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Awareness of Research Data Management Practices at University Libraries in Pakistan: Required Skills, Infrastructure, and Challenges

Muhammad Sajjad [1], Khurshid Ahmad[2]

[1] Ph.D. Scholar, Department of Information Management, The Islamia University of Bahawalpur, Pakistan.
Email: m.sajjadkpt@gmail.com
[2] Associate Professor, Department of Information Management, The Islamia University of Bahawalpur, Pakistan.
Email: khurshid.abaloch@gmail.com

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ABSTRACT

This study examines librarians' views on research data management values, skills, infrastructure, challenges, and incentive factors, as well as RDM practices at Pakistani university libraries. This study observed university libraries in Punjab province and Islamabad, Pakistan's capital city, on research data management (RDM) understanding and use. The study inspects librarians' knowledge, abilities, infrastructure, and RDM challenges. We gathered the data from a poll of university chief librarians in Punjab province and Islamabad, the capital city of Pakistan. We designed an online questionnaire to survey 114 university library professionals. We collected data from 101 chief librarians or head librarians in degree-granting institutions located in Punjab province and Islamabad, the capital. We descriptively analysed the data using SPSS v. 20. The results show knowledge and education gaps, budgetary constraints, cultural barriers, and technological challenges. Punjab province and Islamabad, Pakistan's capital city, require focused training, infrastructure improvements, and open data promotion to enhance research data management. The study results confirmed that efficient research data management is crucial for maintaining research integrity, reproducibility, storage, dissemination, and conservation. Librarians need technological skills, data management strategy, legal and ethical knowledge, and instructional ability, according to the study. It also highlights digital archives, data management tools, and network security for research data management. We identified issues with information professionals' skills, library infrastructure, human resources, and technology. These findings suggest that university administrators and donor organisations must regularly and effectively offer LIS professionals training and development. RDM resources, data analysis and visualization tools, data storage, security, research data sharing platforms, documentation and metadata, access permissions, and data literacy training should be considered. This is Pakistan's first study to investigate RDM techniques and their use in university libraries. The research aims to improve research data management procedures and regulations at higher education institutions in Punjab province and Islamabad, Pakistan's capital city.

Corresponding Author's Email: m.sajjadkpt@gmail.com

1. Introduction

Research data management (RDM) is required to ensure proper storage, sharing, and preservation of research data. This enhances scientific research reproducibility and integrity. The exponential expansion of academic research data, as well as the growing emphasis on open science and data sharing, have made research data management more important (Huang, Cox, & Sbaffi, 2021). This ecosystem relies on university libraries to help researchers manage data

efficiently. University libraries are improving their research data management skills. Many universities recognize the need for research data management, but most are still in the process of integrating it into their research support service (Kumar Sharma, Sreenivasa Chakravarthi, Ara Shaikh, Al Ayub Ahmed, Jaiswal, & Naved, 2023). Library staff must learn research data management, build infrastructure, and overcome hurdles to accomplish efficient RDM. Library staff must possess a variety of skills to assist with research data management. These competencies include technical knowledge of data formats and metadata standards, data management plans (DMPs) development and execution, and legal and ethical knowledge of data privacy and sharing (Johnston & Jeffryes, 2014). Research data management infrastructure, such as secure networks, digital archives, and data management software, must be powerful and trustworthy to suit researchers' needs. Several challenges prevent university libraries from successfully implementing RDM procedures. The difficulties include a lack of knowledge and training among libraries and academics, limited funding for research data management programs, cultural barriers to data sharing, and rapid technological advancements (Borkakoti & Singh, 2021).

RDM is important, but university libraries confront several challenges. Promoting effective data management involves many elements. These factors include librarians and researchers' limited understanding and education (Akers & Doty, 2013), insufficient financial resources for infrastructure and training (Corrall et al., 2013), cultural barriers to data sharing, and the constant need for learning and adjustment due to technology's rapid advancement. These are absolutely the kinds of problems we need to solve in order to support open data and improve RDM wherever possible. Campus-based research data management is the key: university libraries may encounter difficulties in implementing it and innovation investing in Research Data Management technology, ensuring a high level of security for RDM digital preservation as well as advanced interconnection between systems; campus based institution human resource training can cultivate innovation at universities and improve their ability to manage scientific research data (Fecher, Friesike, Hebing, Linek, & Sauermann, 2015).

1.1. Research Aim

This study observes university library research data management (RDM) practices. In Pakistan, academic libraries' research data management practices are critical to supporting the country's research infrastructure. The study aims to assess the awareness and readiness of library professionals regarding RDM. This entails assessing their knowledge, skills, and training needs in relation to RDM practices. The study aims to recommend targeted training programs to enhance the competencies required for effective RDM, thereby enhancing the capabilities of library staff. The study aims to explore the challenges and barriers faced by academic libraries in implementing RDM practices. The study can propose practical solutions and policy recommendations to overcome them, thereby facilitating the establishment of efficient RDM frameworks in academic libraries. To improve RDM practices and policies, the study will examine skills, infrastructure, and difficulties. The study inspects RDM knowledge and practices in university libraries, focusing on skills, infrastructure, and issues. The research seeks to uncover these components to improve RDM practices and regulations in higher education institutions in Punjab province and Islamabad, Pakistan's capital city.

