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5-21-2020

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Nwabugwu, Mgbodichima Jummai and Godwin, Lucky Stephen, "RESEARCH DATA MANAGEMENT (RDM) SERVICES IN LIBRARIES: LESSONS FOR ACADEMIC LIBRARIES IN NIGERIA" (2020). *Library Philosophy and Practice (e-journal)*. 4238.

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**RESEARCH DATA MANAGEMENT (RDM) SERVICES IN LIBRARIES: LESSONS
FOR ACADEMIC LIBRARIES IN NIGERIA**

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ABSTRACT

Research funding organizations understand the importance of infrastructure and services to organize and preserve research data. Academic research libraries have been identified as locations in which to base these research data management services. Research data management services include data management planning, digital curation (selection, preservation, maintenance, and archiving), and metadata creation and conversion. However, some libraries are beginning to provide structure for research data management services. These services are starting to record some degree of success as local data policies are being formulated. The aim of this paper, therefore, is to discuss the importance of research data management in the academic libraries in Nigeria. The article summarized the research data management life cycle to include: data creation; data collection and description, data storage; data archiving and preservation; data access; data discovery and analysis, and data reuse and transformation. The paper further identified research data management tools and applications, which include DMPonline, Data Asset framework, Collaborative Assessment of Research Data Infrastructure and Objectives (CARDIO), and Curation cost exchange. Specifically, the paper examines some skills requirements for research data management in academic libraries. Some of the challenges facing effective research data management services identified by this paper include technology obsolescence, technology fragility; Lack of guidelines on good practice; Inadequate financial and human resources to manage data well, and Lack of evidence about best infrastructures.

Keywords: Data Management, Research Data Management Service, Data Planning Tools
Academic libraries

INTRODUCTION

The management of research data has become topical. The aim is to make the research process efficient, increase research impact, data planning, preserve data by depositing it in a repository, maintain and document the data throughout its life cycle, meet grant requirements, promote discoveries and support open access. The science they say has entered a paradigm that is more computational, collaborative, and more data-intensive, the scientific process is enhanced by managing and sharing research data. Good research data management practice allows reliable verification of results and permits new and innovative research built on existing information. Tenopir, Birch, and Allard (2012) argue that, as science grows and moves toward more collaborative, data-intensive, and computational research, researchers are faced with various data management needs. Research data management service is also mandated for scholarly researchers (Holden, 2013).

The persistent use of computing technology across disciplines now means that an increasing number of researchers generate and use large datasets and digital data as part of the research process. Simply storing these data in a form that can be easily accessed, processed, and analyzed is challenging. The datasets are potentially fragile, being vulnerable to storage failures, and technological obsolescence. A whole range of other activities commonly associated with datasets, such as reformatting them for analysis in various software packages; shipping them between sites; processing them for potential reuse; and carrying out different preservation actions upon them, all create challenges the responsibility for addressing these challenges (in both the short and long term) is likely to fall on institutions (Cox & Pinfield, 2014). As a result, higher education institutions in many countries are beginning to develop infrastructures to support researchers to manage their data more effectively, with services ranging from advice to storage repositories (Jones, Pryor & Whyte, 2013).

Across the world, organizations, institutions, research funders, governments, and legislations are increasingly recognizing the importance of research data management. RDM is the documentation, curation, and preservation of research data. RDM activities ensure long-term value and utility of research data for new analyses and replication of study findings (Flores, Brodeur, Daniels, Nichollas & Turnator, 2015). Some libraries have always offered a variety of

research services, but as digital data became more prevalent and the need to manage them more pressing, academic libraries began incorporating RDM into the research services offered. These RDM services include needs assessment in user communities, policy development; advocacy, awareness, training; advisory services; data repository development; helpdesk services; and data management plan (DMP) development (Flores, et al. 2015).

According to Tenopir, Sandusky, Allard & Birch (2012), the majority of librarians strongly felt that they have the responsibility of providing research data services to patrons and to increase institutional visibility and research impact. Tenopir, Hughes, Allard, Fram, Birch, Baird, Sandusky, Langseth and Lundeen (2015) found out that of those libraries offering research data services, librarians, committees and departments were responsible for research data services planning. The results also stressed that out of the 128 directors, 83.7% stated that librarians should be stewards of all types of scholarships, including data sets. 68.6% indicated that losing data sets jeopardize the future of scholarship, while 76.7% pointed out that the library needs to offer research data services to remain relevant to the institution. Surkis & Read (2015) stressed the importance of librarians in data management because there has been a paradigm shift from primarily focusing on publications as the only significant research output as per tradition towards recognizing that research data are an essential output of the research process. As such, the involvement of librarians in data management has become important, and it facilitates data discoverability, accessibility, and understandability.

