharing of knowledge. Institutional repository is the key factor for networked scholarly communication in the digital environment to enhance the visibility of research output and providing open access through intranet or internet to the scholars (Heath, 2009). This repository is developed as a tool for data publication and sharing, long-term preservation and reuse of

data (Cox & Pinfield, 2014), and it also provide facilities meet the criteria in terms of security, accessibility, and discover. Most of institutional repositories thus serve as archives for scholarly research outputs by providing green open access to these research output or data. Chigwada, Chiparausha and Kasiroori (2017) also recommended that trusted data repositories be established to encourage best data practices among researchers. Academic libraries are thus taking advantage of Open Access repositories by advising researchers to use the available resources alongside their local repositories for data safe-keeping and sharing. The increasing number of academic libraries have so far made great advancement towards developing institutional repositories to manage, preserve and provide open access to research data of the universities. It was established that academic libraries in South Africa are actively leading the way in implementing institutional repositories and digital preservation programmes, as compared with other African countries (Masenya & Ngulube, 2021). According to Masenya and Ngulube (2021) institutional repositories in academic libraries in South Africa perform research data management and preservation activities within a framework that matches international standards, and provide access to data in compliance with legal requirements and follow the principles of the Berlin Declaration on Openness to knowledge in the Sciences and Humanities. These libraries also comply with the Promotion of Access to Information Act (No. 2 of 2000) (PAIA).

The metadata system is also developed to connect data with annotations so that it can be accessed and understood by others (Stillerman, Greenwald & Wright, 2018). A comprehensive metadata-driven system is the developed data repository that can integrate a variety of complex data from various fields (Richard, et al, 2018) For example, Phenomics Ontology Driven Data Management (PODD) repository was developed to facilitate data management in the field of biology (Yuang Fang, 2013). Another data management framework, is called Tagit, which is an integrated indexing and search services for file systems (Hyogi, et al., 2017). Globus is also recommended as a platform for big data transfers between storage systems and supercomputers (Zang, et al, 2016) and it consists of services hosted in the cloud that adopts the Software as a Service (SaaS) model (Bryce, et al., 2017).

Multi-institutional collaboration is another strategy to strengthen the provision of research data management infrastructure and services (Joanna, et al, 2012). In South Africa, the Department of Science and Technology also established DIRISA as one of the three pillars of the National Integrated Cyber Infrastructure System managed by the Council for Scientific and Industrial Research (CSIR). DIRISA is primarily responsible for the creation, management, storage and sharing of research data. This initiative is supported by the South African National Research Network for the transmission of data and by the Centre for High Performance Computing for the processing of data. DIRISA developed South African Data Management Planning tool (SA-DMP), coupled with sound data management practices that supports the findable, accessible, interoperable and reusable principles of open data as well as the processes, policies, ethics and legal compliance regulations that include:

- Data security- compliance with data protection or security policies of the sharing institution or funder;

- Data sharing -improved discovery of data and compliance with the conditions and restrictions of shared data;

- Data destruction - the archiving and expunction of data as needed;

- Data referencing and master data management - documentation and metadata that accompany the data to assist users to understand and reuse it;

- Management of copyright and intellectual property rights - maintaining ownership and intellectual property rights, as well as restrictions on the third-party use of data; and

- Data governance- any other data policies that are applicable to the data, including the management of responsible actors in data management, and the resources that they will require to deliver on their data management plan.