2. Literature Review

2.1. Required Skills for Research Data Management

To help with research data management, university librarians must constantly adapt. Cox, Kennan, Lyon, Pinfield, and Sbaffi (2019), several abilities are necessary for effective research data management. Librarians who work in research data management require collaboration and interpersonal skills. These abilities help researchers, IT staff, and other stakeholders to communicate and collaborate, ensuring research data management success. Effective cooperation requires effective communication. Librarians must be able to simplify complex content for scholars from various professions. This entails explaining research data management (RDM) concepts, rules, and best practices to varied audiences. Furthermore, Goldman, Muilenburg, Schorr, Ossom-Williamson, and Uribe-Lacy (2023) understanding researchers' needs and challenges requires excellent listening skills, which makes individualized help easier. Research data management is a perfect example: it requires everyone from the library, to academic staff locally within faculties and schools, IT people across campus or in certain research specialization areas say at experts placed with researchers, through to designated local 'data

scientist' type roles if you are lucky enough on your campus; then of course coordinated/admin support. They also need to work together as good neighbors in order to share the load and keep all interacting environments data-friendly. Librarians must be collaborative and add value to the team. Librarians must be skilled at mediation and negotiation to solve difficulties and maintain professional relationships.

Briney, Goben, and Jones (2022) A professional network is required to keep up with RDM developments and share best practices. Professional organizations, conferences, and data management forums are essential for librarians. Networking also allows for RDM service improvement partnerships. Library professionals commonly promote research data management in their institutions. Research data management benefits must be promoted to administrators, RDM programs funded, and policymakers influenced. It takes persuasive skills and fact-based arguments to succeed in advocacy. Diversity-filled research requires cultural competency. Librarians should recognize cultural differences that may affect data management practices and preferences. According to Oo, Chew, Wong, Gladding, and Stenstrom (2022), networking facilitates partnerships for RDM service improvement. Library professionals commonly promote research data management in their institutions. We must educate administrators about the benefits of research data management, fund RDM programs, and influence policymakers. It takes persuasive skills and fact-based arguments to succeed in advocacy. Diversity-filled research requires cultural competency. Librarians should recognize cultural differences that may affect data management practices and preferences. Understanding and respecting differing views on data exchange, privacy, and cooperation is necessary.

Bellgard (2020) observed that through training and reflective practice, professionals must acquire collaborative and interpersonal abilities. Librarians must continue to learn through seminars, mentorship, and self-assessment. Data analysis and visualization are becoming vital for research data management librarians. To communicate and influence, researchers must analyze and graph data. Helping researchers requires data analysis skills from librarians. We need knowledge in statistics, data purification, and analysis tools. According to Xu (2022), librarians play a crucial role in enhancing research discoveries. Efficient data processing and visualization can boost research. Visualizations can highlight data trends and enable comparisons. They also make research results more accessible to non-experts, policymakers, and the public. Data analysis and visualization are evolving. Librarians must keep up with new technologies, methodologies, and trends through continuing education. Professional growth, such as attending seminars and working with data scientists, helps maintain skills. Tenopir, Sandusky, Allard, and Birch (2014) noted that librarians must stay abreast of data storage, preservation, and sharing innovations. Data formats, metadata standards, and data curation tools must be well-known. The importance of cloud computing, block chain data integrity, and AI-powered data analysis tools is growing. Creating and implementing data management strategies (DMPs) remains essential. Library staff should be able to assist researchers in creating comprehensive data management plans (DMPs) that cover generation, preservation, and maintenance.

Islam, Ahmad, Rafi, and JianMing (2021) emphasize the importance of comprehending funder requirements and institution data management policies. Librarians must grasp local and international data privacy regulations and ethics. This competence ensures data management follows legal and ethical guidelines, protecting researchers and study participants. Effective research data management assistance necessitates teaching researchers and students the best methodologies and strategies. Librarians must be competent teachers to lead seminars, online tutorials, and specialized instruction. They must express complex ideas clearly. Successful collaboration with researchers, IT staff, and stakeholders is crucial. Librarians oversee multidisciplinary teams and encourage departmental cooperation to develop a unified data management policy. Hamad et al. (2021) say that data analysis and visualization skills are becoming more valuable. Librarians should help researchers analyze datasets and communicate their findings visually. Research data administration requires project management abilities to supervise data management activities, collaborate with varied stakeholders, and complete tasks on time. This requires understanding project management methods and tools.

