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Theme 7: Re-engineering of Libraries and its impact on LIS Education/ Information Literacy including Open Education Platforms & Resources - SWAYAM/MOODLE/MOOCS/MOODLE/VLE

Research Data Management in Libraries: A Study of Awareness and Practices Among Faculty and Research Scholars of IIT Delhi

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ABSTRACT: The main objective of this study was to discover the awareness towards research data management and its service among faculties and researchers of IIT Delhi. For this study, a survey method was adopted. A questionnaire was shared using the Google Forms link to select 150 email addresses where a fair quantity of emails bounced, and only 47 responses were received, eliciting a rate of 30%. The study's findings revealed that respondents stored their massive research data mainly on laptops but bothered least to apply any security measures. DMP was the new term instead of metadata. Respondents have a dim view of whether IIT Delhi has RDM Policies. The study also found several challenges in implementing RDM, like lack of policy, inadequate human resources, financial support and technological infrastructure. Less than half of faculty and research scholars know RDM but require help and assistance managing their data. It recommends that all researchers practise RDM as it is helpful for present and future studies, which can be done by seeking proper training. The current study is significant because it provides insight into the librarian's role in RDM Policy at all levels in their Institutes and brings policies regarding RDM and its services.

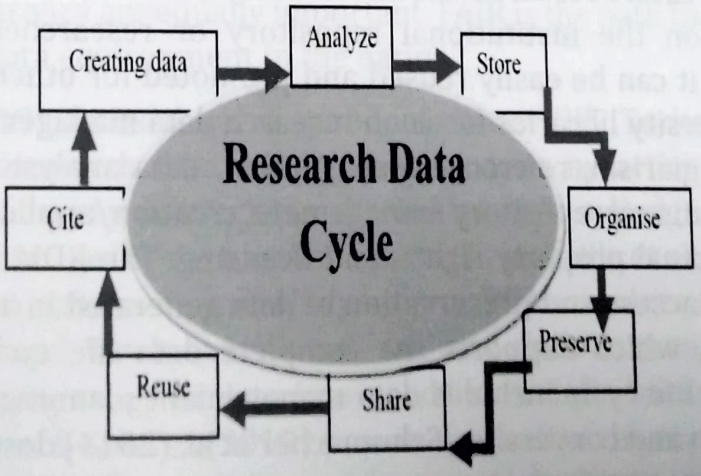
KEYWORDS: Research Data Management, Data management services, IIT, Faculty, Research scholars, Delhi

Introduction

Research data management becomes more complex, mainly when the researcher processes the research at the national and international collaboration level or if the researcher moves between different organizations. It is necessary to archive and manage the research data, including images, records, codes, simulations, digital datasets, and physical items created or collected for or during the research process.

Research Data Management (RDM) is concerned with planning, creating, organizing, storing, sharing, and reusing data for future research. The primary aim of research data management is to develop tools to store and manage data to make an efficient research process with existing research data. The University of Oxford defines RDM as "research data management is a general term covering how to organize, structure, store and care for the information used or generated during a research project" (Whyte & Tedds, 2011) defined RDM as "this practice involves steps from collecting, organize, reuse the research data to analysis, processing and achieving research results. Research data management is also known as the research data lifecycle where data is organized from its entry to the research cycle up to the dissemination and archiving of valuable results". Today, across the world, research and academic institutions understand the significance of research data management and safeguard research data for long-term and further research work at the global level.

In an open-access environment, RDM is an important, rapidly growing research support service; as a result, the organization feels the requirement for data management plans (DMP). Today, most researchers and research organizations are taking the initiative to work with reference management tools like Mendeley, EndNote, Zotero, RefWorks, JobRef and Reference Manager, and Papers. An effective research data management plan is crucial in managing research data without risk and promotes the research data-sharing culture. The UK Data Archive gave a simple model for research data management that comprises six different stages: data creation, data processing, analysis of data, data preservation, providing access to data and reusing it. Also, The University of South Australia defines the research data management lifecycle as displayed in Figure 1.



(Source: http://guides.library.unisa.edu.au/ManagingReferences)

Fig.1: Research Data Management Lifecycle

1.1 Importance of RDM

Research is critical, leading us to a new answer or result; hence, research data management is essential.

(i) It offers replicability, as replicating any result has a central value in science.

(ii) It helps inform and improve future studies—data reuse fosters new results and discoveries.

(iii) It ensures that the research data documentation is adequate and systematic.

(iv) It provides proper and Correct backup of data.

