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David Onyeamaechi Ekeh PhD
*Alex Ekwueme Federal University Ndufu Alike Ikwo*, david.ekeh@funai.edu.ng

Chidiebere Cordelia Ojemuyide Mrs.
*Alex Ekwueme Federal University Ndufu Alike Ikwo*, chidiebere.ojemuyide@funai.edu.ng

Claris N. Eze PhD
*Alex Ekwueme Federal University*, claris.eze@funai.edu.ng

Mercy Ifunanaya Ani PhD
*Federal University Ndufu Alike Ikwo*, merciful.ssit@gmail.com

Ogochukwu Faith Igu PhD
*Federal University Ndufu Alike Ikwo*, ogochukwu.igu@funai.edu.ng

*See next page for additional authors*

## Authors

David Onyeamaechi Ekeh PhD, Chidiebere Cordelia Ojemuyide Mrs., Claris N. Eze PhD, Mercy Ifunanaya Ani PhD, Ogochukwu Faith Igu PhD, Catherine Mbana Okpala Mrs., and Chidiebere Kelechi Duru PhD

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Ekeh DO[1], Ojemuyide CC[2], Eze CN[3], Ani MI[4], Igu OF[2], Okpara CM[2] & Duru CK[4]

**[1]Department of Educational Management, Alex Ekwueme Federal University Ndufu Alike Ikwo,Ebonyi State, Nigeria**
**[2]Department of Vocational and Technical Education,, Alex Ekwueme Federal University Ndufu Alike Ikwo, Ebonyi State, Nigeria**
**[3]Quality Assurance Directorate Unit, Alex Ekwueme Federal University Ndufu Alike Ikwo, Ebonyi State, Nigeria**
**[4]Department of Educational Foundations Alex Ekwueme Federal University Ndufu Alike Ikwo,Ebonyi State, Nigeria**

**merciful.ssit@gmil.com**

## Abstract

An institution cannot exist and function properly without the presence of a library because the services provided by an academic library reflect the quality of the institution. This paper attempts to present a brief overview of the concept of library, research data, Research Data Management (RDM) and its constraints as well as the roles of academic libraries. These roles has experienced new paradigm shift, unprecedented reshaping and alterations as a result of emerging waves of information communication technology (ICT) and its accompanying sustainable and disruptive technologies. Scholars are now producing, storing and disseminating digital data in much larger volumes than the text. The continued existence and access of this data is an issue, since the data is not stored in libraries. It is therefore crucial to preserve data for future generations. This paper tries to delineate the emerging role of academic libraries in Research Data Management (RDM) in tertiary institutions.

**Keywords:** Academic Library, Research Data, Research Data Management, Tertiary Institution

## Introduction

The library is an important aspect of the education system which supports education in general, that has been saddled with the responsibility of playing central support roles in the lives of universities for teaching, learning and research (Towolawi & Fawole, 2018). These roles have experienced new paradigm shift, unprecedented reshaping and alterations as a result of emerging waves of information communication technology (ICT) and its accompanying sustainable and disruptive technologies (Dike, 2018). These profound changes are apparently evident in all spheres of the higher education (HE) sector. As a result of these changes, universities are transforming their operations in response to the opportunities provided by the

digital revolution along with other higher education sectors. Anijaobi-Idem, Berzi & Akuegwu, (2013) affirmed that there has been trendy and tremendous modification in the modes and modality of provision of information services in and among libraries that service the needs of tertiary institutions. The observed trends lead to increased demand for new and emerging library services, which are significantly situated in different technological use, such as artificial intelligence (AI), cloud computing, internet of thing (IoT), internet of everything (IoE), machine learning, big data, data cu-ration and mining as well as data management services; thus, leading to the popularity of the involvement of research data management (RDM) and library. According to Buys & Shaw (2015), more libraries have developed and/or are developing programs to get involved in the emerging data management practices.