2.1. Infrastructure Needs

University libraries need excellent infrastructure to manage research data. This infrastructure should support data gathering, storage, sharing, and preservation. Digital repositories, data management, and secure networks are crucial. Effective research data

management (RDM) necessitates a strong and flexible infrastructure to meet researchers' changing needs while also preserving and accessing research data. Technological advancement and data growth have required more modern infrastructure. This section describes the infrastructure needed for effective research data handling. To simplify data deposit and retrieval, Cox et al. (2019) suggest institutional processes connect digital repositories. Research data storage and distribution require robust, extensible, and compatible digital repositories. Repositories must support several data formats and manage metadata, access, and curation. Likewise, Xu, Zhou, Kogut, and Watts (2022) show that with the increasing prevalence of new technologies and the evolving landscape of research methodologies, the provision of research data management training by libraries has emerged as a crucial service within the academic library domain. It suggests that university libraries have recognized the need to develop a data-driven infrastructure for RDM services, coinciding with the emergence of data librarianship as a distinct field. To make the research data management teaching corpus more complete, it is important to include different disciplinary points of view, geographic locations, and identities, as well as complex methods. Ultimately, our research indicates the need to priorities the subject of data sharing within the context of research data management education.

Zhang et al. (2022) assert that datasets accelerate scientific achievements. High-performance computing (HPC) resources are essential for processing large amounts of data in genetics, climate studies, and physics. For intensive processing, HPC infrastructure needs powerful servers, fast networks, and specialized software. We suggest that a secure network design is essential to preserve sensitive research data and comply with data protection laws. Data confidentiality and accuracy are crucial. Institutions need a resilient network architecture with fast connections and strict security measures to prevent data breaches and unauthorized entrance. We use firewalls, encryption, and multi-factor authentication . Donner (2023) observes that technological advancements, the availability of big data, and the creation of research platforms create a variety of opportunities for the generation, storage, and analysis of research data. Recently, the European Commission and scientific commissions have underscored the necessity for higher education institutions (HEIs) to adopt research data management systems (RDMS) that integrate technical and organizational solutions to guarantee the sustainable management of research data. It is essential for the successful implementation of a research data management system (RDMS) to have a profound understanding of the requirements of research data management (RDM) as well as a broad understanding of the various stakeholders. Organizational structures, technology infrastructures, labor cultures, and strategic considerations greatly affect the implementation of RDMS.

Pinfield, Cox, and Smith (2014) emphasize the need for designing digital repositories to preserve and make research material accessible. They should also support metadata standards to enable data discovery and reuse. Digital repositories help secure and distribute research data. The repositories must be reliable, accessible, and capable of handling various data kinds. Rice et al. (2013) recommend using advanced data management technologies to handle massive datasets and complex data structures. Data curation, metadata generation, and analysis require advanced data management solutions. These technologies organise, clean, and prepare data for analysis and dissemination. Yu (2017) explores the necessity for secure networks to protect data, especially sensitive or personal data. Protecting research data from unauthorised access, breaches, and loss requires a solid network architecture and good security. This requires encryption, strong access controls, and frequent backups. Data-intensive research demands powerful computers. Academics can efficiently handle and analyse huge datasets with HPC equipment. Libraries must offer these resources for complex computational tasks. We must guarantee processing power, storage capacity, and technical support (Tenopir et al., 2014). Collaborative technologies help academics work on data-intensive projects, promoting data sharing and openness, according to Cox and Pinfield (2014) multidisciplinary research and data exchange depend on academic collaboration networks. These systems must provide version control, access management, and collaborative editing. Excellent data management requires continual education and help; according to Johnston and Jeffryes (2014) libraries must train and support scholars and librarians in addition to technical infrastructure. Seminars, online resources, and individual consultations are all part of this effort to help users understand RDM technologies and procedures. Research data management (RDM) is difficult.

2.2. Challenges in RDM Implementation

University libraries must overcome several obstacles to develop effective research data management (RDM) practices. Skills gaps, financial constraints, cultural barriers, and technological challenges are the impediments. When using RDM technologies, university libraries face significant technological challenges. Fast-paced technology innovation, data security concerns, system interoperability, and data infrastructure growth are challenging issues. Despite growing awareness and technology, research data management still faces significant challenges. University libraries still face major obstacles to research data management. Likewise, Chigwada (2021) Research data management is an important role for librarians in Zimbabwe, but most lack the skills and resources to handle research data well. Academic librarians require comprehensive training in technical skills and expertise to provide research data services to academic libraries. The absence of an institutional research data management strategy highlighted information technology challenges like obsolescence and security.

Tenopir, Sandusky, Allard, and Birch (2013) emphasize the need for a balance between data privacy and exchange. The number of data breaches and cyber threats makes data privacy and security more challenging. Libraries must use rigorous security measures to protect proprietary research data. Research data management initiatives lack enough funding, resulting in service gaps. Funding issues limit university libraries' ability to build and maintain research data management infrastructure and services. Budget constraints affect the purchase of needed technology, the hiring of skilled staff, and training. Cox et al. (2019) recommend standardizing research data management across universities. Lack of data management standards makes RDM deployment harder. Data formats, metadata standards, and repository requirements might generate inefficiencies. To address these issues, we suggest promoting transparency and collaboration. Cultures that resist change and data sharing hinder progress. Researchers may not share data due to fear of abuse, loss of competitive edge, or insufficient recognition. Pryor, Jones, and Whyte (2013) indicate RDM procedures improve by addressing skill gaps. RDM is becoming more important, but librarians and researchers lack the skills. Library workers may lack RDM technical, legal, and ethical abilities. Closing this gap requires training and professional progress, but execution is difficult. Interoperable data exchange platforms are a priority. Data management systems and platforms must be interoperable to share data. The multiplicity of system architectures and formats makes interoperability difficult. Tech problems The rapid technological evolution of data management systems and software is a big technical challenge. Improve library systems and train workers on new tech. Consistent and accessible data repositories may be difficult to manage when data formats and storage possibilities proliferate. Researchers need data privacy and integrity. Libraries should restrict access to sensitive data. We use regular security checks, encryption, and access limits. We must follow national data protection rules to secure the data of researchers and participants.

