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RESEARCH ARTICLE

A Framework to Establish Research Data Management Services in Institutions of Higher Learning in Developing Countries

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ABSTRACT

Research data management is a critical aspect of modern academia, with profound implications for the quality and impact of research outcomes. This study explores the multifaceted landscape of research data management in developing countries, focusing on the challenges faced, and strategies employed to enhance data management practices. A comprehensive literature review was done to assess the current state of research data management within African universities. Scopus, Web of Science, and Google Scholar were used to retrieve the articles. "Research data management" OR "Research data repositories" AND "RDM Challenges and solutions" AND "RDM success cases" were used as the search terms. Twenty-one articles were considered in this study. The findings revealed that some institutions have successfully established and maintained research data services, although they have faced some challenges. The challenges include a lack of policy frameworks, incentives, skills, storage network infrastructure, guidance, and support, failure by researchers to engage librarians, and inadequate support from the university. The results were used to develop a framework of the minimum requirements for establishing research data management services in a resource-constrained institution. The findings can inform policymakers, educators, and administrators in developing countries, helping them design and implement effective data management policies and practices sensitive to their unique circumstances. Library schools in developing countries would be able to revise and improve their curricula to address these unique challenges. This is an examination of the specific hurdles and potential solutions in managing research data in developing countries. The literature review identified the challenges faced and proposed actionable strategies for improvement tailored to the specific needs and constraints of developing countries.

INTRODUCTION

The advent of the open science movement encouraged researchers to develop tools and methods for managing data so that it can be shared as appropriate through the UNESCO recommendation on open science (UNESCO, 2022). African universities strive to contribute meaningfully to global knowledge production and socioeconomic development since the advancement of research and innovation has become a focal point (Muriisa and Rwabyoma, 2019). The importance of research data management cannot be overstated as data serves as the foundation upon which scientific inquiry and innovation thrive (Bhoi et al., 2023; Zozus, 2017). However, amidst this pursuit, effective research data management remains a critical challenge (Briney, 2015; Nilashi et al., 2023; Yaqoob et al., 2023). The landscape of research data management (RDM) in African universities is marked by various obstacles, ranging from infrastructural deficiencies to inadequate policies and cultural barriers (Chiware, 2020). Addressing these challenges is paramount to harnessing the full potential of research outputs and fostering a culture of data-driven scholarship across the continent. The study seeks to explore the multifaceted challenges facing African

universities in managing research data effectively and identify viable improvement strategies. By investigating the complexities of RDM within the African context, this research aims to provide valuable insights that can inform policy formulation, institutional capacity building, and collaborative efforts toward enhancing data management practices.

Research data management services have been implemented in some institutions and guidelines and implementation plans are available such as the Digital Curation Centre (DCC) guidelines (Jones et al., 2013), the Library Information Technology Association (LITA) guide (Krier and Strasser, 2014), DCC guide on delivering RDM services (Pryor et al 2014), and the toolkit by Liber and ADBU (2023). However, these guidelines focus on developed countries where financial, human, and infrastructure resources are available. In Africa, some universities have under-resourced libraries, financially embattled research units, budget cuts and staff reductions, and unenlightened management that is not willing to invest in infrastructure and other resources for RDM (Chiware and Mathe, 2015; Chiware, 2020; Mushi et al., 2020; Patterton et al., 2018). Bhardwaj (2019) added that managing research data incurs expenses and requires skilled manpower for its execution. This study seeks to find the forms of evidence documenting the challenges and strategies for improving research data management in African universities. It would offer recommendations for further research in assisting resource-constrained African universities in planning the implementation of research data services to make their research data accessible while considering human, financial, and infrastructural constraints. Against this background, the study sought to document successful cases in research data management from African universities, identify challenges faced by African universities in managing research data effectively, and develop practical strategies for improving research data management in African universities.

MATERIALS AND METHODS

A comprehensive literature review was done in March 2024 to unpack the challenges that are faced by African universities in developing and managing research data services. The research questions which guided the study were what challenges are faced by African university libraries in implementing research data management services, and what success cases of research data management services had been documented in African university libraries. Relevant studies were retrieved from Scopus, Web of Science, and Google Scholar. The search terms that were used were: "Research data management" OR "Research data repositories" AND "RDM Challenges and solutions" AND "RDM success cases". The inclusion criteria involved articles that were written about and in countries that are on the registry of data repositories (re3data, 2024), about research data management, published between 2013 and 2024, and written in English. The retrieved papers were saved into Zotero reference management software for further cleaning and to identify duplicates. The selection of articles was done by two reviewers using a data extraction chart that was developed using the research questions, and it was initially based on titles, keywords, and abstracts. Forty papers were initially selected, and 21 articles were finally considered for this study after the full-text review. Collating, summarising, and reporting the results was done whereby the full-text articles were thoroughly read, and themes were drawn from the studies, guided by the research questions.

