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Exploring the feasibility of Research Data Management services in Zimbabwean academic libraries: the case of Zimbabwe School of Mines

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Abstract

The study applied an adapted Technology, Economic, Legal, Organisational, and Schedule (TELOS) model to explore the feasibility of Research Data Management (RDM) at the Zimbabwe School of Mines (ZSM). The study employed a qualitative approach. Data were collected through interviews that were held with purposively chosen professionals at ZSM in the form of the Information Technology (IT) manager, the Librarian, and three (3) Assistant Librarians. Findings show that ZSM does not currently meet the TELOS model feasibility test. ZSM lacks a robust technological system to support data creation, data collection and description, data storage, archiving and preservation, data access, data discovery and analysis, and data reuse and

transformation. ZSM has not yet created a legal environment conducive for the introduction of RDM. It does not have policies and standards in place to handle issues such as intellectual property, copyright, data licensing, ethics, data protection, freedom of information, and confidentiality. While librarians at ZSM possess basic IT and computer skills they lack skills specific for RDM. The study informs the shaping of policies, practices, and strategies regarding the introduction of RDM services in Zimbabwean academic libraries.

Keywords: research data management, academic libraries, TELOS model, feasibility, technology, legal environment, skills and knowledge, Zimbabwe School of Mines

Introduction

Institutions that conduct research create large volumes of data and information. Such institutions need to manage their research data. This is imperative because the information society has been inundated by an overload of unreliable and invalid information resources. Research Data Management (RDM) is one way to promote the publishing of credible information, arising from existing data sets that support the researcher's findings. RDM can also be used by institutions involved in research to justify the need for financial resources from funders. Many research funders now require beneficiary institutions to ensure that all research data are properly managed, preserved and archived for future use (Ball, 2013). For example, the Organisation for Economic Co-operation and Development (OECD) published a declaration on access to research data from public funding (OECD, 2007). This prompts organisations and institutions involved in research which receive public funds as grants for their studies to openly declare how the data sets of their researches will be managed. The National Science Board (NSB) in the United States of America (USA) earlier adopted an approach which prioritises RDM as a significant service to be prioritised by research institutions (National Science Board, 2005). Funding bodies in the United Kingdom (UK) such as the Medical Research Council (MRC), Cancer Research UK (CRUK), National Centre for the Replacement, Refinement and Reduction of Animals in Research (NC3Rs), the National Institute for Health

Research (NIHR), and Wellcome Trust have also instituted requirements for RDM (MRC, 2006; University of Leicester, 2015). The European Union (EU) has joined in the movement as EU funding bodies like Horizon 2020 requires a solid RDM Plan from potential beneficiaries (EU, 2019).

Research data is data generated when researchers undertake or execute any research activity or project. The data could be textual, quantitative, qualitative, images, recordings, musical compositions, verbal communication, experimental readings, simulations or codes (Manorama, 2017). RDM is a concept within the broader discipline of research life cycle. At each stage of the research cycle, from collection of data to archival or disposal, metadata needs to be generated and preserved for future use. Researchers that produce this data in the course of research activities can be from Higher Education Institutions (HEI) such as universities, polytechnics, teachers' colleges, and mining schools. They can also be from think tanks, institutes, and organisations or companies which have dedicated research and development departments (Lewis, 2010). These researchers find, collect, analyse and reuse data. They collect data from interviews or surveys which they deposit in the research data repository. HEI, for example, produce large volumes of data. The majority of HEI data comes from students who conduct researches in partial fulfilment of the requirements of their respective learning programmes and the lecturers who design modules for their classes and conduct researches for publishing purposes (Whyte & Wilson, 2010).

Researchers, as data creators, are responsible for providing information that would enable other researchers to assess the quality of those data and resultant research findings (Whyte & Wilson, 2010; Tenopir et al., 2014). The Consortium for European Social Science and Data Archives (CESSDA) (2017) implores researchers to provide detailed data documentation, which includes details about the sponsorship, design, history, setting, structure, format, and limitations of the datasets. CESSDA (2017) further states that documentation must fully capture the details of researches, including the instrument used, the sample, the response rate, and other relevant information. Research data should be useful to both novices and experts and must integrate into web infrastructure. Documentation must enable a user to search across and within studies at the study and variable-

levels. It must be able to support automatic generation of system files for popular statistical software. RDM makes research outputs more visible and increases the chance of finding both funding and collaborators for future projects (Cox & Pinfield, 2014).