Kumar Sharma et al. (2023), Data system compatibility is another issue. Because research disciplines employ different data formats and standards, creating a unified data management system is difficult. Libraries must guarantee their RDM systems support several researcher tools and platforms. It will simplify researcher data exchange and collaboration (Johnston & Jeffryes, 2014) According to Chen, Doty, Mollman, Niu, Yu, and Zhang (2015), a lack of understanding of research data management affects data management. This topic requires extensive library and researcher training/materials. Librarian and researcher RDM training is crucial. Researchers often don't understand data management's value or implementation. Corrall, Kennan, and Afzal (2013) emphasize that libraries rarely have the funds to invest in research data management technology and staff. Economic constraints hinder RDM adoption. Data management systems, secure networks, and digital repositories require funding to establish and maintain. In order to address these cultural issues, Masenya (2021) suggests promoting data sharing and fostering transparency and cooperation in the scientific community. Cultural resistance to change and data sharing hinders the adoption of RDM. Many researchers fear data exploitation, loss of competitive advantage, or insufficient acknowledgment and don't give their data. Technology is constantly changing; thus, Searle, Wolski, Simons, and Richardson (2015) advise data managers to constantly study and adapt. Rapid technological innovation and data complexity cause technological problems. Researchers and librarians must constantly improve their skills to keep up with new technologies, standards, and methods. To improve data management, Tenopir et al. (2014) recommend clear data quality and metadata standards. Monitoring data quality and metadata standards is essential for efficient data management, but it can be difficult. Data inconsistency, a lack of standards, and inadequate documentation may

impede data reuse and sharing. According to Yu (2017), libraries have difficulties supporting academics with their data management efforts when they lack the essential infrastructure. Inadequate infrastructure, including insufficient digital repositories and high-performance computer capabilities, might impede the capacity to store, manage, and exchange data efficiently.

3. Research Methodology

This research examines the implementation of research data management practices in academic libraries in Pakistan, specifically focusing on the awareness, required skills, infrastructure, and challenges faced by university libraries in Punjab province and Islamabad, Pakistan's capital city. It also shapes the execution of these practices to improve their effectiveness. A literature review led to the development of a research tool, a questionnaire. Collected data via online survey. The library professionals used a Likert scale ranging from 1 to 5 to assess the questionnaire. The alternatives available are as follows: 1 = strongly disagree, 2 = disagree, 3 = uncertain, 4 = strongly agree, and 5 = agree. Cronbach's Alpha was used for assessing the reliability of the questionnaire. Cronbach's alpha score of 0.898 showed that the questionnaire was reliable. We obtained the email addresses of university chief librarians from the websites of their respective institutions and provided them with a link to the questionnaire. The data collection process in this country took five months, between October 2021 and February 2022, in part due to the country's size. In order to avoid researcher baseness, the data was randomly collected from 101 head librarians and librarians with an 88% response rate belonging to 114 universities (both public and private) in Pakistan. We selected these individuals from LIS professionals who work in public and private universities recognized by the Higher Education Commission in Punjab province and Islamabad, Pakistan's capital city. We selected Punjab province and Islamabad city due to their well-established educational institutions and relatively large number of qualified library professionals. We analyzed the gathered data using SPSS v.20. The descriptive statistics e.g. frequencies, percentages, means and standard deviations were used for analyzing and presenting the data.

3.1. Descriptive Analysis about Respondents

The population of this research comprises head librarians and library professionals working in both public and private libraries in the province of Punjab and Islamabad, the capital city of Pakistan. Furthermore, Table 1 illustrates that the study consisted mostly of male participants, with a ratio of 81 (82.8%) men to 20 (19.8%) girls. Out of the total respondents, a significant majority of 61.6% (62 individuals) were employed by public institutions, and the remaining 38.4% (39 individuals) were affiliated with private universities.

