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Original Research

Identifying Data Librarian Skills in Research Data Management Using Meta-Synthesis Method

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Abstract

Many librarians are assuming new roles in the provision of research data services. However, the emerging field of data librarianship-particularly the specific skills it requires—has not yet been clearly defined. Therefore, the aim of this study is to explore the essential skills librarians need to effectively engage in research data management. In the present study, a meta-synthesis method was employed, following the seven-step framework proposed by Sandelowski and Barroso, to integrate data extracted from previous sources. Search terms were examined across titles, abstracts, keywords, and full texts of resources available in reputable academic databases. Ultimately, 26 credible sources-focusing on data librarians in the context of research data management-were selected for analysis. By analyzing these sources, nine main categories were identified: management and familiarity with data, information technology and information systems, behavioral and communication characteristics, legal and policy skills, research methods and project management, education and consulting, promotion and provision of services, subject knowledge and familiarity with the organization, education and library skill. Our study identifies the various essential skills required to enhance research data management in information centers-particularly within research and academic libraries-for librarians as well as students of Information Science and Knowledge Studies, who are regarded as the primary stakeholders in this domain.

Keywords: Data Librarian Skills, Research Data Management, Meta Synthesis.

Introduction

Although today some consider crude oil to be equivalent to data (Parkin, 2017), from the perspective of the breadth of economic impacts, data possesses characteristics that make it more valuable than crude oil (Mendel, 2017). For example, unlike crude oil, data is not only reusable but also inexhaustible. It is therefore no coincidence that, from 2007 to 2017, the five most valuable companies in the United States (Apple, Alphabet, Microsoft, Facebook, and Amazon) operated with data-driven business models (Amini, Hariri, Ghayori Sales, Babalhavaeji & Taheri, 2019).

One of the important centers where a vast volume of data is produced is universities. The

research data generated annually in these institutions are the result of the efforts of valuable researchers and scholars. Although these data are essential for planning and scientific research, they can be more useful only if they are utilized. Access to large volumes of data not only provides a broader perspective but also leads to greater coherence in research and advancement of sciences. More data result in more precise analyses, and more precise analyses lead to more reliable decision-making; better decisions can mean increased operational efficiency, cost reduction, and risk mitigation (Sohrabi, 2014; cited in Vaziri, Naghshineh, & Norouzi Chakoli, 2018).

Therefore, today, research data management constitutes a significant part of new scientific discussions and has received special attention in recent years. Research data management means the protection, sharing, accessibility, and future reuse of research data, aimed at generating new knowledge. Although data management may be costly, it represents a significant investment since the value of data lies more in its potential for reuse than in its acquisition cost (Ashley, 2012). University libraries can play a crucial role in this regard. Friend (1998) stated that libraries have always been compelled to reinterpret and perform their duties in response to changing circumstances. The mission of academic and research libraries aligns with the main functions of their parent organizations, encompassing education, learning, and research. Therefore, these libraries have been established to play a role in these areas.

One of the recent changes academic and research libraries face is electronic research, which challenges the management of large, diverse, and related data that can be repurposed for other research. A related challenge is that some researchers generate data that are useful but obscure; no one knows about their existence or can reuse them unless these data are properly managed and made accessible (Ohaji, 2016).

If academic libraries of the past focused on collecting and providing access to the final research outputs, such as articles and books, today's libraries support researchers throughout the entire research process—from initial information retrieval to guidance and consultation in selecting journals for publishing their articles. Research data management services are being implemented by academic and research libraries worldwide to support university research activities.

As evidenced in studies, libraries are recognized as a vital factor in the development of research data management (Cox, Kennan, Lyon, & Pinfield, 2017; Kirby, 2017; Kong, 2015; Sessartic & Towhe, 2016; Shores & Stone, 2014; Si, Xing, Zhuang, Hua, & Zhou, 2015; Tenopir, Pollack, Allard, & Hughes, 2016; Tenopir, Sandusky, Allard, & Birch, 2012; Tenopir et al., 2017; Wittenberg & Ellings, 2017; Yoon & Schultz, 2017).