Literature suggests efforts to establish RDM services in Africa, albeit with mixed results (Chiwere & Becker, 2018). In South Africa, the University of Cape Town (UCT) and Cape Peninsula University of Technology (CPUT) took advantage of the open access movement to launch RDM services in their institutions (Chiwere & Mathe, 2015). Librarians in these institutions were at the forefront of this initiative. The existence of cyber infrastructures, data-sharing mandates by funding agencies, and researchers who are committed to open science have made RDM adoption feasible at UCT and CPUT (Kruse & Thestrup, 2014). South Africa hosts the African Open Science Platform (AOSP), managed by the Academy of Science of South Africa (ASSAF) and funded through the National Research Foundation (NRF) which is resident in the Department of Science and Technology (Chiwere & Becker, 2018). The work of AOSP benefits the African continent by advocating for open science policy, ICT infrastructure, data sharing, collaboration, and capacity building. NRF's policy states that research funded by public funds should be archived in trusted repositories. This is widely communicated and accepted by most HEI and research institutions in South Africa (National Research Foundation, 2015). The Data Intensive Research in South Africa (DIRISA) was specifically created to fund South African universities and research institutions to create backups for their metadata and to facilitate open access. South Africa's success in RDM has, however, not been shared by other African countries. A study by Chiwere and Becker (2018) indicated that Namibia, Malawi, Zambia, and Lesotho did not have any reported activities pertaining to RDM in university and research libraries or at national level. Researchers in these countries were sceptical of data ownership and data confidentiality, pointing to the need for clear national or institutional guidelines on RDM practices.

In Zimbabwe, the Research Council of Zimbabwe (RCZ) is the overall board that is responsible for all the research activities and funding in the country. It assists in ensuring that research data is available for archiving

(Chigwada, Hwalima & Kwangwa, 2019). RCZ has forged relations with key stakeholders to support RDM initiatives in Zimbabwe. Ministries, including the Ministry of Higher and Tertiary Education, Science and Technology Development and Ministry of Information Communication Technology (ICT) and Cyber Security have pledged to provide the infrastructure and the resources that are needed for the development of RDM services. HEI have a good chance of receiving grants to introduce RDM services in their respective libraries because the RCZ has been lobbying and advocating for RDM among government institutions which have the potential to fund RDM adoption in HEI. The Zimbabwe School of Mines (ZSM) is an example of one HEI which receives grants from the government through the Zimbabwe Manpower Development Fund (ZIMDEF) and the Ministry of Mines and Mining Development.

ZSM is a regional institution located in Bulawayo, Zimbabwe's second largest city. It serves the mining industry in the Southern African Development Community (SADC) by providing competency based training for high calibre, hands-on technicians. The institution offers: National Certificates, National Diplomas, Higher National Diplomas, Professional Development Programs and Artisanal and Small Scale Mining Programs. ZSM plays a critical role in Zimbabwe and SADC's mining economies. The institution is reputed as a hub of transformational research, producing and harnessing scientific knowledge and related technological innovations to support the sustainable development of regional economies (Zimbabwe School of Mines, 2021). If latest revelations are anything to go by, however, the ZSM's lofty position is under threat. The Zimbabwe Chamber of Mines 2018 annual report expressed concern at the decline of quality research output from ZSM. This situation is very regrettable, as research from the ZSM informs national and regional level policies for the mining industry. Any collapse in research at ZSM has negative national and regional ramifications.

While the situation at ZSM cannot be blamed on one factor, the lack of RDM at the institution has not escaped scrutiny. Ndiweni (2020) alleges that a lot of research data were being lost at ZSM before being prepared for long term preservation. This loss compromises future research and presents lost research opportunities for the mining industry. If this situation continues it is

feared that the institution will lose research funding as its major benefactors, the government of Zimbabwe and the Zimbabwe Chamber of Mines might not take kindly to continuing to fund an institution that is not producing the expected research results (Ndiweni, 2020). The fact that ZSM does not offer any RDM services to its researchers was confirmed by the institution's Librarian in a pre-research interview. The Librarian, however, signalled the intention of the institution's library to offer RDM services to improve research output. This prompted the authors of this paper to embark on a study to explore the feasibility of introducing RDM at the ZSM. This study, which comes at the back of a paucity of similar studies in the country, is critical as any RDM initiative has to be met with the necessary conditions for its success (Kruse & Thestrup, 2014). Beyond the ZSM, this study will inform other HEI in Zimbabwe that want to introduce RDM.

Theoretical framework

This study adopted the Technology, Economic, Legal, and Organisational and Schedule (TELOS) feasibility model. The TELOS framework was proposed by James A. Hall in his 2007 book, "Accounting Information Systems" (Hall, 2007). Though the framework originated in the Accounting field, it has found resonance with a wide variety of fields due to its efficacy in establishing feasibility and improving the design of projects. The principles of this model were used to craft the objectives and research questions of this study. Table 1 shows the independent variables of this framework together with their dependent variables.