Table 1: Demographic Statistics of Respondents

		Frequency	Percentage
Gender	Male	81	82.2
	Female	20	19.8
	Total	101	100.0
Type of University	Public Sector	62	61.4
	Private Sector	39	38.6
	Total	101	100.0
Professional Status	Head librarian	51	50.5
	Librarian	50	49.5
	Total	101	100.0
Qualification	Master	43	42.6
	M.Phil.	51	50.5.
	Ph.D.	07	6.9
	Total.	101	100.0
Experience	up to 5 years	12	11.9
	6-10 years	23	22.8
	11-15 years	26	25.7
	16-2016 years	20	19.8
	21-25 years	20	19.8
	Total	101	100.0

The percentage of respondents holding the position of chief librarian with a professional status is 51 (50.5%), while the percentage of respondents holding the position of librarian with a professional status is 50 (49.5%). We obtained the statistics through a survey that asked about

the respondents' credentials. Among the 101 respondents, 43 individuals (42.6%) had a Master of Library and Information Science degree, 51 individuals (50.5%) held an M.Phil. degree, and 7 individuals (6.9%) had a Ph.D. We gathered data on respondents' experiences via a questionnaire. The bulk of respondents had 6–10 years of experience, whereas 12 (11.19%) and 23 (22.8%) had 11–15 years of experience, respectively. The majority of respondents, including 25.7% and 19.8%, respectively, have 16–20 years of experience in their area. Additionally, 19.8% of respondents have 21–25 years of experience, while another 19.8% have five years of experience in the sector.

Table 2: Skills of library professionals for RDM Practices

Statement	N	Mean	Std. Deviation
Data analysis skills	101	1.64	.593
Technical skills in managing sensitive data	101	1.73	.615
Technical skills in the area of e-infrastructures	101	1.69	.644
Data analysis and visualization	101	1.76	.680
Data curation skills	101	1.69	.579
Metadata and data creation skills	101	1.71	.638
Data cleaning and extraction	101	1.79	.653
Data backup tools and preservation	101	1.78	.701
Legal, policy and advisory skills	101	1.79	.739
Cooperation among departments	101	1.75	.669
Need of collaboration between library and researchers	101	1.60	.694
Standards for collecting data	101	1.69	.674
Awareness about tools /software / system/infrastructure	101	1.59	.681
Acquisition of large-scale data	101	1.76	.650
Data security and risk management skills	101	1.77	.705

Scale: 1 = strongly Disagree; 2 = Disagree; 3 = Undecided; 4 = Agree; 5 = Strongly Agree

The mean score of 1.64 (with a standard deviation of 0.593) suggests that library professionals usually perceive their data analysis abilities to be at a reasonable level. Proficiency in handling sensitive data: The mean score of 1.73 (standard deviation = 0.615) indicates a somewhat elevated level of confidence in handling sensitive data. The average self-assessment of technical abilities in e-infrastructures is 1.69, with a standard deviation of 0.644, indicating a modest level of proficiency. The data analysis and visualization abilities demonstrate a moderate degree of confidence, as evidenced by a mean of 1.76 with a standard deviation of 0.680. A mean score of 1.69 indicates a moderate level of confidence in the data curation skills. The standard deviation of 0.579 shows the variability in the scores. The average score of 1.71, with a standard deviation of 0.638, indicates a high level of trust in metadata and data generation skills. Average score: 1.79 (standard deviation = 0.653), indicating modest development in data cleaning and extraction. Mean 1.78 (SD = 0.701) indicates modest faith in data backup and preservation methods. Advisory, policy, and legal skills On average, 1.79 (standard deviation = 0.739) indicates moderate domain proficiency. The mean interdepartmental collaboration skills score is 1.75 with a standard deviation of 0.669, indicating minimal cooperation. It appears that libraries and researchers must collaborate, as the mean score is 1.60 (SD = 0.694). A mean value of 1.69 and a standard deviation of 0.674 evaluate data collection criteria. As a result, the standard interpretation of data is quite confident.

Table 3: Organizational Infrastructure for RDM practices

Statement	N	Mean	Std. Deviation
The institution has a centralized infrastructure to support researchers data	101	2.03	.806
Researchers have access to commercial active data storage services	101	2.15	.829
There is provision of institutional data repository	101	1.93	.652
Researchers use national and interdisciplinary data repositories	101	1.90	.728
The institution has the infrastructure to support long term data preservation	101	2.01	.714
Researchers use regional and national consortial infrastructure for long term data preservation	101	2.01	.700
The institution has the data transfer mechanism	101	2.07	.778
The institution supports researchers access to different data management tools and collaboration	101	1.89	.631

Scale: 1 = strongly Disagree; 2 = Disagree; 3 = Undecided; 4 = Agree; 5 = Strongly Agree

There is a strong understanding of tools, software, systems, and infrastructure. Awareness is modest but substantial, with a mean score of 1.59 (SD = 0.681). The acquisition of large-scale data demonstrates average competence, with a mean of 1.76 (SD = 0.650). The level of proficiency in data security and risk management is satisfactory. The average value of 1.77 (standard deviation = 0.705) indicates a reasonable level of confidence. An average of 2.03 (SD = 0.806) suggests a reasonably high amount of centralized infrastructure to support researchers' data. The average of 2.15 (with a standard deviation of 0.829) indicates improved availability of commercial storage services. The institutional data repository provides moderate services, with a mean of 1.93 and a standard deviation of 0.652. The mean of 1.90 (SD = 0.728) indicates a modest use of national and interdisciplinary data sources. Long-Term Data Preservation Infrastructure: The average score of 2.01 (with a standard deviation of 0.714) indicates a relatively high level of infrastructure. A mean value of 2.01 (SD = 0.700) indicates a moderate to high level of regional and national consortial infrastructure use. Data Transfer Mechanism: The average score of 2.07 (with a standard deviation of 0.778) indicates a substantially greater presence of data transfer mechanisms. The data suggests a moderate level of support for data management solutions, with an average score of 1.89 and a standard deviation of 0.631.