The Inter-university Consortium for Political and Social Research (ICPSR) Partnership for Data Archiving is supporting colleagues in less well-resourced countries in promoting data sharing. It works with the Centre for Data Archiving, Management, Analysis and Advocacy (C-DAMAA) at the University of Cape Coast (UCC) in Ghana, with funding from the University of Michigan's African Social Research Initiative. ICPSR is also partnered with Data First, a data service at the University of Cape Town in South Africa to advise and train staff on how to use ICPSR systems for data curation. ICPSR staff thus developed a resource guide available in Fall 20115, to help new data centers to understand the policies and processes needed for a data archive. Recently, with support from the Alfred P. Sloan Foundation, ICPSR convened a meeting of 25 domain repositories to discuss the pressing need for innovative funding models for data repositories. The group issued a Call for Change (ICPSR, 2013) and a white paper "Sustaining Domain Repositories for Digital Data" (Ember & Hanisch, 2013), to focus attention on sustaining data repositories. There is also a need for education and training in various aspects of data stewardship and a need for complementary capacity building as groups begin to put their knowledge into practice. The aim of ICPSR is to ensure that training is available in a variety of formats and venues to ensure the widest dispersion of knowledge. ICPSR offers week-long courses on data management for reuse and provides a series of Webinars, many of which relate to data management and stewardship, and maintain a YouTube channel for on-demand access to the Webinars.

Conclusion and recommendations

The study investigated research data management practices and services in academic libraries. Review of literature revealed that academic libraries experienced difficulties in managing their research data due to the absence of established policies and standards, inadequate standardised storage infrastructure, time constraint to organise data, limited funding, inadequate resources, lack of skills and training and incentives for researchers to share their data. Literature review also revealed the barriers to effective research data management such as data privacy, data security and lack of policy to guide on research data management. The staff should have clear documentation policies for data privacy and ownership as well as skills to provide data curation support to the researchers. Academic librarians lack skills to provide research data management services and they are yet to become data fluent to provide data curation services (Manorama, 2017). Academic libraries should create research data management community of practice groups to provide on-going skills and developments to librarians, and increasing the awareness of researchers about research data by conducting workshops and training Furthermore, developing academic librarians' expertise and improving their confidence to engage with the researchers. Academic libraries should also learn and adopt the successful efforts from other countries as that may provide solutions to suite their challenges.

References

Adam, D.2015. *Exploring the academic libraries' readiness for research data management: cases from Hungary and Estonia.* Oslo and Akershus University college of Applied science. Available at: https://oda.hio.no/jspui/bitstream/10642/3367/2/Der.pdf. (Accessed 08 March 2019).

Allard, R. S. 2014. Research data management services in academic research libraries and perceptions of librarians. *Library and Information Science Research,* 84-90.

Allard, S, Birch, B, Sandusky, R.J and Tenopir, C. 2012. *Academic libraries and Research data services: Preparations and attitudes.* International Federation of Library Associations and Institutions, 70-78.

Alter, G.C and Vardigan, M. 2015. Addressing global data sharing challenges. *Journal of Empirical Research on Human Research Ethics,* 10(3): 317-323.

Ashiq, M, Rehman, S.U and Mujtaba, G. 2020. Future challenges and emerging role of academic libraries in Pakistan: a phenomenology approach. *Information Development,* 1-16.

Avuglah, B.K and Underwood, P.G. 2019. Research Data Management capabilities at the University of Ghana, Legon. *Library Philosophy and Practice (e-journal).* 2258.

Aydinoglu, A. U, Dogan, G and Taskin, Z. 2017. Research Data Management in Turkey: Perceptions and Practices. *Libr Hi Tech,* 35:271-289.

Bella, B. 2019. *eScience Curation Report.* (Accessed 11 March 2019) http://www.jisc.ac.uk/publications/publications/pub_escience.aspx.

Boateng, K. A. 2015. *Academic Library and Research Data management Roles.* International Master in Digital Library Learning.

Borglund, E and Engvall, T. 2014. Open Data: Data, Information, Document or Record? *Records Management Journal*, 24(2): 163-180.

Briney, K, Goben, A and Zilinski, L. 2015. Do You Have an Institutional Data Policy? A Review of the Current Landscape of Library Data Services and Institutional Data Policies. *Journal of Librarianship and Scholarly Communication,* 3(2).

Briney, K. 2015. *Data Management for Researchers: Organize, Maintain and Share your Data for Research Success.* Exeter, Pelagic Publishing, UK.