Table 1: The TELOS model

Feasibility	Components to be covered
Technological	Hardware and software requirements Data formats Quantity of research data produced Data repository versus licenses for data services
Economic	RDM Cost/Benefit analysis Risks in RDM
Legal	Research data ownership RDM policies
Organisational	Skills and knowledge required for RDM Researchers' attitudes towards RDM Institutional responsibility for RDM Management support Stakeholders for RDM
Scheduling	Implementation of RDM services When should RDM services provided

This study used aspects of the TELOS model relevant to the ZSM context. The Technology aspect of the model was used as one of the objectives of this study. This was chosen because RDM is a practical service which demands ICT infrastructure to be implemented. It is in this light that the technological requirements needed for establishing RDM services at ZSM were sought through this study. The Legal aspect of the model also informed one objective of this study. If RDM is to be introduced, it needs to be presented in a manner that adheres to organisational standards, meet funders' expectations and meet global standards of data documentation. In light of this, the study had to assess if ZSM has an enabling legal environment for providing RDM services. Under the Organisational factor of

the TELOS model, this study only focused on the skills and knowledge required for RDM on the part of librarians. Cox et al. (2015) point out that RDM need librarians with relevant skills and knowledge. The Economic and Scheduling components of the TELOS framework were not used in this study. Table 2 shows the updated version of the TELOS model used in this study.

Table 2: Updated TELOS model

Feasibility	Components to be Covered
Technology	Hardware and software requirements Data formats Quantity of research data produced Data repository versus licenses for data services
Legal	Research data ownership RDM policies
Skills and Knowledge	Specific skills set needed for RDM

Statement of the problem

The ZSM has suffered a decline in quality research output, a circumstance that undermines the institution's role in national and regional economic development and threatens its research funding. The decline in research has been partly blamed on the absence of RDM at the institution. The institution has now decided to address this problem by introducing RDM services; however, no study has been conducted to establish the feasibility of this plan at the institution. Any effort to introduce RDM in HEI should be preceded by a feasibility study to establish preparedness for such move; otherwise the initiative would fail (Kruse & Thestrup, 2014).

Purpose of the study

The study applied an adapted TELOS model to explore the feasibility of Research Data Management at the Zimbabwe School of Mines.

Research objectives

The objectives of the study were to:

- Find out the extent to which ZSM meets the technological requirements needed to establish RDM services;
- Determine the extent to which the ZSM has an enabling legal environment for providing RDM services; and,
- Examine if the ZSM library staff has the necessary skills and knowledge required for operating RDM services.

Research questions

The research questions of the study are as follows:

- To what extent does ZSM meet the technological requirements needed to establish RDM?
- Does the ZSM have an enabling legal environment for providing RDM services?
- Does the library staff at ZSM have the necessary skills and knowledge required for operating RDM services at ZSM?

Literature review

Technological requirements for RDM services

Academic libraries provide information support to the academic community in and around the university. Information and Communication Technologies (ICTs) have been used by academic institutions to improve teaching and learning practices and libraries have also moved abreast with these changes so as to remain relevant (Tenopir et al., 2017). Some services have been successfully automated but new technologies are discovered every day and may need to be adopted in the library. Although this is ideal to meet user expectations and needs, there are expectations associated with introducing new services like technological requirements and support infrastructure to contain these technologies. Academic libraries that provide research data management services need solid ICT infrastructure because RDM has different activities and processes associated with the data lifecycle, including the design and creation of data, storage, security, preservation, retrieval,

sharing, and reuse of data (Faniel & Connaway, 2018). Latham (2017) comment that RDM services provision needs librarians to consider stretching the libraries' infrastructures beyond capacity to accommodate the preservation of data sets. In light of this, one understands that academic libraries that are considering introducing RDM services need to think about the additional infrastructure required for long term data storage. Faniel and Connaway (2018) interviewed 36 academic library professionals in the United States of America (USA). Common concerns among respondents were on issues relating to long term storage and preservation of various file formats across disciplines.

RDM is a current trend in academic libraries. Libraries are showing a keen interest in adding RDM services because data management is seen as a natural extension of the existing library data curation support services to research (Latham, 2017). However, academic libraries need to properly strategise first on how they will introduce these services. The University of St. Andrews in England started off by acquiring the technical infrastructure which was focused on storage solutions in the form of data repositories. The same approach was used at the University of Edinburgh which had high performance computing (HPC) infrastructure in place before a formal policy of implementation was written on the process of RDM adoption in their library (Avuglah & Underwood, 2019). A similar technique was also followed in South Africa by some universities like the University of Pretoria (UP). Van Deventer and Pienaar (2015) claim that a task team comprised of the library and (IT) staff investigated the infrastructure and technological needs for RDM across the university before establishing RDM services. Steeleworthy (2014) posits that technology plays a central role in RDM activities therefore, it is vital to assess the technological landscape before embarking on the RDM program. This is also supported by a study by Pinfield, Cox and Smith (2014) which revealed that RDM requires significant levels of technology infrastructure. From the above cases, one appreciates that RDM needs librarians to test the technological feasibility of introducing RDM so as to successfully implement it in an academic library.