Table 4: Challenges for implementation of RDM practices

Statement	N	Mean	Std.Deviation
Lack of technical skills and infrastructure	101	1.79	.791
Non-existence of institutional repositories	101	1.93	.919
Lack of interests/ willingness by LIS employees	101	2.20	1.077
Lack of knowledge about RDM among researcher community	101	2.01	.889
Researchers are reluctant for data sharing	101	1.98	.721
Lack of involvement and cooperation among other service departments including library, IT, Research boards, etc.	101	2.12	.875
Data organization preservation and storage issues	101	2.01	.843
Fear of misinterpretation of data intellectual property concerns	101	2.02	.761
Long time storage and preservation issues	101	1.91	.918
Lack of organizational support and lacking RDM policies	101	1.92	.880
Archiving issues and copyright challenges	101	1.72	.680
Costs of storage devices and assistant for proper archiving	101	1.91	.801
Researchers poor data literacy skills and lack of policy/guidelines	101	1.98	.836
Limited training opportunities and technological issues/obsoleteness	101	1.78	.743
Data restrictions, Data security and privacy issue	101	1.91	.801
Fear over data misuse and collaboration issues	101	2.02	.836
Data processing and analyzing issues	101	1.95	.792
Awareness issues ,data curation and reuse	101	1.95	.638
Discovery and acquisition of data	101	1.88	.697
Infrastructural issues and rapid technology change	101	1.88	.725
Misuse of data and fear of losing data	101	1.90	.794
Lack of skilled staff and data storage problems	101	1.83	.801

Scale: 1 = strongly Disagree; 2 = Disagree; 3 = Undecided; 4 = Agree; 5 = Strongly Agree

A mean score of 1.79 (SD = 0.791) indicates the presence of insufficient technical skills and infrastructure, suggesting moderate issues in this area. The existence of institutional repositories is a significant obstacle, with a mean of 1.93 (SD = 0.919), indicating a moderate to high level of difficulty. The data indicates that there is a notable lack of interest or willingness among LIS employees, as seen by a mean score of 2.20 with a standard deviation of 1.077. This poses considerable difficulty. Researchers' insufficient understanding of research data management (RDM) is evident from the mean value of 2.01 (with a standard deviation of 0.889), indicating a significant obstacle. The data reveals that there is a modest level of reluctance for data sharing, with a mean of 1.98 and a standard deviation of 0.721. The lack of involvement and cooperation within departments is a serious difficulty, with a mean score of 2.12 and a standard deviation of 0.875. The data organization, preservation, and storage issues provide modest hurdles, with a mean score of 2.01 (SD = 0.843). With a mean value of 2.02 and a standard deviation of 0.761, there is concern about information misinterpretation and intellectual property protection. Prolonged storage and preservation have modest concerns, as shown by the

mean score of 1.91 (SD = 0.918). Low organizational support and poor research data management procedures cause moderate challenges, as shown by a mean score of 1.92 (SD = 0.880). At 1.72 (SD = 0.680), archiving and copyright difficulties are moderate. Storage devices and archiving assistance cost an average of 1.91, with a standard deviation of 0.801, indicating significant challenges. Poor data literacy and lack of guidelines provide a mean score of 1.98 (SD = 0.836). Lack of training and technology obsolescence result in a mean score of 1.78 (with a standard deviation of 0.743), suggesting moderate issues. Data security and privacy concerns are moderate (average 1.91, standard deviation 0.801). An average score of 2.02 (SD = 0.836) shows moderate data abuse and collaboration difficulties. Data processing and analysis issues: The average value of 1.95 (standard deviation = 0.792) suggests the presence of considerable difficulties. There are modest hurdles in terms of awareness issues, data curation, and reuse, with a mean of 1.95 and a standard deviation of 0.638. Data discovery and acquisition present moderate problems, as shown by a mean of 1.88 (SD = 0.697). The presence of infrastructural issues and the rapid pace of technological advancements result in moderate obstacles, as shown by a mean of 1.88 (SD = 0.725). The mean value of 1.90 (SD = 0.794) indicates moderate problems due to data misuse and data loss fear. A mean value of 1.83 (SD = 0.801) indicates moderate levels of obstacles due to the presence of unskilled personnel and difficulties in data storage.