Bryce, A, et al. 2017. Globus: A Case Study in Software as a Service for Scientists. *In Proc. 8th Working Science Cloud Computing.* ACM, New York, pp. 25-32.

Carlson, J.R. and Garritano, J.R. 2010. *Cyberinfrastructure and the E-science, Cyberinfrastructure and the Changing Face of Scholarship Organizing for New Models of Research Support at the Purdue University Libraries.* Libraries Research Publications.

Chengyu, F, et al. 2015. Managing scientific data with named data networking. In Proc. 15th International Working Network-aware. *Data management*, 1-7.

Chigwada, J, Chiparausha, B. and Kasiroori, J. 2017. Research data management in research institutions in Zimbabwe. *Data Science Journal,* 16 (31): 1-9.

Chiware, E.R. and Becker, D. A. 2018. Research data management services in southern Africa: a readiness survey of academic and research libraries. *African Journal of Library Archives and Information Science,* 28(1): 1-16

Collins, K. M, Onwuegbuzie, A. J and Jiao, Q. G. (Eds.). 2010. *A Framework for Assessing Legitimation in Mixed Research: Implications for the Field of Stress and Coping.* London: Information Publications.

Corti, L. 2011. *Managing and sharing data: best practice for researchers.* University of Essex: UK Data Archive.

Corti, L, Van den Eynden, V, Bishop, L and Woollard, M. 2011. *Managing and Sharing Research Data: A Guide to Good Practice.* UK Data Archive. University of Essex

Corti, M. W. 2011. Managing and Sharing of Data. *Best practice for researchers,* 2-40.

Cox, A. M and Pinfield, S. 2014. Research data management and libraries: Current activities and future priorities. *Journal of Librarianship and Information Science,* 46(4): 299-316.

Cox, A.M. and Tam, W.W.T. 2018. A critical analysis of lifecycle models of the research process and research data management. *Aslib Journal of Information Management,* 70(2): 42- 157.

Cox, A.M, Kennan, M.A, Lyon, L, Pinfield, S and Sbaffi, L. 2019. Maturing research data services and the transformation of academic libraries. *Journal of Documentation,* 75(6): 1432- 1462.

De Waard, A. 2016. Research Data Management at Elsevier: Supporting Networks of Data and Workflows. *Inf Serv Use,* 36: 49-55.

Doucette, L and Fyfe, B. 2013. Drowning in Research Data: Addressing Data Management Literacy of Graduate Students. *In Proc ACRL 2013 Conf*, 165–171.

Elsayed, A.M and Saleh, E.I. 2018. Research data management and sharing among researchers in Arab universities: an exploratory study. *IFLA Journal,* 44(4): 281-299.

Erway, R and Rinehart, A.2016. *If you build it, will they fund? Making Research Data Management sustainable*. Dublin, Ohio: OCLC Research.

Gunjal, B and Gaitanou, P. 2016. *Research Data Management: A Practical Approach to Overcome Challenges to Boost Research, in IASSIST Conference*.

Henty, M, Weaver, B, Bradbury, S.J and Porter, S. 2008. *Investigating Data Management Practices in Australian Universities*. Available at: http:// eprints.qut.edu.au/14549.

Hey, A and Trefethen, A. 2003. Grid Computing -Making the Global Infrastructure a Reality. *In F. Berman, G. Fox, & A. Hey. The Data Deluge: An e-Science Perspective*, Wiley and Sons.

Hey, T, Tansley T and Tolle, K. 2009. *The Fourth Paradigm: Data-Intensive Scientific Discovery,* United States of America.

Higman, R and Pinfield, S. 2015. Research Data Management and Openness: The Role of Data Sharing in Developing Institutional Policies and Practices. *Program,* 49: 364-381.

Hyogi, S, et al. 2017. Tag IT: An Integrated Indexing and Search Service for File Systems. *Proc. SC*, 17.