When comparing initiatives in Europe and America, we see that RDM application is enabled by the availability of technological resources that

support data curation services. However, in Africa, the case is different. Although some technologies that can be used in academic libraries are freeware and open source software, some libraries still have challenges of gaining access to these Web 4.0 tools which can promote access to research data. A study conducted in Nigerian academic libraries by Ukachi (2012) to assess the knowledge and usage of open source ICT tools revealed that there was low usage of these free ICT tools. The unavailability of internet access in most academic libraries in Nigeria disables the downloading of these software packages. Some African universities still face challenges in accessing telecommunications and data networks facilities needed for RDM activities. An example is the University of Zambia (UNZA) library which has limited technological resources to support research services. The available internet connection does not support the university population due to low bandwidth (Twaambo, 2018). The computer laboratory has very few computers to enhance access to digital storehouses. The library subscribes to some electronic resources through a consortium. However, even though the library has access to online remote databases, the local hardware and software technologies needed to facilitate this access are unavailable. African university libraries should start by prioritising the requisite infrastructural technologies needed for facilitating access to other services as a first step towards their aim of introducing technology intensive services like RDM.

Parsons (2013) argues that research data collection, storage, preservation and access are highly dependent on hardware and software used to house the data. Hardware refers to the physical components of a computer that include input devices such as keyboards, storage devices such as hard drives and output devices such as speakers and monitors and software is a set of programs, procedures, algorithms and its documentation concerned with the operation of a data processing system (Parsons, 2013). It is crucial that the data formats, data storage devices and quantities of data produced are determined in advance to successfully implement RDM. The choice of format for research data will determine how that data may be used, analysed, backed up, stored and potentially reused in the future thereby impacting on the choice of hardware and software requirements for RDM implementation (University of Queensland, 2017). Digital data needs to be

stored with caution because if the software and hardware used become obsolete, data may be lost. Eynden et al. (2011) postulates that it is best practice to use standard and open data formats for long-term preservation, avoiding proprietary formats, which may be readable only using specialised software.

Legal requirements for RDM services

RDM as a library activity can be successfully implemented by following set institutional standards or professional codes of best practice. Legal requirements are not limited to enforceable requirements which an academic library must follow to avoid prosecution, but extends to policies and procedures which bring out the best way of implementing RDM. The Australian Code for the Responsible Conduct of Research states that policies are required that address the ownership of research materials and data, their storage, their retention beyond the end of the project, and appropriate access to them by the research community (Australian National Data Service, 2013). Cox et al. (2017) report on an international study of RDM activities, services and capabilities in higher education libraries in Australia, Canada, Germany, Ireland, the Netherlands, New Zealand and the UK. The results of the survey indicate that libraries have provided leadership in RDM, particularly in advocacy and policy development. At supra-institutional level, library consortia, such as Research Libraries UK and CARL (Canadian Association of Research Libraries), have played a significant role in influencing national policy developments, including working with funding agencies and designated bodies, such as Jisc (UK), Australian National Data Service (ANDS), and Research Data Canada. The extent of the coordination of RDM activities by such organisations may in turn influence RDM leadership demonstrated in institutions (Cox et al., 2017).

Higman and Pinfield (2015) maintain that it is important in policy development process to indicate clearly the roles and responsibilities of the different institutional stakeholders and, more especially, of the library, which is often seen as a mere provider of information resources. It must be clear if the library has the autonomy and power to plan and write policies ahead of introducing RDM services. Cox et al. (2017) have noted that, in the UK's

higher education sector, RDM policy formulation and services development have created complex sets of networks within and beyond institutions, involving different role players with varying priorities. Differing interests from different internal and external stakeholders must be addressed in order for the RDM policy to be accepted and for it to achieve the desired results. At Cape Peninsula University of Technology (CPUT) for example, their approach to setting up a leadership team to plan and determine RDM policies was to set up an institutional RDM Working Group made up of the Library, Research Office, faculty research representatives, ICT staff, Records and Archives services, the institutional Quality Management unit, the institutional ethics committee chair, research chairs, heads of research units and centres, and the Centre for Postgraduate Studies (Chiwere & Mathe, 2015). The CPUT strategy ensures involvement of key players from different backgrounds in shaping RDM policy.

The legal feasibility of a proposed project includes a thorough analysis of any potential legal ramifications resulting from the construction and implementation of the new project (Marakas & O'Brian, 2014). It determines whether the proposed system conflicts with legal requirements, for example a data processing system must comply with the local data protection regulations, according to the laws of the land. Greenbaum and Gerstein (2003) acknowledged that it has become increasingly apparent that to achieve seamless access to data, it is necessary not only to adopt appropriate technical standards, practices and architecture, but also to develop legal frameworks that facilitate access to and use of research data, whether on an inter-organisational basis or across national borders. Nhendodzashe (2017) argues that there is a need to understand the legal obligations surrounding RDM because it guides the preservation and access of research data. The UK Data Archive (2015) emphasises that before embarking on an RDM project, it is imperative to know your legal, ethical and other obligations regarding research data, research participants, colleagues, research funders and institutions. RDM legal obligations broadly include intellectual property rights which encompass trademarks, design rights, patents and copyright (Carroll, 2015).

