

A Selective Review of Literature on Research Data Management in Academic Libraries

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ABSTRACT

The present paper dwells on Research Data Management (RDM), its need, importance, the behaviour of the researchers in different disciplines towards data sharing and the role of libraries in extending data management services. The policies of publishers and funding bodies for sharing research data have also been described. It underlines that the library professionals should have a comprehensive understanding of the emerging issues, trends and challenges about the research data management to deploy appropriate services for the researchers. It highlights various resources on research data management, which may serve as guidelines for library professionals and researchers. The study will prove beneficial to library professionals and inspire them to extend RDM services in their organisations. The paper concludes by advocating that the library professionals must update and upskill themselves with new trends, tools and techniques to provide RDM services. They should sensitise researchers to make their datasets accessible for reuse and sharing.

Keywords: Research data; Data sharing; University libraries.

1. INTRODUCTION

The universities and other higher educational institutions are epicentres of knowledge. Their departments and laboratories undertake various research activities to address the challenges which mankind faces. In the process, they generate large and varied datasets which need to be organised and preserved for reuse and validation by others. The rapid strides in Information Communication Technologies facilitate the collection, organisation, description, analysis, storage, long-term preservation and dissemination of datasets for sharing and reuse across the globe. The funding bodies specify that the researchers must mention their data management plans in the research proposals and make their datasets available in open access for others to reuse. The scholarly journals also mandate that the underlying data of the published articles should be made available in the open-access repositories for others to access and browse. In the wake of these reasons, the datasets are considered as critical scholarly records which need to be maintained and preserved for future use. Since the libraries have the primary responsibility of organizing, maintaining, preserving information in different formats, they are expected to extend Research Data Management (RDM) services too. Research Data services may range from creation and management of institutional data repositories, providing data mining and visualisation tools, education and training to researchers on data management activities, writing data management plans, using metadata for describing datasets, sensitizing the researchers

towards the importance of maintaining and sharing research data with others (Koltay,2016)¹.

The purpose of this paper is to familiarise and sensitise the stake holders about the concept and importance of RDM in libraries. The authors have accessed the databases of Scopus, EBSCO-Academic Search Complete and PROQUEST-Academic Research Library to retrieve the apposite literature. They have reviewed the literature and dwelt upon the different aspects of RDM-the basic concept and relevance of research data management; research data sharing practices in various subject areas; role of libraries in research data management; general and specific repositories of research data and capacity building for extending research data management services. The paper also sheds light on the various sources on RDM which librarians may access and consult before they embark upon deploying RDM services in their libraries.

2. RESEARCH DATA AND THEIR IMPORTANCE

Research Data is recorded, factual material commonly accepted in the scientific community as necessary to validate research findings. There are different formats of research data like word document (doc/docx), spreadsheet, lab notes, field note books, diaries, surveys, questionnaires, transcripts, codebooks, audio and video files, images, photographs, artefacts, samples, models, algorithms, scripts, content analyses, focus group discussions and responses, interview notes and so on so forth. The data generated during the research activities are valuable resources which if properly stored may be accessed, browsed, consulted, used and built upon for future academic, research

and scientific purposes. The researchers can add their viewpoint which may assist in the generation of new knowledge. Thus they can avoid squandering of time and efforts, and dissipation of energy on data collection and reinventing the wheel (U.K. Data Service <https://www.ukdataservice.ac.uk/>).

The research data should be preserved because there has to be accountability for public-funded research. The availability of research data for use and reuse benefits and extends scholarship by encouraging interdisciplinary perspectives and prompting research questions. The free access to research data also helps in validating the research findings, supports and maintains integrity and prevents misconduct in education and research. (Kuiper & Hoeven, 2009)²

Research Data sharing facilitates scientific enquiry and debate, promotes innovation, transparency and accountability, examination of research methods and findings, visibility, collaborations among the data users and creators. It also facilitates other researchers in exploring, interpreting and upholding the integrity of the data by verifying and building upon the published results (Child, 2014)³.