(v) It leads to more vital collaboration with funding agencies and across disciplines.

(vi) It keeps the data safe, secure, accessible and reusable.

(vii) It helps to save time and energy for the researcher.

(viii) It provides documented data location, making sharing easy among team members.

(ix) It increases data life and makes it more accessible in an open environment.

(x) It improves transparency, speed of access and efficiency of data.

1.2 Research Data Management Services (RDMS)

RDMS in university libraries is growing and is the most demanded service, especially for researchers. Still, many researchers need help understanding the particular research processing, the life cycle of their research data and its management for future research works. Nowadays, data will be stored, organized, and preserved on the institutional repository or researcher's departmental external disk so it can be easily reused and promoted for other research works. Also, many university libraries focus on research data management services and discouraging plagiarism, reference management, data analysis training, author workshop, institutional repository management, creation/application of metadata advocacy, intellectual property rights, and licensing. The RDM services mention the data storage, access and preservation of data generated in any investigation/ research project, which supports the complete data life cycle Tenopir et al. (2012). The data life cycle includes data management planning, digital curation, metadata creation and conversion. Schumacher et al. (2014) describe that "digital information's organization and preservation are now relatively well mastered. University Libraries have always played a proactive role in shaping research data management and communication".

1.3 Indian Institutes of Technology

The Indian Institute of Technology is an autonomous Institution designated "Institute of National Importance" by the Government of India. The first campus of IIT was established in Kharagpur in 1951. IITs were administered by the Institutes of Technology Act 1961, and there are currently 23 in India. These 23 IITs have over 16,000 seats across various specializations, making them one of India's premier engineering institutes.

Indian Institute of Technology Delhi is an excellent spot for training, research and development in science, engineering and technology, which began in 1961 as the College of Engineering, that later became the Institution of National Importance under the "Institutes of Technology (Amendment) Act 1963". Afterwards, its name was changed to "Indian Institute of Technology Delhi". IIT Delhi has included Engineering, Physical Sciences, Management and Humanities & Social Sciences disciplines.

2. Review of Literature

Xu (2022) described a need for training to perform RDM after 2011, which is necessary for both STEM and non-STEM subjects. However, the training sessions, which are organized, focus only on RDM introduction rather than in-depth knowledge about the topic. Also, this study lacks statistical analysis on RDM involvement. Choi & Lee (2020) revealed that research data was gathered and organized individually on one's own or laboratory level, but these were distributed only on an individual request. DMP policies were adopted recently. The nation is waiting for a data management and application system, but reusability and research transparency are equally important. FAIR is the path that will be taken to create an open data environment in the nation.

Unal et al. (2019) focused on respondents from UK, Turkey and France to understand the research data and its sharing done by active researchers. The results found that many participants needed more knowledge and training that may help them manage the data in their research. Mancilla et al. (2019) concluded that they need to gain more knowledge about RDM services and research data repositories. Instead, faculties wish to learn new skills to manage their research data, as the leading cause of data loss needs automatic backup facilities at the university. Johnson & Steeves (2019) reveals that half of the respondents declared that they are regarding the publishers and open to data sharing but faced challenges in managing data belonging to their research work. Seventy-one per cent do not use any data repository.

RDM supports the services which define what data requires storing and safeguarding for upcoming use, deciding which repository the data can be archived. Maintenance of the repository and its data must be done regularly. Libraries play a vital role in this process as libraries have trained staff to handle such services. Libraries are now responsible for coordinating with the higher authority of the university and other stakeholders to create and develop RDM policies. Also, professionals upgrade their skills with upcoming trends and techniques to provide these services (Payal et al., 2019).

Saeed & Ali (2019) found that research scholars of the Faculty of Social Sciences are inclined towards sharing research data with others compared to the Life Sciences faculty. Among all, 29.33 % publicized their research data using academic and social networks, whereas 37.62 % faced data privacy and confidentiality as an obstacle in data sharing. Mohammed & Ibrahim (2019) identified an absence of suitable RDM due to PG students and research scholars handling the research data alone. Iraqi universities need more directions on effective RDM, more human resources, adequate infrastructure and financial resources, and policies for managing research data. Postgraduate students and researchers suggested establishing and developing research data repositories.

Piracha & Ameen (2018) found that most faculties generate digital data and want to learn about RDM plans via training. They also wish to support the storage, preservation and curation of data. There needs to be more staff having good computer knowledge University needed significant funding to assist in data storage and security. Berman (2017) looks forward to getting it done and sharing their data with others for future use. However, they had issues that count on copyright and IPR, data security, lack of institutional support, and leadership to guide.