Jao, I, et al. 2015. Involving research stakeholders in developing policy on sharing public health research data in Kenya: Views on fair process for informed consent, access oversight and community engagement. *Journal of Empirical Research on Human Research Ethics,* 10(3): 264-277.

Li, Y.F, Kennedy, G., Ngoran, F, Wu, P and Hunter, J. 2013. An Ontology-Centric Architecture for Extensible Scientific Data Management Systems. *Futur Gener Comput Sys,* 29: 641–653.

Naum, A. 2014. Research data storage and management: Library staff participation in showcasing research data at the University of Adelaide. *The Australian Library Journal,* 63(01): 35-44.

Ndemo, B. 2015. *Daily nation.* (Accessed 09 march 2019). Available at: https://www.nation.co.ke/oped/blogs/dot9/ndemo/2274486-2986916-121fwu5z/.

Ndlovu, P. 2018. *The state of preparedness for digital curation and preservation: a case study of a developing country.* Academic library: Bulawayo.

Manu, T.R and Gala, B. 2019. Research Data Management lifecycle: An overview. *In book: The trends, challenges and opportunities for LIS education and Practice.*

Marcus, C, Ball, S, Delserone, L, Hribar, A and Loftus, W. 2007. *Understanding research behaviors, information resources and service needs of scientist and graduate students:* A study for the University of Minnesota Libraries.

Mark, M, Bracket, M, Earley, S and Henderson, D. 2009. *The DAMA guide to the data management body of knowledge.* Bradley Beach, New Jersey: Technics Publications.

Markauskaite, L. and Kennan, M.A. 2015. Research Data Management Practices: A snapshot in time. *International Journal of Digital Curation,* 10(2):69-95.

Marlina, E. and Purwandari, B. 2019. Strategy for Research Data Management services in Indonesia. *The fifth Information Systems International Conference Procedia Computer Science*, 161: 788-796.

Masenya, T.M. and Ngulube, P. 2021. Digital preservation systems and technologies in South African academic libraries. *South African Journal of Information Management,* 23(1):12-49.

Matusiak, K.K. and Sposito, F.A. 2017. Types of Research Data Management services. An international perspective. *Proceedings of the Association of Information Science and Technology*, 54(1): 754-756.

Mobley, A, Linder, S.K, Braeuer, R, Ellis, L.M, Zwelling, L. 2003. A survey on data reproducibility in cancer research provides insights into our limited ability to translate findings from the laboratory to the clinic. *Plos One*, 8(5): e63221.

Merson, L, et al. 2015. Trust, respect and reciprocity: Developing culturally appropriate data sharing practices in Viet Nam. *Journal of Empirical Research on Human Research Ethics,* 10(3): 251-263.

Palumbo, L. 2015. Preparing to Accept Research Data: Creating Guidelines for Librarian. *Journal of eScience Librarianship*, 4(2).

Patel, D. 2016. Research Data Management: A Conceptual Framework. *Libr Rev*, 65: 226-241.

Pinfield, A. M. 2013. Research data management and libraries: Current activities and future priorities. *Journal of Library and Information Science.* (Retrieved 07 March 2019) http://lis.sagepub.com/cgi/doi/10.1177/0961000613492542.

Piorun, M. E, et al. 2012. Teaching Research Data Management: An Undergraduate/Graduate Curriculum. *Journal of eScience Librarianship,* (1)1: 8.

Penev, L. 2017. From Open Access to Open Science from the Viewpoint of a Scholarly Publisher. *Research Ideas and Outcomes,* 3: 12265. (Accessed 10 January 2018)

Poole, A. H. 2015. *How has your science data grown? Digital curation and the human factor: a critical literature review*. Archival Science.

Pryor, G. 2012. *Managing research data.* London: Facet Publishing. (Accessed 11 March 2019).

Read, A.2015. Research Data Management. *Journal of the Medical Library Association (JMLA),* 103(3):154-156.