Research data management (RDM) is used as a call for action in maintaining all forms and formats of research information/data and other digital materials over their entire life cycle and over time for current and future use of generations of users. Myburgh & Tamaro (2013), asserted that RDM is the maintaining and adding of value to the trusted body of research information for current and future use. This implies that the processes of research data archiving and preservation in all formats should include all the processes needed for good research data creation and management and the capacity to add value to data generated from new sources of information and knowledge. RMD is an emerging area in academic and research libraries according to Kruse & Thestrup (2014). A collection of research data services (RDS) is needed by members of the academic community in response to the growth of data-intensive research, changing roles of libraries and the recognition of a need for research data management (Tenopir, Hughes & Allard, 2015). However, there is a dearth of literature to establish academic libraries in tertiary institutions in developing countries, which is not the same in developed countries, where significant developments have been established and recorded to be in existence in academic and research libraries (Towolawi & Onuka, 2019).

**Concept of Library**

The word Library is derived from the Latin word *libraria* meaning a book place. It originates from the term *liber* which means a book. The library is at the heart of the education enterprise and is one of the most important educational services (NPE,

2013). It is a collection of books, serials and non-book materials kept for the purpose of reading and consultation. Libraries have been around for a very long time and are traditionally seen as collections of information and services. Libraries have always played a significant role, in enabling people to engage with all kinds of information and knowledge resources (Curran et al., 2006). Through the technological development of electronic resources the means to collect, store, manage and use widely distributed knowledge resources have become more effective, serving the library users even better (Griffin, 1998). Modern libraries are therefore being redefined as places to get wider access to information in many formats and from many sources. Currently, libraries without walls are being logical extensions to libraries (Fox and Urs, 2002). Libraries provide access to an endless variety of information resources and opportunities for interactive communication. Libraries are widely used bygovernment,universities,researchinstitutes and the public for storing and managingintellectualassets. In modern times, the aims of libraries have changed, they are becoming more faceted and multifarious. Libraries are now agents of educational, social, economic and political revolution and are accessible to all that require their services. This means that the library is now a place entrusted with the acquisition, organization, preservation, storage, retrieval and dissemination of information. A good library and information services have been noted as essential ingredients for research, successful teaching and learning (Banting et al, 2008). This implies libraries play a significant role towards the achievement of the goals of tertiary institutions and hardly would academic institutions be able to provide for the academic, intellectual and other interests and information needs of students without the services of good libraries. According to Agyen-Gyasi, Lamptey and Frempong (2010), academic libraries are essential contributors to knowledge generation and serve a wide spectrum of knowledge seekers.

The existence of libraries actually dates back to the ancient civilizations. Krasner-Khait (2001) observes that the collection of written knowledge in some sort of repository is as old as civilization itself. Feldman (2000) is of the view that libraries began when people realized that information was a valuable resource and must outlive the people who created it. Library collections have since moved beyond written and printed materials to include electronic and audio-visual materials. In fact, a modern library with a few exceptions could be regarded as a service institution (Kumar, 1987).

The academic library serves as the pivot around which academic activities revolves in tertiary institutions. Ubogu and Okiy (2011) have pointed out that academic libraries are those attached to universities, polytechnics, colleges of education and other similar higher institutions of learning. Adeniran (2011) while agreeing with Ubogu and Okiy's assertion also added that academic libraries serve research needs of students and staff. A list of what may be found in today's library, according to Brown (2007), includes: books, periodicals, films, recordings, computer databases, and competent human resources. In the view of Ugwuanyi, Okwor and Ezeji (2011), the abundance of information resources provided by libraries makes them a potential learning environment in a university. They therefore advocate that a good academic library should provide multifunctional environment within the library space as this would create a platform for individuals to achieve set goals. The general objectives of academic libraries is to serve the needs of the academic community; to provide study areas for users; to provide a lending service appropriate to the different types of users; and to provide an active information service that may extend beyond the institution to local industry and commerce. Information and services provided by academic libraries should, at all times, reflect the constantly changing needs of their users. It is an avid fact that libraries significantly support teaching, learning and research in tertiary institutions.