RESULTS

The purpose of the literature review was to identify the success cases and challenges that are faced by African Universities in establishing and maintaining research data services. The findings reviewed that several institutions of higher learning had managed to implement research data services in their institutions. On the registry for research data repositories, 43 research data repositories were registered as shown in Figure 1.

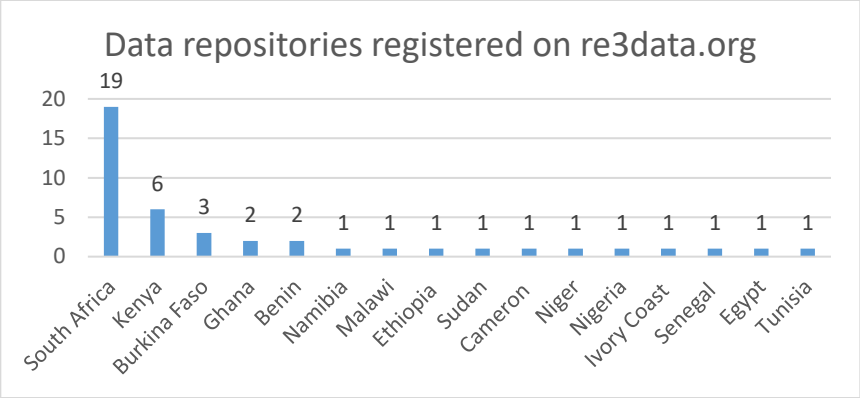

Figure 1: Research data repositories registered in Africa

Successful cases of research data management in African universities

It was noted that most of the case studies done were not indicating the names of the institutions that were studied for ethical reasons i.e., a public university in Malawi, (Chawinga and Zinn, 2020), two universities in South Africa (Van Wyk et al., 2020), a medical school in a developing African country (Chawinga and Zinn, 2020a), a university in Egypt (Elsayed and Saleh, 2018), a South African Research Institute (Patterton et al., 2018). However, some names were given in some studies, for example, the Cape Peninsula University of Technology (CPUT) in South Africa where a detailed framework was provided (Chiware and Mathe, 2015). At the University of Zululand, Mthembu and Ocholla (2020) found that although the university did not have an RDM policy, research activities were being practised. Chiware and Becker (2018) stated that some South African universities had RDM policies, namely the University of Cape Town (UCT), University of South Africa (UNISA), University of Pretoria (UP), Stellenbosch University, and CPUT, while Durban University of Technology (DUT) have guidelines and procedures for RDM services. Kahn et al., (2014) added that the University of Witwatersrand also had an RDM policy.

Koopman and de Jager (2016) documented the University of Cape Town's experiences whereby the eResearch centre was established in 2014 to support research data generators through workshops and conferences. This was a collaborative approach by UCT Libraries, UCT Information and Communication Technology Services, and UCT Research Office. Badenhorst and Raju (2023) documented the competency requirements of academic librarians in providing research data management services using two South African universities, that is, Mangosuthu University of Technology (MUT) and the University of KwaZulu Natal (UKZN). Mthembu and Ocholla (2022) noted that in South Africa, the National Research Foundation improved the research equipment in research institutions as an infrastructural investment. They added that capacity-building programs were done in South Africa to support RDM services through the National Library Association, Library and Information Association of South Africa (LIASA), and other universities at the institutional level. In South Africa, institutions are working to develop the capacity of data librarians and other stakeholders involved in research data management, such as the University of Cape Town Library and Information Studies Centre and the Network of Data and Information Curation Communities (NeDICC).