2.1 RESEARCH DATA MANAGEMENT

The concept of Research Data Management (RDM) has gained tremendous importance. This is evident from the fact that the last and first issue of IFLA Journal of 2016 and 2017 respectively focused on RDM services. Every other year, the ACRL Research Planning and Review Committee produces a report on important emerging trends which pertain to academic librarianship. The ACRL(2018)⁴ has underscored that the datasets, including the text, numeric, multimedia, social media, hypertext and hypermedia, need to be acquired and managed by the libraries. Research Data Management Services refer to a range of tools and support services which libraries offer to help researchers and faculty members in organizing, documenting, preserving their data during and after their research activities are finished. It provides all the data related support which the researchers may require through the life cycle of data, its use and reuse. It is an administrative activity which includes the functions of acquiring, validating, storing, protecting, and processing required data to ensure the accessibility, reliability, and timeliness of the data for its users (Galeto, 2016).⁵

Research Data Management is beneficial for both researchers and disciplinary progress in general. Though data management requires additional work at the beginning of a research project, it reduces difficulties and problems in the course of the project and ensures data availability after the completion of the project. The stakeholders like funding bodies, publishers, academia and industry have formulated FAIR Data principles (Findable, Accessible, Interoperable, Reusable (FAIR) research principles to guide all how to manage and maintain datasets for future use. It means that the datasets should be findable, accessible, citable and reusable by one and all (Wilkinson, *et al.*, 2016)⁶.

3. POLICIES OF PUBLISHERS AND FUNDING BODIES

The National Data Service (NDS) is a US initiative, a consortium of data providers, data aggregators, academic

libraries, publishers and computing infrastructure providers. The NDS portal helps the researchers and scientists in publishing their datasets, searching, linking and reusing the already existing datasets; <http://www.nationaldataservice.org/>.

The Australian National Data Services (ANDS) provides access to research datasets generated in the labs and universities of Australia. It facilitates and collaborates with the researchers in publishing, sharing, handling, de-identifying using and discovering datasets; <http://www.ands.org.au/>.

The Digital Curation Centre is a globally recognised centre for capacity building in RDM and digital curation. DCC works with research organisations to help, design, implement and deploy RDM so that Open Data gains and sustains momentum across the world; (<http://www.dcc.ac.uk/>).

In India, the government supports Open Data through Open Government Data (OGD, data.gov.in). The portal is used by the government departments and ministries for publishing their datasets, documents, services and tools for the general public to access and use.

The National Data sharing and Accessibility (NDSAP) Policy has been formulated to facilitate sharing of non sensitive datasets generated in ministries and departments through the use of public funds. The government intends to encourage sharing of datasets for national planning and development.

The UGC Promotion of Academic Integrity and Prevention of Plagiarism in Higher Education Institutions Regulations, 2018 mandates that the theses submitted to the Indian Universities for the award of Ph. D degree should be made available in open access for others to access and consult.

The major publishers have emphasised that the research should be transparent and reproducible; for this, the research data should be available in public domain for anyone to access. The publishers provide links to the various data repositories, where the researchers may submit their research data. For instance, Elsevier have their own repository, where the researchers may submit their datasets for others to access, use and share (Elsevier, 2019)⁸. Springer Nature have specified four different types of data policies for submission of research datasets.

The researchers need to have a robust plan for research data management which they need to incorporate in their research proposals (Cox, Varbaan, Sen, 2012)⁹. The funding agencies have mandated that researchers must submit detailed data management plans. A Data Management Plan (DMP) is a written document which describes the data the researchers acquire or generate during the course of their research projects, how the researchers manage, describe, analyse and store data for sharing and reuse. The different funding agencies have mandated that the researchers incorporate DMP in their research proposals which they submit for seeking grants.

The AAAS, the American Association for the Advancement of Science mentions that all the datasets and other reading material like codes, patents, fossils, and rare specimens should be submitted to the approved repositories. The AAAS wants the researchers to abide by the MIBBI (Minimum Information in Biological and Biomedical Investigations).

The European Research Council (2017)¹⁰ have provided

guidelines to facilitate open access to scholarly publications and research data. The Councils emphasise that the researchers should always share data if there are no restrictions of copyright, confidentiality or contracts.

The funding bodies underline the public's right to access and reuse the datasets of research activities funded by them. But the funding bodies do not have an adequate mechanism to ensure compliance to data management plans. The onus of maintaining and managing data lies with the researchers once the research project is over with no budgetary support from the authorities; this poses a challenge for the researchers (Poole and Garwood, 2019)¹¹