Well stocked libraries underpin tertiary institutions agenda to offer quality teaching and support learning and research activities. The use of libraries by users and their satisfaction with the library services depend on the availability of appropriate learning materials, accommodation and competent staff. Implicitly, libraries should not only have good collection of materials but also comfortable places for users to learn and staff who can offer assistance to users when the need be. The effectiveness of libraries is often measured by the volume of library materials to clients, the amount of use of the resources and the apparent satisfaction of clients (Simmonds and Andaleeb, 2001). The library as a place of great interest to the students, provides relevant, adequate and up to-date information materials that are needed for learning all potential courses that may be offered an institution. This is why all academic library collections, are setup to meet the information and research needs of any academic program offered by the institution.

**Concept of Research Data**

Data is defined as facts or figures, or information that's stored in or used by a computer. Data denotes units of information observed, collected or created during the course of an academic research. Data is not limited to the science discipline alone, it also includes social science statistical and ethnographic data, humanities texts, or any data used or produced in the course of academic research, whether it takes the form of text, numbers, images, audio, video, models, analytic code or some yest-to-be-identified data type (Erway & Richy, 2013). Data could exist as physical records or files on a researcher's computer or terabytes of data on shared servers. Data should be managed during the active research project process and should be stored afterwards for future use and benefits of the universities (Erway & Richy, 2013). Data produced as part of research take a wide range of forms, from statistics and experimental results to interview recordings and transcripts (Borgman, 2012). According to Victor (2019) research Data are facts, to be collected in fulfillment of the objectives of the research work. These facts are gathered through various means of scientific techniques and tools. They may be qualitative or quantitative or mixed form of these, depend more or less on the nature and types of research.

Research data (RD) is any information that has been collected, observed, generated or created to validate original research findings. Towolawi & Onuka (2019) submitted that RD is the validated units of research information scientifically observed and generalized for decision making and knowledge creation purposes. RD are recorded factual material created in different format for common retention and acceptability in science community to validate research findings (EPSRC, 2015). RD can be either in digital formats or non-digital formats such as laboratory notebooks and diaries. The RD formats may include documents(text, word), spreadsheets, laboratory notebooks, field notebooks, diaries, questionnaires, transcripts, code books, audiotapes, videotapes, photographs, films and test responses, slides, artefacts, specimens, samples, collections of digital outputs, data files, database contents (video, audio, text, images), models, algorithms, scripts, contents of an application (input, output, logfiles for analysis software, simulation software, schemas), methodologies and workflows, standard operating procedures and protocols (Buys & Shaw (2015) and Victor, (2019). The RD are the primary and secondary sources of research data generated, collected, collated, analyzed and preserved for different purposes and in different formats for

future decision making and knowledge creation purposes. Literature have it that RD can be generated for different purposes, through different processes as highlighted below:

i. **Observational data** is captured in real-time, and is usually irreplaceable, for example sensor data, survey data, sample data, and neuro-images.
ii. **Experimental data** is captured from lab equipment. It is often reproducible, but this can be expensive. Examples of experimental data are gene sequences, chromatograms, and toroid magnetic field data.
iii. **Simulation data** is generated from test models where model and metadata are more important than output data. For example, climate models and economic models.
iv. **Derived or compiled data** has been transformed from pre-existing data points. It is reproducible if lost, but this would be expensive. Examples are data mining, compiled databases, and 3D models.
v. **Reference or canonical data** is a static or organic conglomeration or collection of smaller (peer-reviewed) datasets, most probably published and curated. For example, gene sequence data banks, chemical structures, or spatial data portals.

Managing research data is usually an integral part of the research process and extends over the entire life cycle of the data, from the point of creation through to dissemination and archiving, and will usually continue long after the initial research project has concluded. RDM consists of a number of different activities and processes associated with the data life cycle, involving the design and creation of data, storage, security, preservation, retrieval, sharing and reuse, all taking into account technical capabilities, ethical considerations, legal issues and governance frameworks. With the use of a proper data management plan and appropriate tools, the implementation of RDM will yield an effective usage of the system.

