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Research Data Management Services: The Research Data Life Cycle Theory to the Rescue

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Abstract

This study investigated Research Data Management (RDM) services among 3 selected University libraries in South-South, Nigeria. The descriptive survey design was employed in this research. Due to the fact that the population was small (75 respondents) all of them was used for the study. However, after questionnaire administration and retrieval, 72 of the respondents were used for the study. Frequency count and mean statistics were deployed in analyzing the data. Result of the study revealed that the awareness level of (RDM) services amongst the librarians was high; and so was the extent of implementation of RDM. The research recommended that it is imperative that Nigerian libraries and librarians acquire deeper understanding regarding the extent and scope of research data management services so that they can understand where to improve on.

Keywords*: Research Data Management Service, Librarians, University Libraries, South-South, Nigeria*

Introduction

Research data management is currently a hot topic. According to Nwabugwu and Godwin (2020), the objectives are to meet grant criteria, support open access, make the research process more efficient, boost the effect of the research, preserve data by putting it in a repository, manage and document the data throughout its life cycle, and foster discoveries. Research data management, or RDM, services are the way of the future for academic libraries, according to Chukwusa (2021a). However, until librarians in Nigeria acquire the requisite skills and competencies—which appear to be lacking at the moment—this service may not become widely available in Nigeria. Planning, arranging, and supplying data and information to researchers by academic libraries and other information service providers are all part of RDM. It is the kind of data management done for the benefit of science, primarily to improve the caliber of study. The word "data management" in scientific research refers to all methods of safeguarding confidential information. Nwabugwu and Godwin (2020) list the following steps in the process: data creation and use planning; data organization and naming; data safety, accessibility, saving, and backup; information resource discovery and sharing with colleagues and other stakeholders; data publication and citation; and process completion. RDM is in favor of the "Findable, Accessible, Interoperable, and Reusable" (FAIR) data principle (Tunmibi & Ajokotola, 2024). Inadequate management of research data can have detrimental effects, including the loss of important data, the violation of intellectual property or personal information, or even unethical behavior.

RDM, or the processing of various forms of raw or primary data generated throughout the research process, is significantly relied upon by many scientists. The field of library and information science will be significantly impacted by this. Information professionals will need to train scientists, students, data managers, and information experts in order to prepare them for the new challenges associated with delivering and utilizing data infrastructures in almost all scientific fields (Chukwusa, 2021b; Chigwada, Chiparausha & Kasiroori, 2017). Research data management, which entails utilizing suitable and user-friendly technologies in virtual research infrastructures to facilitate data creation, access, verification, storage, and reuse, may make it easier to share and reuse data produced during scientific inquiry (Penev, 2017). According to Tunmibi and Ajokotola (2024) and Nwabugwu and Godwin (2020), these details are crucial to the curatorial process and are managed in the following ways: Ideation, creation or receipt, appraisal, selection, ingestion, storage, access, usage, reuse, and transformation are some of the phases involved in processing research data. A scientist, for instance, needs access to data in three domains: public, collaborative, and private; all of these domains should be permeable to transactions related to curation (Latham, 2017).

University libraries are involved in RDM in two ways: by providing academics with tools for data management planning (DMP) and by storing and preserving data. Furthermore, these roles are seen as an extension of the information curation, storage, and distribution services provided by scholarly communication and research support. The next stage of RDM services involves working closely with researchers to assist and follow through on their studies. Starting with data creation/generation, project planning and data management involve processing, analyzing, storing, sharing, and reusing data (Ridsdale, Rothwell, Smith, Ali-Hassan, Bliemel, Irvine, Kelley, Matwin & Wuetherick, 2015). Data creation/generation occurs when a solution uses information not found in the end user's database or mailing lists.

Data processing includes tasks categorization, modification, and retrieval of information. In order to derive conclusions and support decisions, data must be examined, cleaned, converted, and modelled (Tunmibi & Ajokotola, 2024). Data security and authenticity are guaranteed when it is retained. According to the scholars, data reuse refers to techniques that avoid storing the same information in multiple internal registers or slower-access storage. Data sharing on the other hand is the act of making research data available to other researchers.

Research data creation, processing, analysis, preservation, sharing, and reuse are among the areas where university librarians in South-South Nigeria have been found to be lacking. This has made it more difficult for students to obtain the data and information they need for research, which has resulted in faulty research projects and programs. This informed the study.