Challenges faced by African Universities in managing research data

The findings revealed some challenges faced in implementing research data management services in African Universities. Patterton et al. (2018) classified the challenges into five categories i.e., information and communication technology related, data security issues, financial constraints, RDM practices, and data sharing/ confidentiality. ICT-related issues were regarded as research infrastructure, mainly storage capacity and data transfer (Abduldayan et al., 2021; Raju and Schoombee, 2013). Researchers felt that the

internet was slow and the computing power was not enough. Data security issues were in line with possible data loss, accidental data deletion, data corruption, lack of a disaster management plan, encryption problems, and equipment theft. There were also concerns about the lack of a disaster management plan. Furthermore, financial constraints led to researchers using out-of-date tools and equipment since software packages, servers, and licenses were expensive (Patterton et al., 2018). There were also issues regarding the RDM practices, mainly naming conventions, lack of backup knowledge, no experience in adding metadata, integrity of data collection methods, quality control, data not being accessible when a colleague left the project, researchers failing to avail access to data to members of the research group, and not applying best RDM practices. Moreover, data sharing and confidentiality issues included other parties' unethical use of data, especially when dealing with confidential or sensitive data. This was coupled with a lack of RDM skills among librarians and researchers (Kahn et al., 2014).

Chiware (2020) and Mthembu and Ocholla (2022) pointed out insufficient resources hampering RDM services in African universities. The challenges faced at the University of Zululand were the scarcity of human resources and lack of specific capacity-building programmes and strategies to develop RDM skills. In addition, Adika and Kwanya (2020) and Chawinga and Zinn (2020) found the following as the key challenges: lack of policy frameworks, lack of incentives, lack of skills to create metadata, lack of curation skills and training, lack of storage network infrastructure, lack of guidance and support, failure by researchers to engage librarians, lack of curation tools and software, finding data produced by others, and lack of support from the university. Chawinga and Zinn (2020a), Chiware and Becker (2018), and Chiware (2020a) found that the challenges faced by libraries include organisational structure issues, limited job descriptions without specific data management roles, no existing policies ensuring the collection of institutional research output, no existing capacity building programmes to develop skills to handle data management, lack of well-defined policy framework, not enough data storage facilities or specific institutional data storage solutions, no proper linkage with national initiatives, no specific staffing budget for RDM service provision, lack of IT infrastructure, lack of skilled staff to assist researchers with data storage and preservation techniques, lack of incentives from senior university management to implement RDM services, and lack of understanding of the concept of RDM services by researchers.

Strategies to improve RDM services in African Universities

Considering the challenges stated above, it was imperative to explore strategies that can bolster research data management capacities within African universities. There was a need to involve all the stakeholders from the beginning, as stated by Kahn et al. (2014), and Patterton et al. (2018) indicated that the library should not be in a leadership position, but researchers should manage their research data, while the library influences strategic decisions and not be seen as the responsible party. As a result, Patterton et al. (2018) divided the activities into researcher-led (institutional acceptance and managerial involvement; RDM policy and procedure; promotion, awareness creation, and change management; funder requirements; and RDM and research ethics), library-led activities (establishing an RDM function; RDM training and guidance; providing access to an online DMP tool; providing access to online storage and dataset indexing; data citation standards; and RDM preservation services), and ICT/infrastructure-led activities (research data storage; and research infrastructure) to point out the stakeholders that should be involved as well as their roles and responsibilities.

In line with researcher-led activities, it is essential to have institutional support and managerial involvement and approval for a focused RDM drive from the project's onset. Therefore, advocacy and communication skills are required to convey the right message to the executive and get all the resources needed to implement the project (Patterton et al., 2018). In addition, creating an institutional RDM policy and the necessary procedures are important to ensure that the RDM activities are formalised (Patterton et al., 2018; Chiware, 2020). Within these guidelines, funder requirements must be stressed and incorporated into the DMP tool that would be utilised. Moreover, raising awareness of RDM activities is essential and this

can be achieved through word of mouth, ad hoc inventions, and above all planned promotion and awareness campaigns such as open invitation RDM awareness days, RDM roadshows, and demonstrations of RDM tools (Patterton et al., 2018). The library can be instrumental in informing researchers of training opportunities and equipping them with the skills needed to promote RDM-related events (Badenhorst and Raju 2023; Chiware, 2020; Rabasa and Abrizah, 2022). In addition, the Research ethics committee should be involved in documenting and explaining the steps, activities, and requirements to work with data ethically.