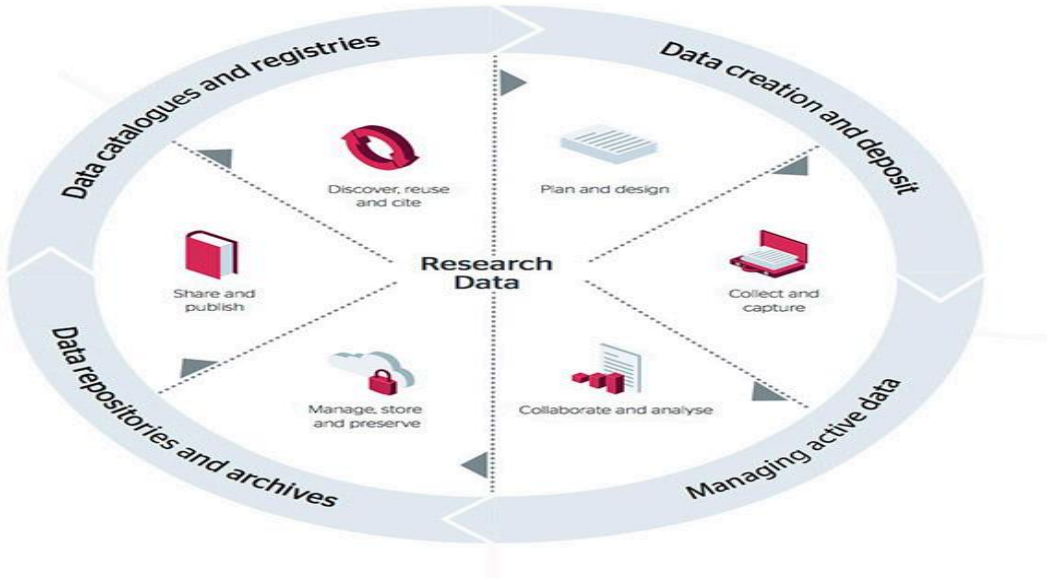


**Figure 1: Life cycle of Research Data and its management Source: Gunjal & Gaitanou (2017)**

Research data generated from the R&D activities and Sponsored Projects needs to be planned covering RDM services, plans, opportunities or challenges faced at the institution. This will provide more opportunities in the following way:

(i) by minimizing the repetition of works by enhancing the re-use of the existing data;

(ii) by providing opportunities for research collaboration;

(ii) by extending research projects and etc.

**An Overview of Research Management Data (RMD) in Tertiary Institution**

Research data management (RDM) has emerged as an area of interest in tertiary institution, leading to crucial investment in services, resources and infrastructure to support researchers data management needs. Tertiary institution refers to post-secondary education received at universities (government or privately funded), monotechnics, polytechnics and colleges of Education (Ani, Ekeh, Ezemuonyih, et.al, 2022). For any tertiary institution to discharge their cardinal responsibilities successfully adequate management of library resources as well as effective handling of information are indispensable. Data management typically involves planning for and creating data; organizing, structuring, and documenting data; backing up and storing data; and preparing data for analysis in order to share with others or to preserve for the long-term. The management of research data ensures reliable verification of results and permits new and innovative research built on existing

information. It has recently emerged as a strategic priority for tertiary institutions as they are trying to figure out the ways that research data should be supported,either in terms of advice and training or infrastructure for storage, sharing and curation (Cox and Pinfield 2013).