Literature Review

RDM services guarantees that research data are usable over time and assists researchers in fulfilling founder and publisher criteria for data sharing (Subaveerapandiyan, 2023). RDM includes all of the procedures used during a project's life cycle to direct data gathering, documenting, sharing, storage, and preservation while also making the data accessible to researchers.

It is common knowledge that the data documented, factual items gathered, arranged, and preserved by other researcher is necessary for conducting high-quality research. Researchers

keep their material in a variety of formats, including word documents, spreadsheets, lab notes, field notebooks, diaries, surveys, questionnaires, transcripts, codebooks, audio and video files, pictures, and photographs (Nwabugwu, & Godwin, 2020).

Additional resources include focus group discussions and responses, interview notes, artifacts, samples, models, algorithms, scripts, and content analyses. Researchers, scientists, and academics anticipate that with the advent of information technology, they will be able to access, study, consult, use, and expand upon meticulously gathered and correctly stored research data.
Researchers throughout the world are constantly searching for distinctive viewpoints that could lead to novel discoveries. They will avoid wasting time and effort by not having to go through the hassle of obtaining information and beginning from zero. Making research data accessible for usage and reuse promotes interdisciplinary thinking and raises fresh ideas, which advances and broadens knowledge.

Galleto (2016) asserts that unfettered access to research data promotes academic integrity, helps validate findings, and keeps the academic community moving in the correct direction. Furthermore, research data sharing promotes relationships between data suppliers and consumers, scientific inquiry and conversation, publicity, and an examination of study methods and findings. It facilitates the process of analyzing, comprehending, and safeguarding the data by assisting fellow researchers in validating and expanding upon published findings. RDM services make all of this possible. When data is organized from the time it enters the study cycle until it is permanently archived after yielding valuable results, the process is referred to as RDM services (American Library Association, 2009).

According to scholars, RDM services are a collection of resources and assistance programs that libraries provide to faculty members and researchers to aid in the organization, documentation, and preservation of their data both while and after their research projects are completed. It offers all the data-related assistance that researchers would need for the data's life cycle, use, and reuse. In order to guarantee that the data is timely, dependable, and accessible for its consumers, it is an administrative task that involves gathering, verifying, storing, safeguarding, and processing the necessary data (Kitchenham, 2004).

Ridsdale, et al., (2015) Data Life Cycle

According to Ridsdale et al. (2015), RDM is an integrated service that includes procedures and actions related to data generation, processing, analysis, preservation, sharing, and reuse. The responsibility of creating data primarily falls to the researchers. The process of locating and gathering data into a format that can be shared and used again is known as data generation. This includes giving the data a name, cleaning, enhancing, and storing it. It facilitates data discoverability, which is critical for enabling researchers to exchange and reuse data. RDM contributes to the process of creating data. All academic libraries have a shared responsibility to create and preserve datasets (Tunmibi & Ajokotola, 2024).
The researchers noted that there has been a suggestion that educational institutions can provide full RDM services by working with pertinent departments to make data production and maintenance easier. But when it comes to RDM services, data generation and acquisition are interchangeable, with librarians gathering data from several sources. Librarians must comprehend how researchers think and behave when creating data, as well as what kind of education and training is necessary for them to manage and preserve research data

collections, in order to create data successfully. Library employees should possess the necessary abilities to provide materials for researchers, and organizations should establish and maintain a robust information infrastructure to facilitate the development of data (Chukwusa, 2021a).

Data processing comes next after data production. While data analysis is a completely different activity, data processing is a crucial component of the data management cycle and is frequently used to describe it. The process of gathering data and turning it into information is known as data processing. Processing raw data for research involves turning it into insights that can be put to use. The process of converting unprocessed data into a more readable format—like a graph, report, or chart—by hand or with the use of an automated technology is known as data visualization. To guarantee accuracy and utility, data processing is typically handled by a data scientist or group of data scientists.

Nwabugwu and Godwin (2020) assert that processing data converts information from its unprocessed state into a more readable format (graphs, papers, etc.) that computers can comprehend and researchers and other information users can use. The main goal of data analysis is to transform and process unprocessed data in order to extract valuable knowledge that could help researchers make the best choices. The method offers insightful information that is typically presented in tables, graphs, charts, and other visual aids that reduce the dangers involved in making decisions.