Tripathi et al. (2017) suggested that staff members upgrade their knowledge of RDM to offer better research data services. Also recommended is to earn updated skills in related technology to mark the researchers' needs to design, apply and arrange infrastructure and services essential to organize, gather and maintain the research data for access and reuse. Vanden-Hehir et al. (2017) reveal that cooperation between two or more entities and conflicts of both towards RDM and created a data lifecycle model and found that at early stages of the life cycle, the conflicts occur; however, the cooperation among steps arise at later stages and clarified that for successful RDM, early stages must be checked to overcome disputes.

Singh (2017) observed that research data management is an excellent initiative by university libraries to research data storage, organization, preservation, reuse and faster communication over the networks at the global level. Nhendodzashe & Pasipamire (2017) found University of Zimbabwe library was partially established

as it had the mandatory technological base and financial resources. However, it needed the legal groundwork and skills to offer RDM services throughout the data lifecycle.

Tripathi et al. (2017) observed that the Indian central universities are beginning to implement RDM services. In contrast, the libraries of the world's top twenty universities have it brought into action and are playing a vital role in favouring the research data requirement of their researchers. It surveyed some central university libraries to highlight how RDM is amplified to researchers. Lacy (2017) observed that only 31% responded to the rate for RDM practices in libraries. 71% have yet to evaluate to measure their Institution's call for RDMS. More than half of the respondents, 58%, declared that they are out of the establishment of RDM policies at the institutional level.

Schumacher & VandeCreek, (2015) concluded that they needed more understanding regarding data curation, storage and management principles. The study's findings showed that faculties faced data loss and used personal devices and cloud accounts to store data but were unaware of the data loss rate. The author suggested awareness requirements to help themselves and others in digital data curation.

Chakravarty (2015) discusses the RDM along with its needs, challenges that one plans that must be taken into account and a few online tools like "DMP Online and DMP Tools" that helps to develop DMP. These tools offer templates to build an effective DMP to help the researcher through the research work and will fulfil the mandates of the institutional research committee and funders. Well-managed research data offers varied opportunities for data sharing and its reuse.

ICSSR (The Indian Council of Social Science Research) portal called, "ICSSR Data Service" exists to help researchers. ICSSR, New Delhi, set it up to offer research data services to the researchers so they can store, use, reuse and analyze data to offer, promote and build up research attempts and analyses of policies drafted and carried out across the nation. The ICSSR Data Service is a handy platform for researchers of social science discipline to carry out future research work.

3. Objectives of the Study

The main objectives of the proposed research study are as follows:

(i) To identify the level of awareness about research data management (RDM) and associated concepts among faculty members and research scholars of IIT Delhi.

(ii) To find out the status of RDM policy at the institutional level.

(iii) To know the current state of RDM practices (including the type of research data generation, tools used for data analysis, storage devices used, and storage capacity) among the respondents.

(iv) To study the security measures to prevent research data and metadata familiarity among the respondents.

(v) To find out the challenges to implementing RDM services.

(vi) To suggest means and ways to enhance RDM services in the studied library.

4. Research Methodology

This study will revolve around IIT Delhi to determine if the Institution has commenced any steps to give RDM services to its researchers.

The current study is limited to research data management practices and the status of research data management services among faculty and research scholars at IIT Delhi. The present study was conducted using a survey method with the help of a structured questionnaire as a data collection tool. The investigator shared Google Forms (online) with 150 select emails where more than 85 emails bounced, and three reminders were sent that turned into 47 duly completed questionnaires. They found them valid from 20 May to 30 May 2022, yielding a 30% response rate.

5. Data Analysis and Discussion

5.1 Demographic Details

A total of 47 responses were received during the survey, where the highest respondents belong to the youngest age group of 20-30 (63.82%). Out of all 47 respondents, 37 (78.70%) belong to the male gender, and the remaining 10 (21.30%) are female respondents. These 47 respondents cover 17 (36.20%) from the Faculty of Civil Engineering, followed by Humanities and Social Science with 9 in number (19.15%) and the Faculty of Design with 5 (10.64%). The data revealed that 40.42% of doctorate scholars, 23.42% were postgraduate students, 14.89% of professors, 8.51% of assistant professors, and the remaining 12.76% included research fellows, associate professors, retired professors and professors of practice.