4. DATA CURATION

Data curation is a rubric terms which encompasses all activities and procedures which are undertaken and followed for organising, describing, cleaning, enhancing and preserving data for sharing and reuse. It helps in data discoverability for reuse and sharing among the researchers (ICPSR, n.d.). RDM is a component of data curation. All academic libraries have a responsibility for collecting and curating datasets. (Toups and Hughes (2013)¹² have suggested that small universities and institutions may also provide comprehensive RDM services by collaborating with other departments for data management and curation. The same has also been proposed by Latham and Poe (2012)¹³. Libraries may partner with other divisions like Photographic services and division of university advancement to undertake data curation activities. The library staff should be aware of researchers' attitude, behaviour towards data curation; the staff should also know the education and training needs of researchers for proper management and maintenance of research data sets (Scaramozzino *et al.*, 2012)¹⁴. Medeiros (2013)¹⁵ has emphasised the importance of partnership between faculty and libraries in supporting data management. David and Alayon (2016)¹⁶ have suggested that library professionals should have digital curation skills and institutions must develop and maintain robust information infrastructure for extending curation services to the researchers. Chao *et al.* (2015)¹⁷ have highlighted that the conceptual framework and taxonomies are essential aspects of data curation. They have introduced DPCV(Data Practices and Curation Vocabulary), which helps in describing different types of data generated and practices to store and archive them. Harris-Pierce *et al.* (2012)¹⁸ have stated that Library and Information science schools should include data curation in their curriculum and offer courses on them and prepared professionals to extend data curation services. There should be interoperable standards for describing datasets. The libraries should know about the concepts of data privacy and ownership (Weber *et al.*, 2012)¹⁹.

5. DATA SHARING BEHAVIOUR OF THE RESEARCHERS

Kim and Stanton (2016)²⁰ have studied the institutional and individual factors which influence the data sharing practices among 1317 scientist from 43 discipline. The individual factors include how the researchers perceive the benefits, risks and efforts involved in data sharing. The institutional factors are policies of journals and funding bodies which mandate that

research data should be made available in the public domain. They have reported that there is no positive correlation between funding agencies' policies for data sharing and data sharing behaviour of the researchers. But the journals' policies for data sharing influence researchers' data sharing practices. Markauskaite, *et al.* (2012)²¹ surveyed 864 researchers of seven Australian universities and reported that the data sharing was not a priority for them; just 9 per cent of them shared data with others. The difference in data sharing practices among the researchers have been underlined by Kurata, *et al.* (2017)²²; Kim and Stanton(2016)²³ and Nguyen, *et al.*, (2017)²⁴.The researchers share their datasets on request or submit to the journals as supplementary content(Joo, *et al.*, 2019)²⁵

Vidal-Infer, *et al.* (2018)²⁶ have reviewed 88 websites of journals covered in the 2014 edition of Journal Citation Report (JCR) in the dentistry subject area for data sharing editorial policies. The authors also surveyed the PubMed Central repository to get information about the characteristics of the supplementary material of 88 journal. Their study reported that there were more chances of getting supplementary or additional material in the first quartile journals. Only 7.6 per cent of the records covered in PUBMED had supplementary material. Alawi, *et al.* (2011)²⁷ have reported that authors of papers published in high impact journals have not followed the publishers' policies of providing underlying data of their articles in open access repositories for others to access and reuse. The authors reviewed 500 paper from 50 original research journals. Out of the 50 journal 44 had mentioned that the datasets should be available for reuse. While some journals simply stated that data should be made available upon request. The researchers across the different disciplines of social, natural, engineering, medicine and health sciences have different perceptions towards research data management plans. They also differ, show reluctance of varying degree to the use of tags, metadata, file naming conventions, standards and version control systems (Polona and Vlasta, 2019)²⁸, Joo, *et al.*, 2019 (ref. 25) Lassi, *et al.* (2016)²⁹

Data sharing is not commonly followed by researchers (Piwowar and Chapman, 2010)³⁰. The concept of scholarly altruism also influences the data sharing behaviour of the researchers. It means the extent to which the researchers are willing to share their datasets with others without expecting any appreciation in return .Mayernik (2016)³¹ has reported that institutional support for data management is not uniform within a single institution or discipline. There are a range of institutional configurations for supporting research data management within an organisation and a single discipline. There is a gap between the library professionals' and researchers' understanding of basic concepts like describing data by using standards of the field like Dublin core etc. The researchers do not use campus wide storage facilities and maintain their own storage servers. The research assistants undertake the major work of data management and professors handle the work of sharing research datasets with other.

Barsky (2017)³³ has surveyed the researchers of Science, Engineering, Humanities, Social and Health Sciences at the University of British Columbia and has found that the majority of researchers use less than 50 GB storage while some use

1TB storage for their research projects. The researchers want assistance in drafting their data management plans. They use cloud-based solutions like Dropbox, Google Drive etc. and flash drives. The researchers also want support from their universities in their data management activities and are also keen on attending the workshops on best practices in data management.