Data analysis is a cognitive process that occurs anytime someone makes a decision based on an assessment of what has already occurred or what will occur if they choose a particular course of action (Tunmibi & Ajokotola, 2024). In essence, making decisions involves considering information from the past or future and taking appropriate action based on it. The phrase "big data" is frequently used while discussing data analysis. Large-scale data analysis yields priceless information.

According to Galleto (2016), "data preservation" is the act of making sure that data is maintained in its original form. Organized efforts that follow guidelines and standards are used to preserve data and information, allowing for their extended use without compromising their integrity. While data are the bits or units from which knowledge is formed, metadata are condensed subsets of data items, or the data about the data. The main goal of data preservation is to protect information from being accidentally or maliciously deleted while simultaneously making it easier to use and develop the data in the future.

By definition, data sharing involves providing other academics with access to study data. You must devote time and resources to RDM, which is a major resource, in order to distribute data efficiently (Cox, Verbaan & Sen, 2012). The degree to which researchers are willing to provide their data to others without charge is referred to as data sharing. As a result of the widespread belief that transparency and openness are necessary for the scientific method, many organizations have policies in place regarding data sharing. Data sharing regulations exempt a wide range of scientific research, and many of these policies include numerous exceptions (Nwabugwu & Godwin, 2020).

Academic libraries' efforts to promote consistency and openness in the research community have resulted in improved data management and a larger collection of shareable data. The two main objectives of RDM programs provided by libraries are to teach researchers new

skills and assist them in complying with data-related regulations and requirements (Chukwusa, 2021a). Research data management (RDM) makes it feasible for others to independently assess and enhance published results, which contributes to the value of shared research data. The skilled and knowledgeable staff members who work in university libraries can offer long-term, secure management of research data. However, a lot of this hinges on how eager researchers are to share their data.

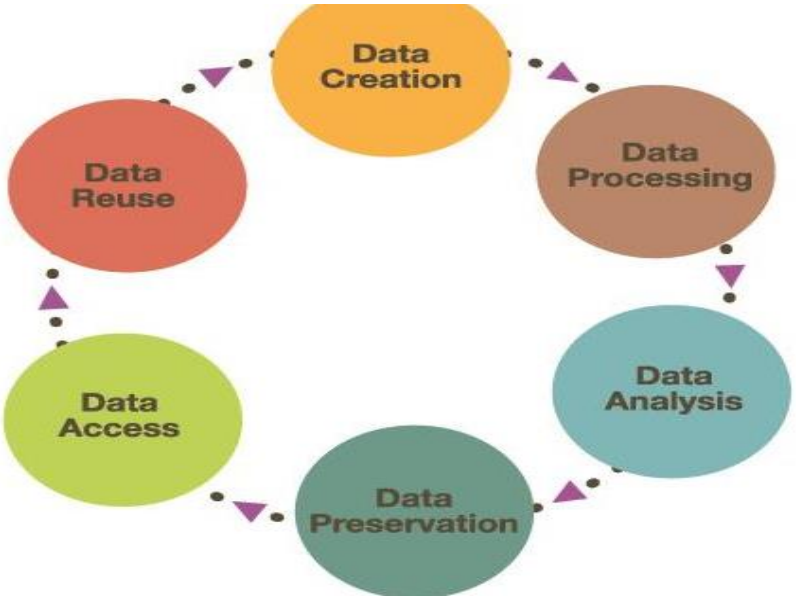
Researchers across a range of disciplines, including social science, natural science, engineering, medicine, and health science, have differing opinions about how research data should be managed. These opinions can be seen in differences in how they view tags, metadata, file naming conventions, standards, and version control systems (Tunmibi & Ajokotola, 2024). The researchers also claimed that, although some researchers may be persuaded to share their data by the idea of academic altruism, most researchers are frequently reluctant to share their data; researchers tend to keep their own storage servers rather than utilizing the data repository provided by their institutions; within a given organization or field, there are differing degrees of institutional support for data management (Ubogu & Chukwusa, 2022; Koltay, 2019).

Organizations can be organized in a number of ways to make it easier to manage research data, whether it is for a particular field of study or the organization as a whole. Onohwakpor (2006) states that there is a knowledge gap between researchers and librarians regarding basic concepts like data description using industry standards like Dublin core. Agreeing on a uniform metadata is crucial because it makes data reuse ie, the practice of using data from one study to another possible.