5.2 Frequency of Research Data Backup

Faculties and scholars were asked if they are currently working on any research project, where 74.50% of respondents accepted that they have full hands and 23.40% were free from any research work at the moment; however, only 2.10% were unsure. Different research works generate different amounts of data needed to be stored, and these ongoing projects and past work show the requirement for different storage spaces. 36.20% opted for 1-50 GB storage space to store data of their research work, <1 GB and 50-100 GB were equally chosen by 12.80% of respondents and other 12.80% respondents said they needed clarification about the needed storage space. 100-500 GB, 500GB-1 TB and 1-50 TB were needed by 10.60 % each, whereas only 2.10% said they needed more than 100 TB storage space for their research data. 50-100TB was not opted by any.

All this data must be backed up to keep it safe. The respondents shared about the frequency on which they take backup of their research data where 25.50% said they take backup every week and 25.50% said they back up every month. 17% take backup daily, and the other 17% are unclear, but 12.80% go yearly. The remaining 2.10% say they never take backup of their research data.

5.3 Types of Research Data and Analysis Tools

The data generated during any research can be of several kinds. Here, respondents were free to choose as many options as relevant. Table 1 describes that 83% of respondents said they generate documents that include text, and MS word, followed by 61.70% and 57.40% representing spreadsheets and models, algorithms, and scripts, respectively. Further, 55.30% show unprocessed data files produced by some software/ instruments, and 51.10% show slides and samples. The website was 42.60%, and notebooks/diaries took 40.40%. Photographs took 38.30%, Audiotapes and videotapes followed others with 21.30%, and 17% represented Databases. Here, no respondents said about questionnaires, transcripts and codebooks, whereas the remaining 8.51% contained PPT, research papers, specialized databases, and electrical recordings. The tools faculties and researchers chose to analyze the collected data were 57.44% representing MS Excel and MS Word and 46.80% representing MS PPT. Tool R was used by 27.65%, and Matlab was used by 25.53%. Adobe Photoshop represents 12.76%, followed by 6.38% of Python. However, 2.12% shows MySQL and SAS individually. None used Zoho Creator, but 21.27% used others, including Vivado, STATA, Fusion 360, and ArcGIS.

Table 1: Types of research data and analysis tools (n=47)

Sl.No.	Particulars	Respondents	Percentage
Types of Research Data			
1	Documents (text, PDF, Microsoft Word)	39	83,00
2	Spreadsheet (e.g. Excel)	29	61.70
3	Models, algorithms, scripts	27	57.40
4	Raw data files generated by software/ instruments	26	55.30
5	Slides, samples	24	51.10
6	Websites	20	42.60
7	Notebooks/Diaries	19	40.40
8	Photographs	18	38.30
9	Audiotapes, videotapes	10	21.30
10	Databases (e.g. Access, MySQL, Oracle)	08	17.00
11	Other (PPT, Research Papers, Specialized databases, Electrical Recordings)	04	08.51
12	Questionnaires, transcripts, codebooks	00	00.00
Common tools used to analyze data			
1	MS Excel	27	57.44
2	MS Word	27	57.44
3	MS PPT	22	46.80
4	R	13	27.65
5	MATLAB	12	25.53
6	Others	10	21.20
7	Adobe Photoshop	06	12.76
8	Python	03	06.38
9	MySQL	01	02.12
10	SAS	01	02.12
11	Zoho Creator	00	00.00

Note: Multiple answers are permitted.

5.4 Storage Devices used to save Research Data and Security Measures

In table 2, respondents were free to choose multiple options per relevance, revealing several ways researchers store their work data to keep it safe. The highest number of respondents, 78.70%, prefer a Hard disk drive on the personal laptop, followed by Web-based services like Dropbox and Google Docs with 57.45%. Further, 46.80% prefer Personal drives to save the data, but Har disk drive of the campus computer was trusted less, with only 36.20%, followed by a shared drive and hard

disk drive of an off-campus computer with 25.50% each. Whereas 23.40% prefer noting down the data on paper only. 21.30% represents the slides, and 19.10% represents email clients/servers to store data. The photograph was another way to store data used by 17%, unlike 14.90% who chose a Hard disk drive or data generating instrument, followed by 6.40% who preferred CD/DVD, whereas none used Microfiche to store data.