4. Discussion

Out of the 101 participants, the study consisted mostly of men, with a ratio of 81 (82.8%) males to 20 (19.8%) girls. Out of the total respondents, a significant majority of 61.6% were employed by public institutions, and the remaining 38.4% were affiliated with private universities. The percentage of respondents holding the position of head librarian with professional status is 51 (50.5%), while the percentage of respondents holding the position of librarian with professional status is 50 (49.5%). We obtained the statistics through a survey that asked participants about their credentials. Among the 101 respondents, 43 individuals (42.6%) had a Master of Library and Information Science degree, 51 individuals (50.5%) held an M.Phil. degree, and 7 individuals (6.9%) had a Ph.D. We collected data on respondents' experiences via a questionnaire. The bulk of respondents had 6–10 years of experience, whereas 12 (11.19%) and 23 (22.8%) had 11–15 years of experience, respectively. The bulk of respondents, including 25.7% (26 individuals), have 16–20 years of experience in their respective fields. Additionally, 19.8% (20 individuals) have 21–25 years of experience, while another 19.8% (20 individuals) have five years of experience in their profession. The mean stands at 1.64 while the standard deviation is equal to 0.593. We now assess the skills as quite poor, suggesting a need for development in data analysis competencies. The mean stands at 1.73 while the standard deviation is equal to 0.615. The individual demonstrates a moderate level of proficiency, which slightly exceeds their data analysis skills. The mean stands at 1.69 while the standard deviation is equal to 0.644. The skill level is comparable to that of data analysis.

The average is 1.76, and the standard deviation is 0.680. The current level is quite low, indicating a desire for more training in data visualization approaches. Bellgard (2020) observed that through training and reflective practice, professionals must acquire collaborative and interpersonal abilities. Librarians must continue to learn through seminars, mentorship, and self-assessment. Data analysis and visualization are becoming vital for research data management librarians. To communicate and influence, researchers must analyze and graph data. Helping researchers requires data analysis skills from librarians. We need knowledge in statistics, data purification, and analysis tools. The average is 1.69, and the standard deviation is 0.579. This indicates a moderate level of proficiency, yet there is still room for improvement. The mean is 1.71, and the standard deviation is 0.638. Although the skill level is satisfactory, there is still potential for enhancement. The mean is 1.79, and the standard deviation is 0.653. The data is marginally elevated, indicating improved proficiency in data cleansing and extraction. Rice et al. (2013) recommend using advanced data management technologies to handle massive datasets and complex data structures. Data curation, metadata generation, and analysis require advanced data management solutions. These technologies organise, clean, and prepare data for analysis and dissemination. The mean value is 1.78, and the standard deviation is 0.701. This region is highly esteemed, yet it still needs more development. The average is 1.79, and the standard deviation is 0.739. The rating was high, demonstrating a commendable level of proficiency in legal and policy matters. The mean is 1.75, and the standard deviation is 0.669. The collaboration is satisfactory, but there is room for improvement across departments. The data set's mean is 1.60, while the standard deviation is 0.694. The data showed a marginal decline, suggesting a

significant requirement to foster teamwork. The average is 1.69, and the standard deviation is 0.674. Partial compliance with data collection protocols. The mean is 1.59, and the standard deviation is 0.681. Insufficient awareness highlights a crucial need for more awareness and training. The data set's mean is 1.76, while the standard deviation is 0.650. The results are satisfactory, although there is room for improvement in the management of large data sets. The mean value is 1.77, and the standard deviation is 0.705. Tenopir et al. (2014) noted that librarians must stay abreast of data storage, preservation, and sharing innovations. Data formats, metadata standards, and data curation tools must be well-known. The importance of cloud computing, block chain data integrity, and AI-powered data analysis tools is growing. Creating and implementing data management strategies (DMPs) remains essential. Library staff should be able to assist researchers in creating comprehensive data management plans that cover generation, preservation, and maintenance.

The mean is 2.03, and the standard deviation is 0.806. Moderate support indicates infrastructure improvement and reinforcement. Data set mean is 2.15, standard deviation 0.829. A higher grade suggests better commercial data storage accessibility. Data set mean is 1.93, standard deviation 0.652. We have sufficient provisions, but we can improve. The mean is 1.90, and the standard deviation is 0.728, indicating moderate use with the potential for more involvement. The data set's mean is 2.01, and the standard deviation is 0.714. While the infrastructure is good, there is room for improvement. According to Yu (2017), libraries have difficulties supporting academics with their data management efforts when they lack the essential infrastructure. Inadequate infrastructure, including insufficient digital repositories and high-performance computer capabilities, might impede the capacity to store, manage, and exchange data efficiently. Statistically, the mean is 2.01, and the standard deviation is 0.700. If infrastructure is sufficient, this is similar to long-term data preservation. The mean is 2.07, and the SD is 0.778. The mechanisms are well-established, although upgrades may boost efficiency Likewise, Xu et al. (2022) show that with the increasing prevalence of new technologies and the evolving landscape of research methodologies, the provision of research data management training by libraries has emerged as a crucial service within the academic library domain. It suggests that university libraries have recognized the need to develop a data-driven infrastructure for RDM services, coinciding with the emergence of data librarianship as a distinct field. To make the research data management teaching corpus more complete, it is important to include different disciplinary points of view, geographic locations, and identities, as well as complex methods. Ultimately, our research indicates the need to priorities the subject of data sharing within the context of research data management education. The mean is 1.89, and the SD is 0.631. Support improves resource access and collaboration. Cox and Pinfield (2014) claim that collaborative tools help academics work on data-intensive projects, promoting data sharing and openness. Multidisciplinary research and data exchange depend on academic collaboration networks.