PURPOSE OF THE STUDY

Taking into consideration the benefit of research data management services, academic libraries can situate themselves in the RDM landscape so that they can make strategic decisions, support RDM development and work with those parties outside of the library to address emerging research needs. The purpose of this paper is, therefore, to call the attention of academic libraries, especially in Nigeria, to the importance of RDM service delivery. The article discusses the concept of research data management, the landscape and stakeholders involve in RDM, the Data Management Life cycle, skills, and tools for RDM in Academic libraries. The paper further discusses RDM Services in academic libraries and the roles of academic libraries in RDM service delivery. Some of the challenges facing successful research data management services were also identified.

CONCEPT OF RESEARCH DATA MANAGEMENT (RDM)

Research data management is the process of ingesting, storing, organizing, and maintaining the data created and collected by an organization (Rouse, 2019). Data is seen as a corporate asset that can be used to make more-informed business decisions, improve marketing campaigns, optimize business operations, and reduce costs. Research data management is the management, preservation, and sharing of data that are integral to modern research practice. Galetto (2016) sees Data management as an administrative process that includes acquiring, validating, storing, protecting, and processing required data to ensure the accessibility, reliability, and timeliness of the data for its users. Research data management refers to the storage, access, and preservation of data produced in particular investigations or research projects. These services support the full data lifecycle, including data management planning, digital curation, and metadata creation and conversion (Tenopir, Sandusky, & Birch, 2014). Data management plans state what data will be created and how it outlines the procedures for sharing and preservation, noting what is appropriate given the nature of the data and any restrictions that may need to be applied (DCC,2019). Digital curation involves maintaining, preserving, and adding value to digital research data throughout its lifecycle. The active management of research data reduces threats to their long-term research value and mitigates the risk of digital obsolescence. As well as reducing duplication of effort in research data creation, curation enhances the long-term value of existing data by making it available for further high-quality research.

Research data management concerns the organization of data, from its entry to the research cycle through to the dissemination and archiving of valuable results. Research data management is part of the research process. It aims to make the research process as efficient as possible and meet the expectations and requirements of the university, research funders, and legislation. Research data management is the sum of activities undertaken concerning the collection, processing, preservation, and sharing of research data throughout the research lifecycle. It encompasses activities carried out by both researchers and research organizations. Pinfield, Cox, and Smith (2014) asserted that research data management is a complex issue involving multiple activities carried out by various actors addressing a range of drivers and influenced by a broad set of factors. According to Davidson (2014), researchers, librarians, administrators, ethics advisors, and IT professionals all have a vital contribution to make in ensuring that research data and related information is available, visible, understandable and usable over the mid- to long-term. These services are provided in complex environments and require systematic and holistic approaches from many of the key players involved in research support services. University and

research libraries have thus been responding by taking on the responsibility and leadership of managing research data.

Research data management is the care and maintenance of the data that is produced during a research cycle. It is an integral part of the research process and helps to ensure that your data is appropriately organized, described, preserved, and shared. Funding agencies (especially the federal government) are increasingly requiring data to be made available and requiring the creation and execution of a Data Management Plan (DMP), which is a formal document that states what you will do with the data during and after your research project. According to Whyte and Tedds (2011), research data management concerns the organization of data, from its entry to the research cycle through to the dissemination and archiving of valuable results. It aims to ensure reliable verification of results, and permits new and innovative research built on existing information'. Research data management is essential because data are a valuable resource whose production requires time and money (Corti, Van den Eynden, Bishop & Woollard 2011).

Corti, Van den Eynden, Bishop & Woollard (2011) put great emphasis on research data sharing because it enables scientific enquiry and debate, promotes innovation, transparency and accountability. It will enhance the examination of research findings, validation of research methods, avoiding duplication of data collection, increase research visibility, collaborations between and among data users and data creators. Research data would enable other researchers to discover, interpret, and reuse the data as well as to sustain the value of the data by allowing others to verify and build upon the published results. Corti, Van den Eynden, Bishop & Woollard (2011) suggested that best practice research data management should address issues relating to which data will be generated during research, metadata, standards, and quality assurance measures, modalities for sharing and securing data, ethical and legal issues relating to data sharing that include copyright and intellectual property rights of data, data storage and backup, resources and costs associated with data management and, data management roles and responsibilities. Therefore, a data management plan addressing all these issues must be in place.