The library plays a critical role and librarians should display operational expertise and technical know-how (de Jong and del Junco, 2023; Rabasa and Abrizah, 2022). The data librarian should have personal experience with working with data to be able to lead the RDM activities and participate in continuous professional development such as courses, workshops, conferences, and webinars (Patterton et al., 2018). RDM training is essential, and this can be regarded as an extension of the information literacy training sessions. Information specialists from each school or faculty can be recruited to deal with discipline-specific research data formats, software, and metadata standards. In addition, librarians should provide access to online storage and dataset indexing where institutional repositories can be used or guidance on where to archive the research data using the registry of research data repositories (Re3Data.org, 2024) to identify relevant subject repositories. Furthermore, awareness about data citation and the ability to publish data papers should be created among researchers so that they are encouraged to archive their datasets. The library should also ensure that preservation standards for various data formats are adhered to, and researchers comply with those standards. Abduldayan et al. (2021) concluded that institutions should ensure a backup of data, research data protection, data management plans, institutional policies that support RDM, awareness creation, and training.

The library should collaborate with ICT to identify appropriate standard preservation formats and deal with file corruption, technology obsolescence, and data storage. There should be a procedure for reliable and stable data storage, and researchers should be aware of the need to incorporate such costs when applying for research funding (Patterton et al., 2018). The library should also ensure that the research infrastructure is functional and adequate (Chiware, 2020; Kahn et al., 2014; Raju and Schoombee, 2013). Badenhorst and Raju (2023), Mosha and Ngulube (2023), and Moyo and Bangani (2023) added that training, support, and collaboration with other departments are key to ensure that librarians have the necessary skills and competencies needed for research data management. Therefore, library science schools should start teaching research data management courses to enhance the levels of RDM literacy among librarians (Mosha and Ngulube, 2023). Chiware (2020a) added that reassigning and restructuring staff, professional development programmes, revising the library and information science curriculum, and diversity by bringing computer science lecturers to LIS programmes would enhance RDM services in African universities. Furthermore, Chawinga and Zinn (2020a) added that institutions should offer monetary rewards to researchers who archive their data, there should be a collaboration between librarians and researchers, librarians should sell their RDM capabilities to researchers, build robust data storage infrastructure, develop, and implement RDM policies and guidelines, and librarians developing their RDM skillset. This discussion led to the development of a framework for the minimum steps that should be taken to establish research data management services, as shown in Figure 2.

DISCUSSION

From the findings that were obtained from this study, a framework to establish RDM services in African universities was developed. The framework can be linked to the Technology-Organisation-Environment (TOE) framework coined by Tornatzky et al., (1990) which has technological, organisational, and environmental contexts (Awa et al., 2017; Jere and Ngidi, 2020; Nguyen et al, 2022; Ramdani et al., 2013). The technology context encompasses all technological tools and systems used in managing and storing research data, such as data storage and backup, data management tools, and security and privacy issues. The issues of relative advantage, such as benefits gained by the business, such as financial benefits,

convenience, satisfaction and high standard, compatibility with the existing systems and business processes, and complexity are considered (Jere and Ngidi, 2020). The organisation context looks at top management, financial resources, ICT knowledge, and size. These are responsible for policy development, institutional support, and training, and involve the alignment of RDM policies with the organisation's mission, goals, and culture. It emphasises the role of leadership in fostering a culture that values good research data management practices (Kim, 2020; Kim, 2021). The organisation provides support through dedicated RDM teams or units within an organisation and offers training programmes and resources to ensure researchers understand and can implement RDM practices (Rod et al., 2023; Singh et al., 2022). It is also responsible for establishing policies and procedures for data management, including data sharing and retention policies. The environmental context concerns government support, competitive pressure, and external support such as regulatory requirements, funding body mandates, and ethical considerations that impact RDM (Bratt, 2022; Marlina et al., 2022). This ensures adherence to legal, ethical and funding requirements related to RDM services and sustainable practices considering the long-term preservation and accessibility of data.