The mean is 1.79, while the SD is 0.791. This major impediment highlights the need to improve skills and infrastructure. Mean is 1.93, standard deviation 0.919. The lack of repositories is a serious issue. The mean is 2.20, and SD is 1.077. The final challenge shows a huge motivation and willingness gap. The mean is 2.01, and the standard deviation is 0.889. We need to address this significant lack of understanding through awareness and education. The mean and standard deviation are 1.98 and 0.721, respectively. Data sharing resistance is a major issue that requires specific solutions. The mean is 2.12, and the SD is 0.875. High difficulty implies poor departmental teamwork. The mean is 2.01, and the standard deviation is 0.843. Data management is complex and requires complete solutions. The mean is 2.02, and the standard deviation is 0.761. Data interpretation and IP protection are problematic. The mean is 1.91, and SD is 0.918. Long-term storage is problematic. Libraries without the necessary infrastructure struggle to help academics manage data. The crucial RDM support and policy framework gap averages 1.92 and varies 0.880. In order to address these cultural issues, Masenya (2021) suggests promoting data sharing and fostering transparency and cooperation in the scientific community. Cultural resistance to change and data sharing hinders the adoption of RDM. Many researchers fear data exploitation, loss of competitive advantage, or insufficient acknowledgment and don't give their data. Technology is constantly changing; thus, Searle et al. (2015) advise data managers to constantly study and adapt. Rapid technological innovation and data complexity cause technological problems. Researchers and librarians must constantly improve their skills to keep up with new technologies, standards, and methods. Data set mean is 1.72,

standard deviation 0.680. We must address the archiving and copyright issues. The mean is 1.91, while the SD is 0.801. Archiving is hindered by cost constraints. The mean is 1.98, and the SD is 0.836. This is a major issue that requires data literacy and stated rules. Data set mean is 1.78, standard deviation 0.743. Insufficient training and outdated technology are major issues. Corrall, Kennan, and Afzal (2013) emphasize that libraries rarely have the funds to invest in research data management technology and staff. Economic constraints hinder RDM adoption. Data management systems, secure networks, and digital repositories require funding to establish and maintain. The mean is 1.91, and the SD is 0.801. Data security and privacy are major challenges. Research data security and privacy are crucial. Kumar Sharma et al. (2023), Data system compatibility is another issue. Because research disciplines employ different data formats and standards, creating a unified data management system is difficult. Libraries must guarantee their RDM systems support several researcher tools and platforms. It will simplify researcher data exchange and collaboration. Data misuse and cooperation barriers are major concerns. Simons and Fane (2022) worry about data exploitation, loss of competitive edge, and lack of recognition. The mean is 1.95 and the SD 0.792. Cox et al. (2019) Insufficiently trained staff and data storage issues are major impediments. Lack of technical expertise among library staff is a major issue. Librarians must undergo ongoing professional growth and training to master new data management systems. cover data curation, metadata, and data management technologies.

5. Conclusion

Pakistan must develop its capital, skills, and facilities to enhance RDM expertise and procedures at universities in Punjab and Islamabad, while simultaneously addressing current issues. Training, infrastructure, and open data can improve research data management and quality at universities. University libraries in Punjab and Islamabad, Pakistan's capital, must improve research data management standards. Effective research data management requires essential competencies, resources, and challenges, as this study has shown. To help researchers, university librarians need technology abilities, data management planning, legal and ethical knowledge, and teaching ability. Digital archives, data management systems, and strong security and networking measures are also essential infrastructure. However, we must overcome poor knowledge and training, insufficient financial resources, cultural unwillingness to share data, and constant technical changes. To overcome these problems, academic institutions must invest in librarian and researcher training, infrastructure improvements, and open data cultures. These strategies can improve research data management practices in Punjab and Islamabad, Pakistan's capital, resulting in improved research quality and integrity. We must develop skills and facilities, while resolving current issues, to enhance RDM expertise and procedures at colleges and universities in Punjab and Islamabad, Pakistan's capital. Training, infrastructure, and open data can improve research data management and quality at universities. University libraries in Punjab and Islamabad, Pakistan's capital, must improve research data management standards. Effective research data management requires essential competencies, resources, and challenges, as this study has shown. To help researchers, university librarians need technology abilities, data management planning, legal and ethical knowledge, and teaching ability. Digital archives, data management systems, and strong security and networking measures are also essential infrastructure. However, we must overcome poor knowledge and training, insufficient financial resources, cultural unwillingness to share data, and constant technical changes. To overcome these problems, academic institutions must invest in librarian and researcher training, infrastructure improvements, and open data cultures. These strategies can improve research data management practices in Punjab and Islamabad, Pakistan's capital, resulting in improved research quality and integrity.

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