The research data management (RDM) process help to create data and plan for its use; organise, structure and name data; keep to make it secure, provide access, store and back it up ad find information resources and share with collaborators and more broadly, publish and get cited. RDM plays a crucial role in the documentation, curation and preservation of research data. Research data management, put simply, refers to the effective handling of information that is created in the course of research. RDM encompasses all the activities and processes undertaken to ensure the proper documented, organized, stored, archived and curated of research data, to make it available for access, use and reuse whenever, the need arises after the research has been done and reported (Archana and Sharad, 2017). Similarly, Chigdawa (2017), explained that RDM makes research data obtainable for impact, longevity, transparency, quality, efficiency, accessibility and speed in the overall research process. RDM is the active management and appraisal of the life cycle of scholarly and scientific data of interest (Donnelly, 2015). As a result of the aforementioned submissions, the researchers concludes that RDM is concerned with the generation, collection, organization, interpretation, storage, retrieval, dissemination, storage, retrieval, dissemination, transformation and use of research data with more emphasis on the applications of modern technologies.

The academic and research libraries in tertiary institutions and research related organizations have mandated to provide RDM services (Kruse, et. al, 2014). Managing research data is an emerging area of activity, where responsibilities and practices within libraries are generally not yet firmly established. RMD is mandatory for scholarly research and its faces the challenges of storage, facilities and infrastructure, skill, personnel, data integrity and backup options (Yoon and Theresa, 2017). Hence, the role of academic library in the RDM process has been affirmed in popular and current literature (Brown, et al. 2016; Grynoch, 2016; Nhendodrzashe and pasipamire, 2017). This implies that many libraries are keen to take on the new roles by providing support for effective research data management (RDM).

**Constraints in the Research Data Management (RDM) in Tertiary Institutions**

A dearth of literature in RDM practices in tertiary institutions and among academic libraries revealed that tertiary institutions lack the following identified prerequisites among others too numerous to mention below:

i. **Investment in Research capacity and Training (RC&T)**: The research capacity and training (RC&T) is integral to the research data management landscape efforts in fighting the global constraints of RMD in tertiary institution. As the RDM landscape environment become increasingly complex and challenging, the need to straightened the research abilities of individual researchers, institutions and systems to help perform core research data management functions.

ii. **Research data Management Specialist Cum Experts**: The main asset and driver for quality education, research and development of capacities are the highly-qualified human resource (experts/specialists) that need to adapt and adopt RDM techniques cum technologies. But there are dearth of specialists/experts in developing countries that leads to ineffective research data management.

iii. **Research Data Infrastructure (RDI)**: RDI provide guidance on intellectual property issues, licensing of data and raises awareness on research data (Wilma, Magchiel and Joeri, 2013). RDI assist researchers to decide on the RDM tools and processes and as well give information about tools and good practices available both at national and international level. In developing nations, tertiary institutions do not set up research data infrastructure and as such researchers do not deposit their data. As a result, no data publishing and archiving workflows exist. This is an anomaly of tertiary institution. However, RDI also bridge the gap between data and publications by encouraging researchers to link data with publications and feedback.

iv. **Data Management Policies**:The management polices support research and management of data. Tertiary institutions are to put such policies in place. The advocacy for the data management policies should reiterate the content cum elements of the policy to addressed:the responsibilities and roles involved in research data management, training and support, access and reuse, security and long term preservation among other elements.

v. **Research and Data Statistics:** Research and data (R&D) statistics and their indicators are relevant tools for evidence based RDM policy but they are scarce in the developing countries like Nigeria. Gaillard, (2008), supported the need for widely recognized R&D statistics in policy documents because such statistics provide vital information for policy formulation and decision making, assessment of performance, monitoring and evaluation of progress, making predictions about future trends and identification of priorities; helping with understanding the strengths, weaknesses, and potential opportunities for research development. Hence, in the context of developing countries, R&D statistics are needed to identify sources of quality research data, researchers, the research areas of interest, the research areas specialization of institutions, highly skilled personnel among other benefits.

vi. **Data Plan Template:** The provision of RMD template is very important in tertiary institutions, without which it become highly impossible to execute any successful research development management plans. Hence, the template to be put in place should highlight samples of successful data management plans to support researchers.

vii. Other constraints for the management of research data that hinders the progress of the RDM process in tertiary institutions include **lack of funding; lack of organizational structures**; **lack of professional preparation**; **lack of priority among researchers** and **lack of institutional mandates**.