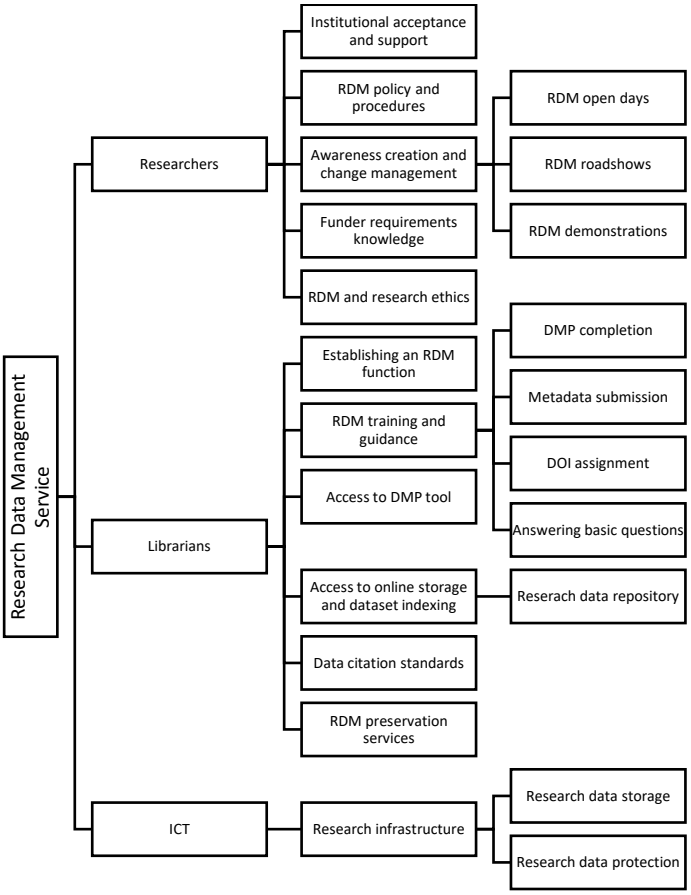

Figure 2: Minimum steps for the successful initiation of RDM services

The role of ICT in establishing research data management services is to ensure that the research infrastructure is available where research data can be stored with maximum protection (Ashiq et al., 2022; Mushi et al., 2020). The librarians are responsible for establishing the RDM function and providing training and guidance on data management plan (DMP) completion, metadata submission, DOI assignment, and answering basic questions (Badenhorst, 2022; Madibi, 2021; Mosha et al., 2020; Ntja, 2022). In addition, access to the DMP tool, online storage and dataset indexing within the research data repository, data citation standards, and RDM preservation services would be provided by librarians (Al-Jaradat, 2021; Sheikh et al.,

2023; Xu, 2022). The researchers are the creators of the datasets and users of the research data repository. They should ensure that there is institutional acceptance and support, RDM policies and procedures, funder requirements knowledge, RDM and research ethics, and awareness creation of RDM services through RDM open days, roadshows, and demonstrations (Ashiq et al., 2022; Krahe et al., 2020; Lefebvre et al., 2020). Therefore, there is a need for a stakeholder approach when establishing and managing research data management services to ensure that the project is successful (Liber and ABDU, 2023; Mushi et al., 2020).

Limitations of the study

The study focused on African universities with research data repositories registered on the open data repositories registry. However, some institutions also struggle to establish and implement research data management services, let alone register on re3data in Africa. These institutions should also be studied as well to note the challenges that they are facing. This will be covered in a separate study that documents the activities in those universities and their challenges.

CONCLUSION AND RECOMMENDATIONS

It can be concluded that some African universities have made inroads into establishing and managing research data repositories, as indicated by the various success cases noted in this study, especially in South Africa. In the process, the unique socio-economic, technological, and institutional dynamics in African universities present distinct challenges to acquiring, storing, sharing, and preserving research data. African universities face challenges such as poor research data infrastructure, lack of resources, both financial and human, poor collaboration between stakeholders, and lack of skills among both librarians and researchers in research data management. Cultural factors, such as varying perceptions of data ownership, intellectual property rights, and concerns regarding data privacy and security, further complicate the landscape of research data management in African universities. To deal with those challenges, there is a need for commitment from government and institutional management to have a clear roadmap for research data management through developing RDM policies and guidelines. Every university planning to implement RDM services should ensure that the RDM policy is available. African universities should also collaborate with international agencies such as the European Union, EIFL, the World Bank, Research Data Alliance, Digital Curation Centre, and CODATA to promote national open science policies and the development of infrastructure, policy frameworks, and national initiatives for eResearch and eScience where research data management would be part of the activities. Without robust mechanisms in place to address these challenges, African universities risk falling behind in the global research arena and failing to realise the transformative potential of scholarly endeavours.