After storing the data, it is equally important to keep it safe from loss. There are ways faculties and researchers used to protect data. As per Table 4, unfortunately, the highest number of respondents, 57.44%, do not bother using any security measures to protect data. Still, Applock and Restriction on password guesses were used by 23.40% of respondents individually, followed by 10.63% using the encrypted data uploading method. Hiding identity of person and Folder level encryption method is practised by 8.51% each. Only 4.25% used File level encryption as a security measure.

Table 2: Storage devices to save research data and its security(n=47)

Sl.no.	Particulars	Respondents	Percentage
Storage Devises to Save Research Data			
1	The hard disk drive of the personal laptop	37	78.70
2	Web-based storage service	27	57.45
3	Personal drive	22	46.80
4	The hard disk drive of the campus computer	17	36.20
5	Shared drive/Institutional server	12	25.50
6	The hard disk drive of the off-campus computer	12	25.50
7	On paper	11	23.40
8	Slides	10	21.30
9	Email client/server	09	19.10
10	Photographs	08	17.00
11	The hard disk drive of data generating instrument	07	14.90
12	CD/DVD	03	06.40
13	Microfiche	00	00.00
14	I do not store	00	00.00

Sl.no.	Particulars	Respondents	Percentage
Security Measures are taken to Protect Generated Data			
1	I do not practice it	27	57.44
2	Applock	11	23.40
3	Restriction on password guesses	11	23.40
4	Encrypted data uploading	05	10.63
5	Hiding the identity of the person	04	08.51
6	Folder level encryption	04	08.51
7	File-level encryption	02	04.25

Note: Multiple answers are permitted.

5.5 DMP and Matadate Familiarity

Table 3 discusses the Data Management Plans where the highest number of respondents needed clarification about DMP, but only a few have the idea. 4.25% discussed that DMP is available at the Institution, the next 4.25% used DMP personally, and the last 4.25% were currently using it for their new work. Adoption of DMP for Projects/Research was also discussed, where 80.85% had not adopted anything, and 12.77% were not sure about the DMP adoption, but only 6.38% have adopted the DMP for their research.

Further, Familiarity with Metadata, DOI, and the researcher's ID was also discussed, and 36.17% have formal training on metadata, which is helpful to research data management, followed by 27.65% who knew about DOI. Next, 21.28% said they were familiar with metadata. 14.90% of respondents said that Institution has issued a metadata format but has yet to share about having a unique researcher's ID and unawareness of all these terms. Next, 63.80% do not record any metadata for their research data, followed by 23.40% who needed clarification about recording metadata; however, only 12.80% practice recording metadata of their research metadata.

Table 3: Use of Data Management Plans and Adoption of DMP for projects (n=47)

Sl.No.	Particulars	Respondents	Percentage
Data Management Plan			
1	Not sure	41	87.25
2	Institute has DMP	02	04.25
3	I used it for a previous project	02	04.25
4	I am using DMP for current research	02	04.25

Adoption of DMP for Projects/Research			
1	No	38	80.85
2	Maybe	06	12.77
3	Yes	03	06.38
Familiarity with Metadata, DOI, and Researcher's ID			
1	I got formal training in metadata, which is helpful for the management of research data	17	36.17
2	I know about DOI	13	27.65
3	I am familiar with metadata	10	21.28
4	The institution has issued a set of metadata format	07	14.90
5	I have a unique researcher's ID	00	00.00
6	I am unaware of all these terms	00	00.00
Record any Metadata about research data			
1	No	30	63.80
2	Maybe	11	23.40
3	Yes	06	12.80

Note: Multiple answers are permitted.

5.6 IPR and Open Access of Research Data

Table 4 reveals that 36.17% of respondents transfer the IPR of their work with their research team, followed by 34.04% who keep the IPR only with themselves. Other 19.15% need to learn about its transfer, whereas 8.51% mentioned various points like transfer of IPR depends upon the nature of the project, preference is an open database, and transfer IPR to institute. The remaining 2.13% said that they transferred it to the funding agency.

The views were taken about the availability of raw data for free, where the highest, 34.04%, strongly agreed to the fact, followed by 19.15% who agreed. However, another same percentage, i.e., 19.15%, remained neutral about this, and the next 19.15% cannot say anything about this. Precisely, 8.51% disagreed about the free availability of raw data, and none strongly disagreed with this. Furthermore, 44.68% needed clarification about depositing their research data to the public or subject repository, but 40.43% said no. In contrast, only 14.89% were interested in depositing research data to the subject/public repository.