**Strategies For effective Adoption of Research Data Management**

Despite the aforesaid constraints, there are possible strategies to adopt research data management in tertiary institution. According to Gunjal, & Gaitanou, (2017), the following highlighted strategies should be taken care:

a. By adoption of policies;
b. User training of library staff;
c. Training for stakeholders;
d. Support from stakeholders, such as technical expertise and academic fraternity;
e. Voluntary submission of publications to the repositories;
f. Data curation;
g. Database creation;
h. Compliance of policies with funding agencies;

i. Upgradation of features and software;
j. Culture change;
k. Change management.

**Roles of Academic Libraries During the RDM Process**

Data from academic research projects represents integral part of the global research knowledge base, and so managing data should be a natural extension of the tertiary institution library's role in providing access to published part of the knowledge base. Academic libraries perform the under-listed roles during the RDM process:

1. **Instructions:** Academic librarians are experts in designing, managing and delivering educational content which are customized to the research practices of members of various disciplines and levels of expertise within the tertiary institution enterprise. Instructions are used by experts to educate members of the tertiary institutions in RDM issues.
2. **The Hub of Quality Data:** Academic libraries have a crucial role to play as data quality hubs in academic and research communities of tertiary institution. Giarlo, (2013), affirm that academic libraries provide quality data auditing and verification services for the tertiary institution enterprise as well as reassure the researchers that accessed data are of high quality.
3. **Information Support and Training:** academic libraries play the key traditional roles of engagement with the academic community through provision of information support and training. According to Brown, et. al (2015), opined that strategic priorities must be expanded to all aspects of the research life cycle fso that effective support and training will be implemented by the library.
4. **Data Provisioning:** Academic libraries assist researchers with data location, interpretation, documentation, retrieval in formats that can be directly loaded into analytic software (Shaw, 2015). Data provisioning is the configuration, deployment and management of multiple types of data system resources provide equipment, software or services to employees, customers and users.
5. **Research Data Management Service Provider (RDMSP):** One of the identified role of libraries include: offering RDM services and support in the area of data management, planning, preparation, preservation, organization, security, documentation and sharing, preparation of datasets for deposit and long term

preservation as well as issues relating to copyright, licensing and intellectual property (Dora & Kumar, 2015; Kennan and Afzal, 2014).

6. **Promotion of RDM Policy:** The library provides advocacy for RDM policies, advice and work with the IT support unit to develop appropriate local data storage capacity, training and curation for researchers and students.
7. **Creation of Data Management Awareness Within Academic Community of Tertiary Institutions:** The library highlights the benefits inherent in the active management of research data and its preservation thereby, influencing how researchers create, format, use, publish and disseminate research data. These potential roles also includes increasing/creating data awareness among researchers; providing archiving and preservation services for data within the institution through institutional repositories and development of new professional strand of practice in the form of data librarianship with multiple aspects of data management specialists.
8. **Coordination and Collaborating**: The academic library play a crucial role as coordinator and collaborator in the RDM process according to Floex, et.al.(2015). Libraries also, coordinate research staff and administrators across campus to raise awareness of RDM mandates and services. Academic library experts in research methodology and knowledge retention offer relevant leadership in RDM efforts within the institution.

## Conclusion

Libraries are no longer a room of four walls which contain printed collection of materials but presently libraries have new image of libraries which contain papered and paperless collections of sources, resources etc. Currently, there is a tendency that libraries are moving towards developing new institutional RDM policies and services considering it as an important part of their future role. Research data management is a complex issue involving multiple activities carried out by various actors addressing a range of drivers and influenced by a large set of factors**.** Institutional policy development is required as a basis for coordinated action on data management**.** Academic libraries play a significant role towards the achievement of the goals of tertiary institutions and hardly would academic institutions be able to provide for the academic, intellectual and other interests and information needs of students without the services of good libraries. The paper presented the role of academic libraries in

research data management in tertiary institutions as the constraints, strategies benefits to be gained by managing the research data.

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