One of the primary goals of RDM is data reuse; yet, an efficient data reuse process necessitates the establishment of an appropriate framework to guard against data exploitation. Sen, Cox, and Verbaan (2012). Because the compiler has trouble finding data reuse opportunities for some data access patterns, it is not easy to automatically apply data reuse techniques. In the case of microprocessors, this can result in an increase in register pressure because we may need to add more scalar variables to the code. Data reuse efficiency can be significantly increased with hardware assistance, such as rotating registers.

Library professionals need to speak up in favor of data repositories, educate researchers and teachers about the value of research data and RDM techniques, and promote their use. Ensuring, maintaining, and monitoring data quality is the aim of data governance. The model below (Ridsdale, et al., 2015) shows the phases of data management and details the flow of data from the beginning to the completion of a research project.

Figure 1: Research Data Life Cycle by J. Ridsdale.



Challenges and Skills Requirements for RDM Services in University Libraries

Koltay (2019) asserts that perceptions of the need for RDM vary greatly among disciplines and nations; as well as academic libraries' readiness to assume accountability on an equal footing across all nations and establishments. Librarians need to have a fundamental understanding of research data challenges in order to successfully provide services in these situations. Technical and socio-ethical abilities, the latter of which includes understanding of legal and ethical issues, should be part of this appreciation. However, librarians in the paper-based world are familiar with a lot of these.

According to Cox, Verbaan, and Sen (2012), the following are the biggest obstacles that academic and research libraries trying to provide RDM services must overcome:

- A lack of awareness of the variety of research data
- Restricted librarians' skill sets
- How to align new RDM responsibilities alongside older roles
- Absence of domain-specific knowledge; study data settings are created based on present experiences
- Librarian's ignorance of the intentions and methods of researchers as well as the variety of research data;
- The difficulty in interacting with researchers who believe that a librarian's job is to assist teaching.

The need for strong data management procedures by funding institutions is a major factor in the rise in demand for RDM services. Libraries are looking into RDM services and reassessing how to assist research. Libraries are vital resources for researchers because they can help with data management, establish data management strategies, and provide policy formulation knowledge. Limited resources, skill development, and cooperation between IT and research administration are some of the difficulties they face (Onohwakpor & Chukwusa, 2023; Subaveerapandiyan, 2023).

Methodology

The research design was a descriptive survey. The population includes 75 library staff (librarians and library officers) from 3 university libraries in South-South, Nigeria. The total population was used, but after questionnaire administration and retrieval 72 of the questionnaire (sample size) was found useable. Data collection was done using questionnaire that was structured on a 4-point Likert scale. The data retrieved were analyzed by means of frequency count and statistical mean.

The universities studied are:

The 3 Selected Federal Universities in South-South, Zone, Nigeria	**No. of Librarians Administered the Questionnaire**	**No. of Library Officers**	**Total**
Federal University of Petroleum Resources, Effurun, Delta State	14	11	25
Federal University, Otuoke, Bayelsa State	8	15	23
University of Port Harcourt, Rivers State	14	13	27
Total	**36**	**39**	**75**

Results Presentation

Table 1: Extent of awareness of research data management services

S/N	**Items**	**VHE**	**HE**	**LE**	**VLE**	**Mean Scores**
	Research Data Management Services	**4**	**3**	**2**	**1**	
1.	Data creation	47	25	-	-	3.7
2.	Data processing	10	62	-	-	3.1
3.	Data analysis	34	38	-	-	3.5
4.	Data preservation	49	23	-	-	3.7
5.	Data access	16	56	-	-	3.2
6.	Data reuse	43	29	-	-	3.6
	Grand Mean					3.5

Table 1

Table 1 showed the extent of awareness of RDM services by librarians. With 2.5 as cutoff mean score and 3.5 as grand mean score the table revealed that the extent of awareness is high among the respondents. They scored high on all the metrics of RDM services such as data creation, data analysis, data preservation, data sharing, and data reuse.