A recent study in the UK (Davidson, 2014) showed that the emergence of data-intensive science and the establishment of data mandates are motivating academic and research librarians to develop research data services for faculty and students. These responses are prompting library directors to plan for additional research data services. Such as policy development, advocacy,

awareness, and training; advisory services; data repository development (Cox & Pinfield 2013); At the same time, many librarians are looking for opportunities to develop their research data services-related skills (Tenopir et al. 2014). Tenopir, Sandusky, Allard & Birch (2014) acknowledged that there had been an increasing need for libraries and librarians to play a leading role in research data management. The authors went further to give examples of new functions of librarians as a result of this new development. The new roles would see librarians as managers of data, datasets, and data curation managers. Surkis & Read (2015) concurred with Tenopir, et al. (2014) and further noted that librarians now provide a range of services in research data management that includes teaching data management to researchers, assisting researchers in improving their data management practices, creating data management subject guides, and assisting in supporting funding agency and publisher data requirements.

According to Tenopir, Sandusky, Allard & Birch (2012), the majority of librarians strongly felt that they have the responsibility of providing RDM service for patrons and to increase institutional visibility and research impact. Tenopir, et al. (2015) found out that of those libraries offering research data services, librarians, committees, and departments were responsible for research data services planning. The results also stressed that out of the 128 directors, 83.7% stated that librarians should be stewards of all types of scholarships, including data sets. 68.6% indicated that losing data sets jeopardize the future of scholarship, while 76.7% pointed out that the library needs to offer research data services to remain relevant to the institution. Surkis & Read (2015) stressed the importance of librarians in data management because there has been a paradigm shift from primarily focusing on publications as the only significant research output as per tradition towards recognizing that research data are an essential output of the research process.

The involvement of librarians in providing RDM services has become important because it facilitates data discoverability, accessibility, and understandability. However, Peters and Dryden (2011) found that the most important data services needed by researchers are mainly directional ones. This includes grant proposal support for data management planning, locating data-related services, publication support, and specific data management assistance. Another study (Bach, 2012), however, found that, of the surveyed biodiversity data repositories, most only deliver low-level support for users. Many librarians and researchers engaged with RDM have discussed the

possible roles for both libraries and librarians in providing RDM services (Association of Research Libraries, 2006)

RESEARCH DATA MANAGEMENT LANDSCAPE AND STAKEHOLDERS

RDM improvement depends on the collaborative and coordinated work of many engaged partners. Considering the job of the academic library in exercises at any of these levels requires a general thought of the current RDM landscape. Building up the different partners engaged with RDM exercises and characterizing their interests, jobs, and duties make it conceivable to identify activities where the library is well situated to facilitate and coordinate RDM development. According to Pinfield (2014), RDM stakeholders can be assembled into four main categories;

- ***Governments and Funding Agencies:*** These are primary funders of academic research; they have an interest in getting the most out of the return on their investments.
- ***University Leadership:*** These include University Vice-Chancellors, Chief Information Officers, Heads of Research Units, and University Librarians reflect their responsibilities to influence government agencies and funders.
- ***Institutional Researchers:*** Institutional researchers' interests include ensuring compliance, advancing the creation and preservation of knowledge, tracking research output, and building the institution's reputation and prestige.
- ***Research Support Units:*** They include Campus IT Service Providers, Research Libraries, Federated Groups, and Infrastructure Providers.

RESEARCH DATA MANAGEMENT (RDM) LIFE CYCLE

Fary and Owen (2013) stressed the importance of understanding data lifecycle. The lifecycle informs data management for any institution which is summarized below:

- Data Creation
- Data Collection and Description
- Data Storage
- Data Archiving and Preservation
- Data Access
- Data Discovery and Analysis
- Data Reuse and Transformation

TOOLS AND APPLICATIONS FOR RESEARCH DATA MANAGEMENT

The following are some of the tools and applications that are recommended by the Digital Curation Centre (DCC) to help institutions prepare for a research data service delivery.