The authors recommend that those African universities that have successfully implemented research data management services should evaluate and continuously improve their services by soliciting feedback from stakeholders. They should also assist those universities that are struggling to establish these services by sharing their experiences and lessons learnt. Moreover, the upskilling of librarians should be intentional to deal with some of the challenges being faced by African universities. RDM training for both librarians and researchers is essential to make the RDM project a success and create awareness of the roles and responsibilities of each category. Training can be in the form of short courses, workshops, seminars, or conferences to support RDM services. There is also a need to ensure that the other stakeholders are also involved from the planning stage to avoid resistance along the way and consider other factors such as infrastructure, funding, incentives, and RDM procedures. Institutions should invest in infrastructure to address data storage issues, and this can be done at institutional, consortia, national, regional, or international levels as a way of sharing resources among key stakeholders. This means a sustainable funding model and institutional support structures should be developed to ensure the long-term viability of research data management efforts in African universities. Furthermore, institutions should provide incentives to researchers who archive their research data as a way of rewarding data sharing and reuse

through a stipulated rewarding policy and procedures manual. Moreover, library science schools should ensure that their curriculum is revised to cover the skills and competencies needed in offering research data management services.

Author's contribution

JC conceived the idea, designed the project, and wrote the manuscript. PN participated in the design of the study and helped write the manuscript. JC and PN read and approved the final manuscript.

REFERENCES

Abduldayan FJ, FP Abifarin, GU Oyedum, and JA Alhassan, 2021. Research data management practices of chemistry researchers in federal universities of technology in Nigeria. Digital Library Perspectives, 37 (4), 328-348. https://doi.org/10.1108/DLP-06-2020-0051.

Adika FO, and T Kwanya, 2020. Research data management literacy amongst lecturers at Strathmore University, Kenya. Library Management, 41 (6/7), 447-466. https://doi.org/10.1108/LM-03-2020-0043.

Al-Jaradat OM, 2021. Research data management (RDM) in Jordanian public university libraries: present status, challenges and future perspectives. The Journal of Academic Librarianship, 47 (5), 1-9. https://doi.org/10.1016/j.acalib.2021.102378.

Ashiq M, MH Usmani, and N Naeem, 2022. A systematic literature review on research data management practices and services. Global Knowledge, Memory and Communication, 71 (8/9), 649-671. https://doi.org/10.1108/GKMC-07-2020-0103

Awa HO, O Ukoha, and SR Igwe, 2017. Revisiting technology-organization-environment (T-O-E) theory for enriched applicability. The Bottom Line, 30(1), 2-22. https://doi.org/10.1108/BL-12-2016-0044.

Badenhorst P, 2022. Competency requirements of academic librarians in providing research data management services: the case of two university libraries. Faculty of Humanities ,Library and Information Studies Centre (LISC). http://hdl.handle.net/11427/37091

Bhardwaj RK, 2019. Research data management in higher educational institutions. DESIDOC Journal of Library and Information Technology, 39(6), 269–270. https://doi.org/10.14429/djlit.39.06.15281.

Bhoi NK, I Patel, and B Dutta, 2023. State of Research Data Management Practices in the Top-ranked Higher Education Institutions in India. The International Information and Library Review, 55 (4), 283-301. https://doi.org/10.1080/10572317.2023.2167051.

Bratt S, 2022. Research data management practices and impacts on long-term data sustainability: an institutional exploration. Syracuse University.

Briney K. 2015. Data management for researchers: organize, maintain, and share your data for research success. London" Pelagic Publishing Limited.

Chawinga WD, and S Zinn, 2020. Research data management at a public university in Malawi: the role of "three hands". Library Management, 41 (6/7), 467-485. https://doi.org/10.1108/LM-03-2020-0042.

Chawinga DW, and S Zinn, 2020a. Research data management at an African medical university: Implications for academic librarianship. The Journal of Academic Librarianship, 46 (4), 1-10. https://doi.org/10.1016/j.acalib.2020.102161.

Chiware ERT, 2020. Open research data in African academic and research libraries: a literature analysis. Library Management, 41 (6/7), 383-399. https://doi.org/10.1108/LM-02-2020-0027.

Chiware ERT, 2020a. Data librarianship in South African academic and research libraries: a survey. Library Management, 41 (6/7), 401-416. https://doi.org/10.1108/LM-03-2020-0045.

Chiware ER, and DA Becker, 2018. Research data management services in South Africa: a readiness survey of academic and research libraries. African Journal of Library Archives and Information Science, 28(1), 1-16.

Chiware E, and Z Mathe, 2015. Academic libraries' role in research data management services: A South African perspective. South African Journal of Libraries and Information Science, 81(2), 1-10.

de Jong S, and C del Junco, 2023. How do professional staff influence academic knowledge development? A literature review and research agenda. Studies in Higher Education, Vol ahead of print. https://doi.org/10.1080/03075079.2023.2258155.