Table 4: IPR transfer, raw data available for free and deposit of research data (n = 47)

Sl.No.	Particulars	Respondents	Percentage
Transfer of IPR of work			
1	My research team	17	36.17
2	Only me	16	34.04
3	I do not know	09	19.15
4	Others: Depends upon the project, Prefer open database, Institute	04	08.51
5	Funding Agency	01	02.13
Free Availability of Raw Data			
1	Strongly agree	16	34.04
2	Agree	09	19.15
3	Neutral	09	19.15
4	Cannot say	09	19.15
5	Disagree	04	08.51
6	Strongly disagree	00	00.00
Deposit data in a public or subject repository			
1	Not sure	21	44.68
2	No	19	40.43
3	Yes	07	14.89

Note: Multiple answers are permitted.

5.7 Training required to manage research data

Table 5 shows that faculty and researchers required training for research data management as 44.68% of respondents said they needed it, but 31.92% denied any training requirement; however, 23.40% were unsure whether they needed any training to manage research data. There are a few points that need to be focused, highest respondents with 63.82% wanted help formatting research data followed by 38.29% who wanted to know about research data sharing, other 38.29% needed to know about analyzing data and 34.04% who required help in documenting research data. 27.65% of respondents required help in copyright and IPR matters, whereas the next 12.76% opted to mention others that included data presentation, funding and data organization. The remaining 10.63% required help with ethics and consent.

Table 5: Training required to manage research data (n=47)

Sl.No.	Particulars	Respondents	Percentage
Training required to manage research data			
1	Yes	21	44.68%
2	No	15	31.92%
3	May be	11	23.40%
Point(s) at which help required			
1	Formatting research data	30	63.82%
2	Help with analyzing data	18	38.29%
3	Sharing research data	18	38.29%
4	Documenting research data	16	34.04%
5	Copyright and intellectual property rights (IPR)	13	27.65%
6	Other data presentation, funding,	6	12.76%
7	Ethics and consent	5	10.63%

Note: Multiple answers are permitted.

5.8 Challenges in RDM implementation and RDM policies

Table 6 shares the challenges that occur in the way of RDM implementation and discusses the availability of RDM policies at IIT Delhi. Multiple options were available to choose from. More than half of respondents, i.e., 53.19%, said the challenge is the lack of policy and inadequate human resources. 46.80% said insufficient institutional support and software were absent for research data processing. Next, 34.04% and 27.65% choose inadequate financial resources and lack of technological infrastructure as the reason for the non-implementation of RDM. The remaining 17.02% felt the obstacle was using different vocabulary between researchers and librarians. RDM policies could help researchers in various ways, but respondents with 74.50% need an idea of whether IIT Delhi has any RDM policy. 17% of the respondents said that Yes, IIT Delhi has these policies, but 8.50% denied them.

Table 6: Challenges in RDM implementation and RDM Policies (n=47)

Sl.No.	Particulars	Respondents	Percentage
Challenges to implementing RDM			
1	Lack of policies	25	53.19
2	Inadequate human resources	25	53.19
3	Insufficient institutional support and absence of software for research data processing	22	46.80

Sl.No.	Particulars	Respondents	Percentage
4	Inadequate financial resources	16	34.04
5	Lack of technological infrastructure	13	27.65
6	The difference in vocabulary between librarians and researchers	08	17.02
RDM policies in IITD			
1	May be	35	74.50
2	Yes	08	17.00
3	No	04	08.50

Note: Multiple answers are permitted.

6. Conclusion and Recommendations

"Today's research community must also assume responsibility for building a robust data and information infrastructure for the future" (ICSU, 2004). This study concludes that most respondents prefer using something other than any security measure. DMP is the thing that is known the least though maximum respondents avoid adopting it. However, training is required where significant help is needed in formatting, analyzing, sharing and documenting the research data. Respondents have a dim view of whether IIT Delhi has RDM Policies. There are several challenges in implementing RDM, like lack of policy, inadequate human resources, financial support and technological infrastructure. Less than half of faculty and research scholars know RDM but require help and assistance managing their data. It is recommended that all researchers practise RDM as it is helpful for present and future studies, which can be done by seeking proper training.

The current study is significant because it provides the importance of research data and its services. However, this survey's results can provide insight into the librarian's current role in providing proper training to library users. This study reports on how librarians address RDM Policy at all levels in their Institutes and bring policies regarding RDM and its services and challenges must be focused on to overcome them so that researchers become more aware towards this. Likewise, research data will get more attention, organization, preservation and sharing. A similar study on a large population, among students, faculty, and librarian, can give more insight.

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