- **DMP Online (<http://dmponline.dcc.ac.uk>)**

DMP online helps to create, review, share data management plans that meet the research council and funding body mandates. Research funders and organizations increasingly require data management plans, both during the bid-preparation stage and after funding has been secured. Some funders mandate the use of DMP online, while others point to it as a useful option. The tool provides tailored guidance and examples to help researchers write data management plans. It provides a number of templates for funders in the UK and overseas so researchers can write DMPs according to the specific requirements they need to meet. Anyone can use DMP online. The funders template is also a template for research data management plans. It is based on the specific requirements listed in funder policy documents. The DCC maintains some templates; however, researchers are advised to always consult the funder guidelines directly for authoritative information.

- **Collaborative Assessment of Research Data Infrastructure and Objectives (CARDIO)**

CARDIO is a benchmarking tool that enables organizations to:

- a) collaboratively assess data management requirements, activity, and capacity at their institution
- b) build consensus between data creators, information managers, and service providers
- c) identify practical goals for improvement in data management provision and support

The CARDIO matrix can be used to arrange a meeting between Library, IT, and Research Support colleagues to plan a roadmap or action plan towards a live service.

- **Data Asset Framework (DAF)**

Data Asset Framework helps organizations to identify researchers' current data management activity, their data holdings, and their data management requirements. The Data Asset Framework provides organizations with the means to identify, locate, describe, and assess how they are managing their research data assets. It does this by offering a set of methods to gather the information, views, and experiences you need to scope research data support services. DAF recommends a four-stage process:

1. Stage one is for planning, defining the purpose and scope of the survey, and conducting preliminary research.
2. Stage two is about identifying what data assets exist and classifying them to determine where to focus efforts for more in-depth analysis.
3. Stage three is where the information life cycle is considered to understand researchers' workflows and identify weaknesses in data creation and curation practices.
4. Stage four pulls together the information collected and provides recommendations for improving data management.

- **Digital Repository Audit Method Based on Risk Assessment (DRAMBORA)**

Digital Repository Audit Method Based on Risk Assessment helps to define and address the risks threatening the digital repository content and infrastructure. DRAMBORA originated as a paper-based methodology for helping repository managers to develop a documented understanding of the risks they face, expressed in terms of probability and potential impact. These risks are then mapped to organizational aspirations and effort allocations in order to facilitate ongoing organizational development and resource allocation. The best and most efficient way of carrying out a DRAMBORA audit is by using DRAMBORA Interactive, an online tool that guides one through the audit process on a step-by-step basis. DRAMBORA Interactive audit helps provide peace of mind concerning growing, valuable, and at-risk digital collections. It can strengthen the trust of users and staff, increase efficiency by helping to focus and refine operational policies. It may even highlight potential opportunities for repository managers to leverage increased development potential by offering a clear way to demonstrate the risks related to shortfalls in repository funding (<http://www.repositoryaudit.eu/>).

- **Curation Costs Exchange (CCEX)**

The Curation Costs Exchange (CCEx) is a community-owned platform that helps organizations of any kind assess the costs of curation practices through comparison and analysis. The CCEx aims to provide real information about costs to help make more informed investments in digital curation. Research in digital preservation and curation tends to emphasize the cost and complexity of the task in hand. Organizations that understand this will be more able to control and manage their digital assets over time, and they may also be able to create new cost-effective solutions and services for others (<https://www.curationexchange.org/>).

ROLES OF ACADEMIC LIBRARIES IN PROMOTING RESEARCH DATA MANAGEMENT (RDM) SERVICES

For those managing academic libraries and information centers, one of the most challenging considerations relating to data management is working out what needs to be done locally, and what might best be done nationally or internationally. In most of these areas, they will want to work in partnership with other campus agencies, notably IT services, but also research offices and those responsible for research governance (such as a Vice-Chancellor). In addition to these activities, the RDM pyramid proposed by Lewis (2010) suggests a broader role for academic libraries and librarians, including the integration of RDM into teaching at the undergraduate level and in schools of library and information science, as well as influence and participation in national policy development.