Elsayed AM, and EI Saleh, 2018. Research data management and sharing among researchers in Arab universities: An exploratory study. IFLA Journal, 44(4), 281-299. https://doi.org/10.1177/0340035218785196.

Jere JN, and N Ngidi, 2020. A technology, organisation and environment framework analysis of information and communication technology adoption by small and medium enterprises in Pietermaritzburg. South African Journal of Information Management, 22 (1), a1166. https://doi.org/10.4102/sajim.v22i1.1166.

Jones S, G Pryor, and A Whyte, 2013. How to develop research data management services - a guide for HEIs. DCC How-to Guides. Edinburgh: Digital Curation Centre. http://www.dcc.ac.uk/resources/how-guides/how-develop-rdm-services.

Kahn M, R Higgs, J Davidson, and S Jones, 2014. Research Data Management in South Africa: How We Shape Up. Australian Academic and Research Libraries, 45 (4), 296-308. https://doi.org/10.1080/00048623.2014.951910.

Kim J, 2020. Academic library's leadership and stakeholder involvement in research data services. In: Proceedings of the Association for Information Science and Technology, 57 (1), e304. https://doi.org/10.1002/pra2.304.

Kim J. 2021. Determining research data services maturity: the role of library leadership and stakeholder involvement. Library & Information Science Research, 43 (2), 101092. https://doi.org/10.1016/j.lisr.2021.101092.

Koopman MM, and K De Jager, 2016. Archiving South African digital research data: How ready are we? South African Journal of Science, 112(7/8), 1-7. http://dx.doi.org/10.17159/sajs.2016/20150316.

Krahe MA, J Toohey, M Wolski, PA Scuffham, and S Reilly, 2020. Research data management in practice: Results from a cross-sectional survey of health and medical researchers from an academic institution in Australia. Health Information Management Journal, 49(2-3):108-116. doi:10.1177/1833358319831318.

Krier L, and CA Strasser, 2014. Data management for libraries: a LITA guide. Chicago: ALA Tech Source.

Lefebvre A, B Bakhtiari, and M Spruit, 2020. Exploring research data management planning challenges in practice. it - Information Technology, 62(1), 29-37. https://doi.org/10.1515/itit-2019-0029.

Liber and ABDU, 2023. Research data management and support services by libraries in collaboration with other stakeholders: toolkit by Liber and ABDU. https://libereurope.eu/wp-content/uploads/Liber_ABDU1920X1080_FINAL.pdf.

Madibi Z, 2021. The role of academic libraries in implementing research data services: a case study of the University of KwaZulu-Natal Libraries. Faculty of Humanities, Knowledge and Information Stewardship. http://hdl.handle.net/11427/35828.

Malina E, AN Hidayanto, and B Purwandari, 2022. Towards a model of research data management readiness in Indonesian context: an investigation of factors and indicators through the fuzzy Delphi method. Library & Information Science Research, 44 (1), 101141. https://doi.org/10.1016/j.lisr.2022.101141.

Mosha NF, and P Ngulube, 2023. Teaching research data management courses in higher learning institutions in Tanzania. Library Management, 44 (1/2), 166-179. https://doi.org/10.1108/LM-04-2022-0033.

Moyo M, and S Bangani, 2023. Data literacy training needs of researchers at South African universities. Global Knowledge, Memory and Communication, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/GKMC-02-2023-0041.

Mthembu M, and D Ocholla, 2022. Development strategies as catalysts for provision of the RDM services in the South African higher education institutions. South African Journal of Libraries and Information Science, 88(1), 1-8.

Muriisa RK, and AS Rwabyoma, 2019. Globalisation and knowledge production in higher education: the impact of internationalisation and liberalisation on university education in Rwanda and Uganda. African Journal of Public Sector Development and Governance, 2 (1), 26-48.

Mosha NF, ET Luhanga, MV Mosha, and JJ Marwa, 2020. Research Data Management Among Researchers in Higher Learning Institutions of Sub-Saharan Africa. In: Ngulube P (Ed.), Handbook of Research on Connecting Research Methods for Information Science Research IGI Global, Hershey, pp: 479-488. https://doi.org/10.4018/978-1-7998-1471-9.ch024.