Legal obligations also take into consideration issues of governance of RDM. Data governance is the system of rights, rules, and responsibilities that specify who can do what with data. Many of the skills needed to deal with data governance are those that librarians already possess: experience dealing with licensing terms and agreements, knowledge about copyright, and the ability to read contracts carefully to bring out ownership issues (Strasser, 2014). Much of the complexity of data governance is related to the array of stakeholders in the data being produced. Various stakeholders have different needs from and investments in the data and are not always clear about their rights and responsibilities in relation to that data. A detailed understanding of legal obligations regarding research data is also centred on access and use. While several authors have provided benefits of open access to data, there has not been agreement on whether research data should be made available without any restrictions (Strasser, 2015; Schopf et al., 2017; Wessels et al., 2014). The UK Research and Innovation (2015) argues that there are sometimes legitimate reasons to restrict access to data. Institutions should ensure they are aware of relevant legislation in particular regarding data protection, freedom of information and environmental information regulations and disseminate this to their researchers as appropriate. Additionally, the Royal Society (2012) suggests that open access to data must ensure that the provenance and clarity of data and metadata are clearly understood by stakeholders and by those accessing the data. This is particularly important for RDM which deals with researcher's intellectual property.

Higman and Pinfield (2015) opine that RDM policies respond to a number of drivers, including data collection, storage and preservation, but also data access and sharing (Pinfield et al., 2014). Policies are mostly used to provide credentials for those championing RDM, gain access to funding for IT infrastructure (Pryor, Jones & Whyte, 2014), clarify institutional positions, and outline roles and responsibilities (Brown & White, 2014). Patel (2016) recommends that the institutional RDM policy should clearly spell out the following in the context of data sharing: purpose, scope, applicability and guidelines to the data contributors relating to data submission, licensing, metadata entry, data classification, copyright agreements and conditions under which the data withdrawal requests, if any, will be considered, terms

and conditions of the use of data, protection of confidentiality of sensitive data, protection of data against security breaches, and intellectual property (IP) concerns. However, the policies are not without difficulties. There are, for example, concerns that they will become unachievable statements of aspiration as opposed to intent (Brown & White, 2014). Even when policies are written realistically there remains a significant risk that they will be unfulfilled without considerable cultural change (Pryor, Jones & Whyte, 2014). Chigwada et al. (2017) comment on RDM in research institutions in Zimbabwe and show that researchers have largely been left to do their own data management without institutional guidelines and data management policies.

Skills and knowledge requirements for RDM services

The success of RDM implementation programmes also rest on the required, expected and mandatory skills and knowledge levels and capacities of the librarians offering those services (Cox et al., 2017). Henderson and Knott (2015) observe that the introduction and success of RDM services in academic libraries calls for the need to hire new staff or re-skilling and up-skilling of librarians to take up new roles and responsibilities. Many academic libraries are hiring data librarians to cater for the emerging role of RDM. For example, the Virginia Commonwealth University libraries, Witwatersrand University, and University of Pretoria, among others, have data services librarians specifically skilled and trained for RDM (Van Wyk & Van der Walt, 2014; Henderson & Knott, 2015).

Several studies have cited the importance of library staff training in the area of data curation and management services. For example, identifying and collecting data and data sets to include in repositories has become a necessary skill for research librarians. Newton, Miller and Bracke (2011) in their exploration of the librarian's role in institutional data set collection, found strong evidence that although research libraries through their connections with faculty across campus and their expertise in developing traditional collections are prime candidates for developing scientific data collections for universities, additional skills are required to populate an institutional repository with relevant data. In particular, libraries need to make

use of professional relationships and collaborations with faculty across fields and between institutions to identify materials.

Creamer (2015) found that of the needed data competency areas, the greatest need for librarians was ICT skills because the majority of librarians' expertise is limited to traditional materials. Research data services and bibliometrics services are relatively new skills that librarians need and do not possess. Identifying and collecting data and data sets to include in repositories requires IT skills. Ameen (2006) argues that the problem of inadequate skills originates in library schools that produce graduates who are insufficiently skilled. This is supported by Newton, Miller and Bracke (2011) who emphasised that librarians would be in a better position to develop scientific data collections for universities if they possessed additional skills in data management.

MacDonald and Martinez-Urbe (2010) have come up with data curation requirement skills for academic librarians that are ideal for RDM services as suggested by departmental heads, IT staff, principal investigators, records managers, archivists and research office staff. These skills include: information management, computing, economics, institutional governance, and understanding social dynamics. RDM calls for collaboration among various departments to establish a data curation system which combines both resources and expertise. Data curation competence has become necessary for academic librarians because funding agents have come to the realisation that their investments to have datasets generated and preserved is not being properly curated or fully utilised and is often lost by librarians due to the lack of adequate curation skills (Heidorn, 2011).

At New York University Libraries (NYUL), the research support services library staff members provide high performance computing machines and geographic information systems. They also assist in quantitative and qualitative data analysis; data finding and management; the digitisation, creation, manipulation, storage, and sharing of media content; repository services; digital preservation; streaming media platforms; digital journal publishing; online collaboration; and intellectual property consultation (Vinopal & McCormick, 2013). These services are offered in conjunction with a unit of the IT Services at NYUL. This places emphasis on the role played by

academic libraries in collaboration and in connecting resources in order to offer superior services. As each institution has different cultures and needs, the scope of the services offered by research support centres in a library depends on institutional needs. However, ICT skills are indispensable (McCullough, 2014).