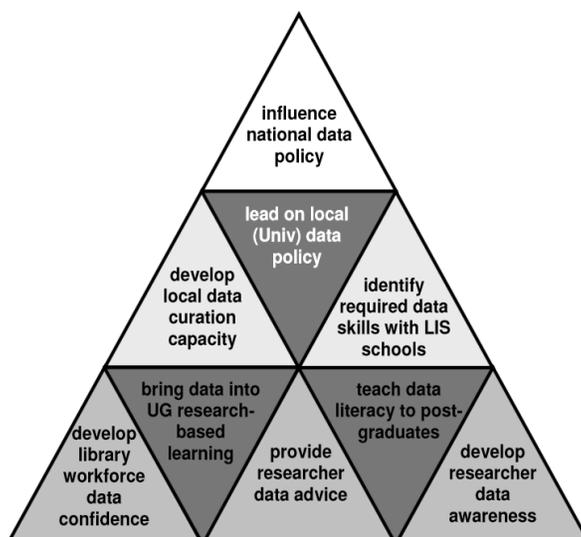


Figure 1: The Research Data Management Pyramid for Libraries (Lewis, 2010)

Developing library workforce data confidence is about lifting the general level of awareness of the existing academic library workforce concerning data management issues, intending to equip

staff to hold conversations with academic colleagues and research students on these topics. The target audience is primarily academic librarians. However, other library staff such as systems teams, repository managers, and e-resource managers may likewise benefit from an improved level of information and understanding of the data management landscape. There are several ways by which this can be achieved.

- Library staff has a professional responsibility to update their knowledge about data management. There is now a wealth of reading available on the subject, not only from the sources already mentioned but also as a result of several recent studies and projects funded by bodies.
- There is an increasing number of externally-organized workshops and courses dealing with data management. Many societies and organizations have organized several seminars aimed at academic librarians, short courses for data managers, as well as a series of international conferences on digital curation.
- Networks of professional practice Research Data Management Forum are beginning to emerge. There is still a need, however, to reach out to those university library staff for who research data is barely on the radar.
- Provide researcher data advice. Most university libraries may not have the ability to provide local data management for digital datasets. Still, once they have connected with the issue, and their contact staff has enhanced their knowledge of the landscape, they can start to provide advice on data management to researchers, both informally and through the development of more formal content on library websites. Many libraries already offer advice on open access and other aspects of scholarly communication, and data management should be seen as a natural extension of this role.
- Develop researcher data awareness in parallel with the provision of advice to individual teams or researchers, there is a role for university libraries in raising awareness of the challenges of data management within their institutions, and initiating a discussion about it through a range of channels. In most institutions, there will be a vast range of interest in data issues, from researchers who have given the fate of the data they generate little, if any thought, to those working in areas with well-established cultures of data curation. Libraries embarking on local data management advocacy need to consider these points

carefully and ensure that their messages are aligned with those of other institutional stakeholders.

- Teach data literacy to postgraduate research students: According to Lewis (2010), Most UK university libraries have some involvement in research training, either through formal research training programs or through less formal channels. However, relatively few of them cover research data management. Research training for postgraduate students is a crucial contribution area concerning research data management because it presents an opportunity to influence how postgraduates students generate and use data. How they need to describe it to facilitate future retrieval, how they might approach the identification of data appropriate for preservation, and what options might be open to them for the subsequent storage and curation of their data.
- Bring data into undergraduate research-based learning is a logical extension of the development of data management skills for postgraduate students. Many undergraduate programs include a dissertation requirement that will give students experience in the generation of data, and this is an opportunity to start to develop good practice among those who progress to research careers. However, effective management of research data on a broader scale may also bring pedagogic benefits for undergraduate education by enabling students to access and use real research data in an educational context.
- Develop local data curation capacity by assuming that a combination of advocacy and research funder policies impacts effectively on researcher's behavior, should libraries invest in actual data storage and curation capacity? The business case for such investment remains a challenging one, mainly when library budgets are under pressure from the need to sustain current services, to innovate in a wide range of areas, and to meet the inflationary pressures associated with content procurement.
- To identify required data skills with LIS school while the existing library workforce can make a significant contribution to getting research data curation on the institutional map. Even libraries with well-developed IRs are likely to find that they need additional skills to provide significant data curation capability locally. There is a role here for library managers in identifying the skills gap and working in partnership with library and information science (LIS) schools to develop new training and development resources to fill it. Not every university library will need or want to be active in this area, but there is a sense among many university library directors that professional practice has changed

faster than the curricula of the LIS schools supplying new entrants to the workforce. Consequently, libraries have a part to play in providing the evidence.