Mushi GE, H Pienaar, M van Deventer, 2020. Identifying and Implementing Relevant research Data Management Services for the Library at the University of Dodoma, Tanzania. Data Science Journal, 19 (1), 1–9. https://doi.org/10.5334/dsj-2020-001

Nguyen TH, XC Le, and THL Vu, 2022. An Extended Technology-Organization-Environment (TOE) Framework for Online Retailing Utilization in Digital Transformation: Empirical Evidence from Vietnam. Journal of Open Innovation: Technology, Market, and Complexity 8, 200. https://doi.org/10.3390/joitmc8040200.

Nilashi M, O Keng Boon, G Tan, B Lin, and R Abumalloh, 2023. Critical Data Challenges in Measuring the Performance of Sustainable Development Goals: Solutions and the Role of Big-Data Analytics. Harvard Data Science Review, 5(3), 1-36. https://doi.org/10.1162/99608f92.545db2cf.

Ntja B, 2022. Enhancing the role of the libraries in South African Higher Education Institutions through Research Data Management: A case study of Cape Peninsula University of Technology. Faculty of Humanities, Library and Information Studies Centre (LISC). http://hdl.handle.net/11427/37692.

Onyancha OB, 2016. Open Research Data in Sub-Saharan Africa: A Bibliometric Study Using the Data Citation Index. Publishing Research Quarterly, 32 (3), 227–246. https://doi.org/10.1007/s12109-016-9463-6.

Patterton L, T Bothma, and M Van Deventer, 2018. From planning to practice: an action plan for the implementation of research data management services in resource-constrained institutions. South African Journal of Libraries and Information Science, 84 (2), 14-26. https://doi.org/10.7553/84-2-1761.

Pryor G, S Jones and A Whyte, 2014. Delivering research data management services: fundamental of good practice. London: Facet Publishing.

Rabasa TA, and A Abrizah, 2022. Academic librarians' roles and competencies in research partnership: A qualitative study. Malaysian Journal of Library and Information Science, *27*(3), 69–95. https://doi.org/10.22452/mjlis.vol27no3.4

Raju R, and L Schoombee, 2013. Research support through the lens of transformation in academic libraries with reference to the case of Stellenbosch University Libraries. South African Journal of Library and Information Services, 79 (2), 27-38.

Ramdani, B, D Chevers, and DA Williams, 2013. SMEs' adoption of enterprise applications: A technology-organisation-environment model. Journal of Small Business and Enterprise Development, 20(4), 735-753. https://doi.org/10.1108/JSBED-12-2011-0035.

re3data.org, 2024. Registry of Research Data Repositories. https://doi.org/10.17616/R3D.

Rod AB, B Zhou, and M Rousseau, 2023. There's no "I" in Research Data Management: Reshaping RDM Services Toward a Collaborative Multi-Stakeholder Model. Journal of eScience Librarianship, 12 (1), 1-17. 10.7191/jeslib.624. hal-04001425.

Singh RK, S Bharti, and DP Madalli, 2022. Evaluation of research data management (RDM) services in academic libraries in India: a triangulation approach. The Journal of Academic Librarianship, 48 (6), 102586. https://doi.org/10.1016/j.acalib.2022.102586.

Sheikh A, A Malik, and R Adnan, 2023. Evolution of research data management in academic libraries: A review of the literature. Information Development, 0(0). https://doi.org/10.1177/02666669231157405.

Tornatzky, LGM, F Tchell, and KC Alok, 1990. The Process of Technological Innovation. Lexington Books, The Free Press: Cochranton, PA, USA.

UNESCO, 2022. An introduction to the UNESCO recommendation on open science. https://doi.org/10.54677/XOIR1696.

Van Wyk, J, T Bothma, and M Holmner, 2020. A conceptual virtual research environment model for the management of research data, a South African perspective. Library Management, 41 (6/7), 417-446. https://doi.org/10.1108/LM-02-2020-0037.

Xu Z, 2022. Research Data Management Practice in Academic Libraries. Journal of Librarianship and Scholarly Communication 10(1), 1-31. https://doi.org/10.31274/jlsc.13700

Yaqoob, I, K Salah, R Jayaraman, et al. (2022). Blockchain for healthcare data management: opportunities, challenges, and future recommendations. Neural Computing and Applications, 34, 11475–11490. https://doi.org/10.1007/s00521-020-05519-w.

Zozus M, 2017. The data book: collection and management of research data. New York: Chapman and Hall/CRC. https://doi.org/10.1201/9781315151694.