Research Council of Norway report. 2015. *Open Access to Research Data; Policy for The Research Council of Norway* (Retrieved 10 June 2015).

Richard, G, Hartmann, V, Jejkal, T and Kollai, H. 2018.The MASi Repository Service: Comprehensive, Metadata-Driven and Multi-Community Research Data Management. *Futur Gener Comput Syst*. doi: 10.1016/j.future.2017.12.023.

Richardson, J, Nolan-Brown, T, Loria, P and Bradbury, S. 2012. Library Research Support in Queensland: A Survey. *Aust Acad Res Libr,* 43: 258-277.

Sanjeeva, M. 2018. *Research data management: a new role for academic/research librarians.* Available at: www.researchgate.net/publication/323604761.

Serrano-Vicente, R., Melero, R. and Abadal, E. 2016. Open Access Awareness and Perceptions in an Institutional Landscape. *The Journal of Academic Librarianship.* 42:595-603.

Sonker, S. K., Shukla, A and Tripathi, M. 2017. Research Data Management Practices in University Libraries: A Study. DESIDOC *Journal of Library & Information Technology,* 417- 4.

Stillerman, J, Greenwald, m and Wright, J. 2018. Scientific data management with navigational metadata. *Fusion Eng Des,* 128:113-116.

Surkis, A. 2015. Research Data Management. *Journal of the Medical Library,* 103(03):154- 156.

Takeda, K., et al. 2010. Data management for all: the institutional data management blueprint project. *Presentation at the 6th International Digital Curation Conference.* Available at:

http://eprints.soton.ac.uk/169533/1/6th_international_digital_curation_conference-idm (Accessed 29 April 2018).

Tenopir, C, Birch, B and Allard, S. 2012. *Academic libraries and research data services: Current practices and plans for the future.* An Association of college and Research Libraries (ACRL) White Paper.

Tenopir, C, Sandusky, R.J, Allard, S and Birch, B.2013. Academic librarians and research data services: Preparation and attitudes. *International Federation of Library Associations and Institutions,* 39(1): 70-78.

Tenopir, C, Sandusky, R.J, Allard, S and Birch, B.2014. Research data management services in academic research libraries and perceptions of librarians. *Library and Information Science Research,* 36(2):84-90.

Trifan, A and Oliveira, J.L. 2018. A FAIR Marketplace for Biomedical Data Custodians and Clinical Researchers", in 2018 IEEE. 31st Int. *Symp. Comput. Med. Syst, 188*-19.

Tripathi, A, Shukla, M and Sonkar, S.K. 2017. Research data management practices in University libraries: A study. *Journal of Library & Information Technology,* 37(6):417-424.

Van den Eynden, V. 2013. *Data lifecycle and data management planning. University of Essex: Research data management team.* Available at: https://data-archive.ac.uk/med//managingsharing.pdf.

Wambani, H. N. 2011. *Improving scientific research at Kenya agricultural: research institute (kari)-kakamega research centre.* Masters Dissertation. (Accessed 09 March 2019).

Ward, C, L. Freiman, L. Molloy, S. Jones, and K. Snow. 2011. Making Sense: Talking Data Management with Researchers. *International Journal of Digital Curation*, 6(2).

Weber, N. M., Palmer, C. L and Chao, T. C. 2012. Current Trends and Future Directions in Data Curation Research and Education. *Journal of Web Librarianship,* 305-320.

Whyte A. T. J. 2011. *Making the case for research data management.* Available at: http://www.dcc.ac.uk/webfm_send/487.

Van de Venter, M. and Pienaar, H. 2015. Research data management in a developing country: a personal journey. *International Journal of Digital Curation,* 10(2): 33-47.

Yoon, A and Schultz, T. 2017. Research Data Management Services in Academic Libraries in the US: A Content Analysis of Libraries. *College & Research Libraries,* 78 (7).