Tenopir et al. (2015) investigated data intensive roles for the future in selected Association of College and Research Libraries (ACRL) library directors across the United States of America and Canada. Respondents were asked how their libraries had developed staff capacity for RDM. About 25% of those offering RDM indicated that they had reassigned existing staff. Only a few had hired new staff. However, the 2011 baseline survey of academic librarians by Tenopir et al. showed that many academic librarians did not feel prepared to take on these new roles despite plans by their libraries to offer RDM. Similarly, Cox and Pinfield (2014) conducted a study which revealed that libraries had patches of the relevant skills but these were not widely spread. Librarians were found to be strong in the following skills: cataloguing including metadata, digital preservation, curation, training, academic engagement, copyright, and the publication process. Over 50% said the library staff did not have the right RDM skills (Tenopir et al., 2011).

Methodology

The study employed a qualitative approach. Data were collected through interviews that were held with purposively chosen professionals at ZSM in the form of the Information Technology (IT) manager, the Librarian, and three (3) Assistant Librarians. The qualitative approach allowed the respondents room to speak their views concerning the feasibility of introducing RDM at ZSM. The depth of data enabled by the qualitative approach was of immense benefit to the study as it made for greater understanding of the issues at stake.

The IT manager was included to assist with the first research question which deals with technological feasibility of introducing RDM at ZSM. The IT department manages all the technological assets of ZSM. The IT manager's input was therefore indispensable. The Librarian's voice was critical because she heads the department responsible for implementing RDM at ZSM. The

Librarian's views were invaluable in addressing the three objectives/research questions of this study. The Librarian was able to shed light on the technological readiness of ZSM for the introduction of RDM, availability of an enabling legal environment for the provision of RDM services, and whether library staff at ZSM had the requisite skills and knowledge required for introducing RDM services. The Librarian, as one of the principal officers of ZSM was also able to speak to policy issues relevant to the objectives of the study regarding the feasibility of introducing RDM at the institution. The Assistant Librarians work as an interface between the institution's library and the researchers whose intellectual output is the subject of RDM. It was important to determine if they had the skills and knowledge to deal with RDM issues. Assistant Librarians were, therefore, included to augment the Librarian's responses to the third research question. Table 3 summarises the sources of data for the study's research questions.

Table 3: Sources of data for research questions

No.	Research Question	Source of Data
1.	To what extent does ZSM meet the technological requirements needed to establish RDM?	IT Manager Librarian
2.	Does the ZSM have an enabling legal environment for providing RDM services?	Librarian
3.	Does the library staff at ZSM have the necessary skills and knowledge required for operating RDM services at ZSM?	Librarian Library Assistants

The study complied with research ethics. Permission to conduct the study was secured from the Registrar of ZSM. The respondents agreed to participate in the study. They were advised of their right to withdraw from the study at any point without suffering any prejudice. No procedures during the conduct of the study exposed respondents to any harm.

Results and discussion

Interviews were successfully held with the IT Manager, Librarian, and three Assistant Librarians. Each interview took approximately twenty (20) minutes. The interviews were recorded with the permission of the interviewees. This facilitated data retention for analysis purposes. The collected data were thematically analysed. The results are organised according to themes emerging from the data in line with the research questions of the study.

Technological requirements for RDM services

The first research objective sought to find out the extent to which ZSM meets the technological requirements needed to establish RDM. The IT manager was concerned that the technological infrastructure at ZSM was far below the standards expected to accommodate RDM services. He indicated that ZSM lacked a robust technological system to support data creation, data collection and description, data storage, archiving and preservation, data access, data discovery and analysis, and data reuse and transformation. The items of requirements identified by the IT manager as lacking at ZSM are needed for RDM according to the TELOS framework (Hall, 2007) and the Data Lifecycle Model (Fary and Owen, 2013). The IT manager indicated that a server, content management software, Local Area Network (LAN) infrastructure and network infrastructure are key hardware components needed when a library is considering to introduce RDM services. In terms of software requirements needed for successfully introducing RDM services, the IT manager commented that this can be achieved either by a file server or web based system, or an operating system such as Windows or Linux. In emphasising the technologies needed for RDM the IT manager said:

The technological infrastructure needed for RDM covers a wide range of technologies, which are costly to establish, and for which we currently do not have a budget. The technologies include those needed for collecting, storing, processing, organising, transmitting, and preserving data. We also need platforms that allow communication and collaboration. The range of the required infrastructure includes networks, databases, authentication systems, and software applications. All these systems require adequate funding to establish and maintain, and appropriately skilled human capital to successfully run the service.

In addition to appropriate hardware and software the IT manager pointed out that technological feasibility necessarily includes policies and standards. This he said was necessary because raw data collected through different avenues such as observations, experiments, modelling, and simulations usually need to undergo processing, transformation, and quality check before the data can be used for analysis. The IT manager said differences in data types and formats within and across disciplines can become barriers for data sharing and reuse hence the need for suitable policies and standards to go with the technology. These policies and standards were not yet in place at ZSM.