- Lead on local data policy, the informal contacts with researchers and other research stakeholders discussed earlier represent an opportunity for the library to exercise a degree of policy leadership more formally at the university level. University research and innovation committees and even senior management teams need to understand the nature of the data management challenge and the benefits of a coherent approach across the institution. They may also need to approve a business case for any investment in this area, and their commitment will be crucial in helping to bring skeptical researchers on board.
- Influence national data policy; Librarians can and should expect to be players in their national policy arenas for research data where these exist. Their influence has been especially apparent in Australia, where librarians are well represented on the ANDS Steering Committee, Cyberinfrastructure. In Canada, the multiagency Research Data Strategy Working Group, led by the Canada Institute for Scientific and Technical Information, included several university library staff among its membership. The working group has recently published a detailed gap analysis of Canadian research data management provision. (Lewis, 2010).

SKILLS REQUIREMENTS FOR RESEARCH DATA MANAGEMENT (RDM) IN ACADEMIC LIBRARIES

Chiware and Mathe (2015) suggest the special skills development programs required for RDM services in academic libraries which include the following:

- Subject-specific orientation.
- Understanding of institutional research processes and policies.
- Knowledge of relevant tools (such as Mendeley, Scopus author management, Data Management Plan Tool, ORCID identifier).
- Communication and collaboration (video, web-conferencing technologies).
- Current awareness – alerts and RSS services;
- Research methodologies (for example, research data lifecycle, data analysis, tools, and statistics).
- Bibliometrics (for example, impact factor, h-index) and altmetrics.

- Intellectual property rights.
- Publication processes and requirements.
- Awareness of DOAG.org and Sherpa Romeo.
- Academic networking.

In South Africa, according to Chiware and Mathe (2015), it is encouraging to note that some library and information science schools have started to recognize the need for skills in this area and are beginning to offer several programs dedicated to data management and curation. UCT's Library and Information Studies Centre offers a short course in RDM and an M. Phil in Digital Curation. In other disciplines, the Wits School of Public Health offers a Master of Science in Epidemiology in Research Data Management. Some funding agencies and research councils like the NRF and CSIR have been organizing awareness and information-sharing workshops to build capacity among library professionals. These exercises, if welcomed, will go a long way to addressing the much-needed skillset in this emerging service area within academic and research libraries.

CHALLENGES AND SKILLS REQUIREMENTS FOR RDM IN ACADEMIC LIBRARIES

According to Cox, Verbaan and Sen (2012), the most significant challenges facing academic, and research libraries attempting to offer RDM services are:

- Limited skillsets of librarians
- Lack of understanding of the diversity of research data
- How to balance existing roles with new RDM roles
- Lack of knowledge by librarians of the motives and practices of researchers and the diversity of research data;
- Lack of domain-specific knowledge, using current experiences for creation of research data contexts
- The problem of engaging researchers who view librarians' role as that of supporting teaching.

Corti, Van den Eynden, Bishop and Woollard (2011) observed that research data management is not an easy task, and data centers may not accept all data submitted to them. Institutional repositories may not afford long-term maintenance of data. More sophisticated research data may

be challenging to store and manage, and some websites are ephemeral with little sustainability. Harvey (2010) as cited by Kennan and Markauskaite (2015) also identified the following challenges associated with digital data management:

- Technology obsolescence.
- Technology fragility.
- Lack of guidelines for good RDM practice.
- Inadequate financial and human resources to manage data well.
- Lack of evidence about best infrastructures.

However, to overcome these challenges Tenopir et al. (2012) have suggested that Skill sets in RDM, is the best approach and reassign the existing staff to new roles with appropriate training.

CONCLUSION

The concept of research data management is fundamental in academic library service delivery. Librarians, research officers, records managers, information technology professionals, and researchers need to explore the concept to participate in good research data management practice effectively. Academic libraries should actively take advantage of research data management service to possibly transform their relationships with their broader institution community. In addition to the vital role of educating researchers about RDM planning, academic libraries should take on the role of RDM advocacy. Librarians should believe that RDM service is essential services in academic libraries. They should also believe that RDM services will increase the visibility of their institutions, impact their institution research activities, and improved alignment between library services and the university research mission. Furthermore, the study stated encourage the establishment of research data repositories or the use of already established research data repositories like institutional repository (IR) for active RDM service. Academic libraries should also ensure that research data management standards are adhered to when rendering RDM services. The paper concluded that there is a need to partner with international organizations such as DataCite and Research Data Alliance as these forums would assist academic library and research institutions in managing research data professionally.

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