The 1372 researcher spread across different stages in Earth Sciences from 116 countries have reported that do not share data because it might be misused. Further, they are unaware of the data-sharing tools and policies (Borycz, *et al.*, 2018)³⁴. The researchers are ignorant about different aspects like automatic data backups, ownership of data, data management plans, FAIR data principles and research data repositories (Mancille, 2019)³⁵.

Park and Gabbard (2018)³⁶ have examined the five determining factors like the mutual benefit, anticipated relationship, recognition, altruism and fear of being scooped influence researchers' intention to share implicit and explicit knowledge. The authors used the method of Partial Least Square (PLS) method on 142 survey responses in the field of life and health sciences and highlighted that the mutual benefit and fear of being scooped were important factors which influenced knowledge sharing in the life and health sciences.

6. ROLE OF UNIVERSITY LIBRARIES

A number of studies have examined and analysed the types of RDM services which the university libraries provide across the globe (Cox & Pinfield, 2014³⁷; Tenopir, 2015)³⁸

Libraries are the best agents to handle such activities as the library professionals are trained in the skills of organizing and preserving information; their very mission is to preserve knowledge for posterity. They have worked successfully to set up institutional repositories and data archiving and curation work is just an extension of the work which they have already been doing efficiently since long. Data Management offers a beautiful opportunity to library professionals to support the research endeavours of their universities. The library professionals have the requisite expertise to take the lead and initiate the work of data management; this will also bridge the chasm which generally exists between the library professionals and the researchers (Surkus & Read, 2015)³⁹. The library professionals need to advocate, disseminate awareness about research data and research data management plans and promote the use of data repositories among the researchers and faculty members. (Y, *et al.*, 2019)⁴⁰

Data governance is all about maintaining, ensuring and monitoring the quality of data. The characteristic features of data are that it should be available, discoverable, trustworthy, authentic, acceptable and accurate (IBM, 2012). In this connection, libraries can play a significant role by consistently auditing and verifying the quality of research data; by ensuring that proper metadata have been used (Giarlo, 2013⁴¹; Zilinski and Nelson, 2014)⁴². The successful data governance involves proper compliance to data standards metadata, proper documentation of provenance of data (ORACLE, 2015)⁴³ and it may differ from one subject field to another; but general guidelines may be framed for adherence across the subject

areas (Koning, 2019)⁴⁴.

Yoon and Schult (2015)⁴⁵ have categorised research data management services as active and passive. When libraries extend help to researchers for depositing data, it is an active service. When libraries merely describe the different activities and procedures involved in data management and how researchers should do it, these are passive services. Their study examined the research data management services through a content analysis of 185 library websites. The study focused on four parameters; services, information, education and network and concluded that libraries need to take more concerted efforts to provide research data management services like put more information on their websites and develop better educational and training services. The authors observed variation among the data management services and programmes offered by the academic libraries. The North American and European libraries provide more consultation services and less technical sessions or hands-on training to the researchers (Tenopir, *et al.*, 2014;⁴⁶ Tenopir, *et al.*, 2017)⁴⁷

7. CAPACITY BUILDING FOR RDM

(Antell, *et al.*⁴⁸, Corral, *et al.*, 2013⁴⁹; Creamer *et al.*, 2012⁵⁰) have reported that the staff does not have skills and expertise to provide necessary specialised data management services. The lack of adequate financial support and skilled human resources support prevents deployment of general and subject specific RDM services. (Castle, 2019)⁵¹

Verbakel and Grootveld (2016)⁵² have described the Research Data Management (RDM) course for library staff that extends RDM services to the researchers. The course aims to equip the library staff with the required skills and knowledge so that they become capable enough to provide RDM services to the researchers. Briney, Goben & Zillinski (2015)⁵³ have studied the data policies of various libraries, and have elaborated that the library professionals should know about the concepts of intellectual property, research data, ownership and retention of data. They should be well versed with the policies of funding bodies and publishers. It will facilitate them in providing essential research data services to ensure compliance with the funding bodies' and publishers' policies by the researchers. The professionals have also developed pilot programmes and tool kits for libraries to use for extending RDM services (Read, 2019)⁵⁴. Grunzke, *et al.*⁵⁵ (2019) have developed MASi (Metadata Management for Applied Sciences) repository service which is OAI compliant and uses a generic metadata programming interface and a generic graphical web interface for providing RDM services across different subjects-geography, chemistry, digital humanities.