Just like the IT manager, the Librarian had reservations about the technological preparedness of ZSM to institute RDM. The Librarian's concerns centred on lack of hardware and software facilities to support RDM services, lack of institutional repository to store research data and data sets, and unreliable internet connection. The Librarian indicated that currently ZSM stores data in physical format. This has had the effect of undermining investment in technology such that any move to introduce RDM should be preceded by heavy financial commitment to buttress technological facilities at ZSM. The Librarian indicated that the library department is the major proponent of the introduction of RDM at ZSM; however, this should be accompanied by the requisite investment in hardware and software facilities and a commitment to upgrade the technologies when necessary to avoid data loss.

The concerns by both the IT manager and Librarian at ZSM about the technological preparedness of the institution to introduce RDM are shared by several institutions in Africa. The challenges mainly stem from lack of funding to acquire or upgrade technological facilities. In Nigeria for example, Ukachi (2012) points out that many institutions of higher learning could not introduce RDM due to challenges with technology. Many of the institutions did not even have internet connection to download free software packages. Twaambo (2018) speaks of the situation at the University of Zambia where RDM services were undermined by lack of technological facilities. Some African institutions, however, such as the University of Cape Town (Kruse & Thestrup, 2014) and Cape Peninsula University of Technology (Chiwere &

Mathe, 2015) have managed to surmount these challenges and succeeded in running RDM services. This should provide hope to other African institutions that with the right support and investment it is possible to run successful RDM services.

Legal requirements for RDM services

The second research objective sought to determine the extent to which ZSM has an enabling legal environment for providing RDM services. The Librarian indicated that currently ZSM does not have legal policies and standards in place to facilitate the operation of RDM services. She said:

The Zimbabwe School of Mines in general and the library department in particular do not yet have an enabling legal environment to run RDM. There are many issues that still need to be tied up legally, in terms of policies and standards. These include issues of intellectual property, copyright, data licensing, ethics, data protection, and confidentiality issues.

The Librarian indicated that there was a need to craft a policy that defined who holds intellectual property for data sets submitted to the library as part of RDM. She noted that while in other institutions intellectual property created by staff and students are generally owned by the respective institutions there are always issues when other stakeholders such as partners, collaborators and funders are involved. The Librarian also indicated that the reuse of data advocated for in RDM has to take into account copyright issues and the conditions and restrictions that might be imposed by policy. It was also important to license all published research data to show what users may or may not do with it. Issues of ethics would involve the practices in collecting and sharing personal or sensitive data and the acquisition of necessary consent from participants who provided such personal or sensitive data.

The Librarian also indicated that it was necessary to come up with data protection policies that give individuals the right to know what information is held about them while detailing how this information is preserved and how it is protected from unauthorised access. Legal policies that are still lacking at

ZSM according to the Librarian include freedom of information (FOI) requests for access, where data from publicly funded research might of necessity need to be released. This requirement for release might conflict with confidentiality rights of the researchers and participants of studies. Data might also be subject to commercial confidentiality or collaboration agreements that prevent data sharing or place restrictions on how data may be used. This typically occurs where such data was obtained from a commercial partner or licensed from a provider.

The Librarian indicated that in the current state of lack of data management policy at ZSM the library kept no research data. However, some academic departments at the institution keep physical copies of their research data. This was done without any clear policies concerning the collection, storage, preservation, and access to such data. Some individual researchers keep their data in electronic form in folders in their computers while some keep printed copies in their drawers. There is no coordination of the data and the institution does not know what amount and type of data is being held by departments and researchers at the institution. The consequences of such lack of research data management policy is too ghastly to contemplate. The Librarian indicated that leadership at the institution has already begun conversations on how this can be rectified at policy level.

It is evident from the preceding discussion that the range of legal issues that needs to be dealt with before operating RDM are quite vast. Chiware and Becker (2018) note that many institutions in Africa have not developed the necessary legal environment for RDM. RDM policies and standards are lacking even at national level in countries such as Namibia, Malawi, Zambia, and Lesotho (Chiware & Becker, 2018). This goes against the expectations of the TELOS model that envisages the creation of an enabling legal environment to deal with issues pertaining to research data ownership and RDM policies, among other legal issues. Fitzgerald and Pappalardo (2007) have impressed upon the importance of academic institutions crafting legal policies to handle RDM issues of copyright, privacy, data protection, and access.