Table 2: The extent of implementation of RDM services in the libraries

S/N	Items Research Data Management Implementation	VHE	HE	LE	VLE	Mean Scores
		4	3	2	1	
1.	**Data creation**					
	• Users can easily locate and use data sources	25	32	15	-	**3.1**
	• There is an Institutional repository for data management in my library	20	26	10	7	**2.6**
	• My library provides assistance to users on data documentation standards	13	24	16	19	**3.3**
	Grand Mean					**3.0**
2.	**Data Processing**					
	• A good number of electronic documents are processed easily.	22	28	10	12	**2.8**
	• The few available ICT equipments are used efficiently for processing of data.	27	33	12	-	**3.2**
	• There are defined information management principles by the school management e.g. documentation format.	56	2	9	5	**3.5**
	• Documents created are usually proof read and reexamined before release.	11	43	18	-	**2.9**
	Grand Mean					**3.1**
3.	**Data Analysis**					
	• I have the wherewithal to scrutinize current research	32	15	25	-	**3.5**
	• I have the wherewithal to deploy digital technologies in research planning	16	20	21	15	**2.5**

	• I have the wherewithal to working with scientific literature and to compile. • I can use digital technologies to solve a specific research problem	29 9	8 25	18 28	17 10	**2.7** **2.5**
	Grand Mean					**2.8**
	Data Preservation • In my library there are enough data storage facilities • In my library there are skilled staff who assist researchers with data storage and preservation techniques • In my library, data are stored in conventional formats such as text documents, graphics, spreadsheets and databases • Data can be safely stored and back-up options provided.	12 15 19 34	27 17 53 8	16 27 - 30	19 13 - -	2.5 2.5 3.2 2.6
	Grand Mean					**2.7**
	Data Sharing/Access • My Library has data repositories for data sharing and access. • In my library processed data are released almost instantly they are demanded. • In my library most of the data is disseminated through electronic means.	10 19 13	21 25 9	25 28 48	16 - 2	**2.3** **2.9** **2.5**
	Grand Mean					**2.6**
	Data Reuse • My university library allows us to archive research data for future use • Data are stored for easy retrieval • Unused data are disposed off	21 9 9	34 63 25	9 - 23	8 - 15	**2.9** **3.1** **2.4**

	Grand Mean					**2.8**

Adapted from Nwabugwu & Godwin, 2020

On the extent of implementation of data creation service, Table 2 revealed that aside 'there is an Institutional repository for data management in my library' with 2.6 mean score (though high), the other items were implemented to a very high extent.

The table further revealed that with 3.1 grand mean score for data processing, 2.8 for data analysis, 2.7 for data preservation, 2.6 for data sharing/access and 2.8 for data reuse, the study concluded that all the RDM services were being implemented to a high extent.

Discussion

The data presented in Table 2 indicates that librarians had a high level of awareness of RDM services. The results of a study that measured the attitudes and level of preparation of academic librarians in the US and Canada regarding RDM are consistent with this finding (Mahraz, Benabbou & Berrado, 2022). According to the report, librarians are fully aware of the importance of providing data services as well as how doing so could increase library and librarians profile in the years to come.
It was discovered that the degree to which librarians applied research data collection services in the libraries was strong, and that they consistently identified data sources. This runs counter to what previous research has shown. Studies by Nwabugwu and Godwin (2020) and Abduldayan, Abifarin, Oyedum, and Alhassan (2020) have revealed that researchers typically exhibit reluctance when it comes to submitting their research data to journals or libraries.

According to this study, librarians who practiced data analysis also rated their own data analysis practice and implementation well, which suggests that the level of data analysis implementation was high. According to David and Abbas (2020), librarians at a few federal universities in Nigeria possess the necessary abilities to efficiently offer and execute research data services through standard metadata production. The results were consistent with a study conducted by Abduldayan, Abifarin, Oyedum, and Alhassan (2020) on the RDM practice of chemistry researchers, who were purposively picked from among the five federal universities of technology in Nigeria. The study found that in order to guarantee the long-term access, preservation, and reuse of their research data, chemical researchers' RDM procedures require significant improvement. In a similar spirit, Gowen and Meier's (2020) study suggested that libraries start educating scholars about the advantages of appropriate RDM methods.

Recommendations

• Libraries' capacity to maintain focus on their primary mission, which is to assist the creation of new information through the utilization of existing knowledge, will determine how relevant they are in a changing world. As a result, it is important to maintain the high level of RDM service awareness.

• Research data management is a highly broad and difficult task, despite the fact that librarians in South-South Nigeria reported very high levels of satisfaction for the majority of the metrics of research data management services. Therefore, in order for Nigerian libraries

and librarians to know where they need to make improvements, it is essential that they gain a broader grasp of the breadth and depth of research data management services.

Conclusion

It is imperative that university administrations provide librarians with ongoing training to enhance their proficiency in using diverse data management systems and assess research data of all kinds. The survey found that librarians have a very high level of awareness of RDM services and the RDM concept. Also, all the RDM metrics are being implemented to a large extent.

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