The University of Cambridge has launched data champions programme. Data Champions constitute a network of volunteers from different departments like researchers, supervisors, project investigators, data managers, information technology professionals, librarians and data scientists. The data champions organised workshops, delivered talks, undertake one on one mentoring, and participate in developing data management. They guide researchers about how to organise and maintain their datasets in keeping with the FAIR research principles (University of Cambridge, 2019)⁵⁶

An appropriate research data management system should cater to the needs of the researchers and procedures they follow in their work. It should also follow common standards. Further, the procedures for acquiring and maintaining datasets should be automated. The use of right semantics and ontologies should facilitate timely discovery and retrieval of the required datasets. Fitschen, *et al.* (2019)⁵⁷ have devised CAOSDB, a research data management system for ensuring seamless integration of varied and legacy datasets from simulations and experiments in the field of biomedical sciences.

It is evident that as the scientific activities and research become more collaborative and data intensive, scientists and researchers will have serious and crucial data management needs. They will need the support system of experts, physical and computing infrastructure for data storage, archiving and ensuring integrity of data. University libraries have to play an active role in this regard. They have to implement services to attend to the full data life cycle-data management plan, digital curation, creation and addition of metadata.

8. DATA JOURNALS AND REPOSITORIES

Data journals are publications which make research data discoverable, interpretable, reusable, researcher known and citable. The authors may publish their datasets, considered as primary research output in data journals. Some of the data journals are as under:

- Data in Brief <https://www.journals.elsevier.com/data-in-brief>
- Journal of Physical and Chemical Reference Data <https://aip.scitation.org/journal/jpr>
- Journal of Open Research Software <https://openresearchsoftware.metajnl.com/>
- Geosciences Data journal <https://rmts.onlinelibrary.wiley.com/journal/20496060>.

There are many journals which provide information on digital preservation and curation like International journal of digital curation <http://www.ijdc.net/>; International journal of digital libraries <http://www.dljournal.org/> etc.

There are several multidisciplinary repositories, free and commercial (charge fees) which archive research datasets like

- **Zenodo:** This repository is operated by CERN and covers all scientific disciplines. It extends free data submission support to researchers as long as it is openly published.; <https://zenodo.org/>
- **Dryad:** It is a curates general purpose scientific data repository. All datasets and records are associated to the published articles. <https://www.datadryad.org/>
- **Figshare:** It offers free data deposition and access for all disciplines and attributes systematically. It is a commercial repository. It means that the data repositories are myriad and diverse and are not integrated. It also implies that the discovery and reusability of data gets more complex for individuals and computers. <https://figshare.com/> (Wilkinson, *et al.*, 2016)⁵⁸.
- **Mendeley Data:** is an open research data repository, where researchers may upload and share their research data. Datasets can be shared privately amongst peer

researchers, as well as published to share across the world. <https://data.mendeley.com/>

9. CONCLUSIONS

The literature provides a snapshot of the trends in research data management and services which libraries extend to their researchers. Data Management helps in meeting the objectives of reproducible and transparent research. Well documented and maintained data are easy to use and share across the disciplines and important for all stakeholders-researchers, teachers, and universities libraries and fund-granting bodies. It also results in better return on investment for funding bodies and higher education institutions (NISO, 2015).⁵⁹ The different tasks involved in extending research data management support are planning for various services, selecting and analysing the data to be stored and archived, documentation work for making results intelligible, understandable and verifiable by others, ingesting or migrating data which is to be stored for preservation on long-term basis, deciding in which repository data has to be archived, ensuring that data is accessible in public domain. Maintenance work is required to be done on a regular and consistent manner. The different studies have highlighted the challenges which the libraries face and future implications for data management planning and preparing professionals for future. Libraries have an important role to play in research data management services. They are equipped with staff to handle data management services and they are central place in universities having connections with different stakeholders associated with data management. Libraries should coordinate with the university authorities and other stake holders to formulate RDM policies. The professionals must update and up skill themselves with new trends, tools and techniques to provide these services. They should also regularly hold orientation sessions to sensitise researchers to make their datasets accessible for reuse and sharing through general and specific repositories.

Surveys should be done in order to collect the feedback from researchers and faculty members to find out what kind of support they expect from their libraries. The library professionals should also be surveyed to find out the hurdles they face in deploying RDM for their researchers. Libraries should coordinate with the university authorities and other stake holders to formulate RDM policies.

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