Skills and knowledge requirements for RDM services

The third research objective examined if the ZSM library staff had the necessary skills and knowledge required for introducing RDM services. The Librarian felt there was a wide range of skills needed to successfully run RDM. Some of the skills were already resident in the library team that she leads. Some required skills, however, were evidently missing and would have to be acquired through training or employing appropriately skilled staff to add to the current pool of librarians. The Librarian said:

The task of running a research data management service in an institution such as ZSM is an elevated role that requires numerous skills. Fortunately as librarians we are already trained in some skills such as basic computer skills, metadata, digital preservation, curation, copyright, and the publication process. We, however, lack many other skills that are necessary for RDM. I am not sure, for example, that my staff, without further training, can handle different data types such as observation data, experimental data, computer modelled data, simulated data, text, spreadsheets, videos and other forms of data. I also doubt that as a library we can say we are confident of handling the technical aspects of RDM technology, intellectual property disputes, data description, and issues of data access. I however, hope that with the necessary training and with a clear RDM policy we will be equal to the task as a library.

Assistant Librarian 1 was asked about the skills he felt he needed to operate successfully in RDM environment. He said he will need strong liaison skills to work with researchers in academic departments for the purpose of acquiring data sets. In addition, he said while he possesses general IT skills and can work with computer hardware he was not sure he can handle specific RDM software applications without training. Assistant Librarian 2 was asked about whether she possessed skills for RDM and she said:

I don't know much about research data management but from what I have read I would certainly need to be trained to come to grips with the system when it is introduced. I cannot say much at the moment since I don't know what the specifics of the system will entail.

Assistant Librarian 3 was confident of her IT skills but still indicated that she would need training in technologies and practices specific to RDM.

She indicated that she would need to improve her data curation skills, subject or disciplinary knowledge, knowledge of research methods, knowledge of research processes, and how to handle scientific data produced by researchers at ZSM.

The theme that emerges from data collected from the Librarian and the three Assistant Librarians is that library staff members at ZSM were not fully equipped to handle RDM. It is important, however, that all the interviewed librarians were receptive of RDM and were willing to be trained to offer the service. Researchers such as Henderson and Knott (2014) and Cox et al. (2015) have written about the need to up-skill librarians to offer RDM because it is a new experience to many of them. To address the RDM skills issue some institutions such as the Virginia Commonwealth University libraries, Witwatersrand University, and University of Pretoria have hired data services librarians specifically skilled and trained for RDM (Van Wyk & Van der Walt, 2014; Henderson & Knott, 2015).

Conclusions

The researchers conclude that ZSM does not currently meet the TELOS framework feasibility test as seen through the prism of technology, legal environment, and skills and knowledge required for the implementation of RDM. ZSM lacks a robust technological system to support data creation, data collection and description, data storage, archiving and preservation, data access, data discovery and analysis, and data reuse and transformation. ZSM has not yet created a legal environment conducive for the introduction of RDM. It does not have policies and standards in place to handle issues such as intellectual property, copyright, data licensing, ethics, data protection, freedom of information, and confidentiality, among other issues. The researchers further conclude that while librarians at ZSM possess basic IT and computer skills they lack skills specific for RDM.

Recommendations

The researchers make the following recommendations to improve the preparedness of ZSM to introduce RDM at the institution:

- There is an urgent need for ZSM to invest in RDM technology capable of supporting data creation, data collection and description, data storage, archiving and preservation, data access, data discovery and analysis, and data reuse and transformation. The institution needs LAN and network infrastructure, with appropriate server and authentication systems, computer hardware, and content management software. Admittedly, the technological infrastructure is costly. However, ZSM can take advantage of funding availed through the Research Council of Zimbabwe; Zimbabwe Manpower Development Fund; Zimbabwe Chamber of Mines; the Ministry of Higher and Tertiary Education, Science and Technology Development; and Ministry of Information Communication Technology (ICT) and Cyber Security. These funders have pledged to provide the infrastructure and the resources that are needed for the development of RDM services.
- ZSM should consider developing a legal framework for RDM which, according to Patel (2016), must handle issues of purpose, scope, applicability and guidelines to the data contributors relating to data submission, licensing, metadata entry, data classification, copyright agreements and conditions under which the data withdrawal requests, if any, will be considered, terms and conditions of the use of data, protection of confidentiality of sensitive data, protection of data against security breaches, and intellectual property concerns.
- The library staff at ZSM must be trained in preparation for the introduction of RDM. There are several online trainings on RDM held regularly by leading international universities that ZSM can take advantage of. ZSM can also second some of its staff to go and learn from institutions that are successfully running RDM in the region. South African universities such as the University of Pretoria, University of Cape Town, and Cape Peninsula University of Technology have done well in their implementation of RDM. ZSM and other Zimbabwean institutions have a lot to learn from these institutions.
- In order to drive the RDM agenda ZSM must establish a broad-based RDM Working Group made up of various relevant units and individuals

within the institution. At Cape Peninsula University of Technology, for example, such a Working Group comprised of the Library, Research Office, faculty research representatives, ICT staff, Records and Archives services, the institutional Quality Management unit, the institutional ethics committee chair, research chairs, heads of research units and centres, and the Centre for Postgraduate Studies (Chiwere & Mathe, 2015). The involvement of key players from different backgrounds in driving RDM establishment and operation would bring harmony and common purpose towards the RDM goal. This is in addition to the benefit of having different talents and skills collaborating for a common institutional good.

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