On the other hand, managers face challenges such as the nature and extent of their role in research data management, shifting the focus toward providing research data support, development of research data, and skill development among librarians in delivering such services (Cox et al., 2017; Resnick-Zelin, Adamic, & McGinty, 2012; Yu, 2017). Nevertheless, its advancement as a library service is evident (Ojire, 2014; cited in Ecloya et al., 2019).

Since data hold great importance in universities and research centers, it is necessary to have a person with the ability to understand, store, manage, and retrieve data—known as a data librarian—actively involved in the process of data management and utilization. In other words, we need librarians with the specific role of data librarian who are concerned with the data produced and published by researchers, faculty members, and students at various academic levels, and who formally protect the data and publish or synergize it in line with organizational

goals.

Table 1 presents definitions and roles of the data librarian from the perspectives of various researchers.

Table 1

Definition and role of the data librarian (Park & Park, 2021)

Definition and role of data librarian	author (year)
A data librarian provides means for storing, retrieving, and recording laboratory data.	Liscouski (1997)
A data librarian is someone from a library background who specializes in data curation, preservation, and storage.	Swan & Brown (2008)
A data librarian is a professional performing data curation tasks, mediating data-related issues, and assisting researchers with data access strategies.	Macdonald & Martinez-Uribe (2010)
Data librarians share and apply the same technical skills as data scientists and possess capabilities in implementation and communication.	Xia & Wang (2014)
Data librarians are expected to design metadata for research data technologies, create components for raw data analysis and management, and provide integrated research consulting through data fusion. They are also anticipated to act as data consultants, data conservators, and data publishers.	Kim & Choi (2016)
The job titles such as data librarian, data curator, data manager, and digital humanist are used interchangeably. These roles preserve and manage data based on data curation strategies to promote reuse.	이유경, 정은경(2015)
The data librarian role has evolved by blending traditional library skills with expertise in resource discovery, knowledge of data formats and digital obsolescence, and the ability to advise on copyright, data management during research, and appropriate data analysis tools.	Henderson (2017)
Data librarians constitute a heterogeneous community of information professionals with diverse educational and professional backgrounds performing various types of tasks.	Federer (2018)
The term "data librarian" emerged from data management and curation, initially concerning public data produced by governmental agencies, but now focuses on various types of data, especially research data. Data librarians serve as facilitators at all stages of scientific research and contribute to potential services related to data management and curation.	Semeler, Pinto, & Rozados (2019)

In the concept of the data librarian, librarians assume new roles in acquiring, recording, analyzing, monitoring, and providing access to data. Therefore, they must learn and embrace new skill sets to assist their clients in better understanding data and guide them in selecting the most appropriate tools according to their research objectives (Hui, 2014). Ecloya et al. (2019) state that librarians responsible for research data services are generally recognized as data librarians. Emerging from the influence of academic libraries in advancing data management practices, the concept of data librarianship was conceptualized, leading to the emergence of the data librarian as a professional position (Khan & Du, 2018; Xia & Wang,

2014).

However, the role of data librarians is not limited solely to managing research data; research related to the collaborative aspects of librarians in research data management is one of the key performance areas of data librarianship and involves working with various types of data, although the focus remains primarily on research data (Semler, Pinto, & Rosados, 2019).

Data management necessitates recognizing the competencies and responsibilities of such positions, which are expected by library managers (Chen & Zhang, 2017). The data librarian is one of the four roles defined by Swan and Brown (2008, p. 1) for data professionals, alongside the "data manager," "data scientist," and "data creator":

- **Data Creator:** Researchers with expertise in their field who produce data. These individuals may possess advanced skills in managing, manipulating, and utilizing data.
- **Data Scientist:** Professionals working where research is conducted—or, in the case of data center personnel, in close collaboration with data creators—who engage in creative research, analysis, and advancements in database technology, enabling others to work effectively with digital data.
- **Data Manager:** Computer scientists, information technology specialists, or information scientists responsible for computing facilities, storage, continuous access, and data retention.
- **Data Librarian:** Individuals originating from the library community who are trained experts in caring for, preserving, and archiving data (Ohaji, 2016). Figure 1 illustrates the core skills for data management outlined by the Center for Digital Research (November, 2008) (Brochu & Burns, 2019).

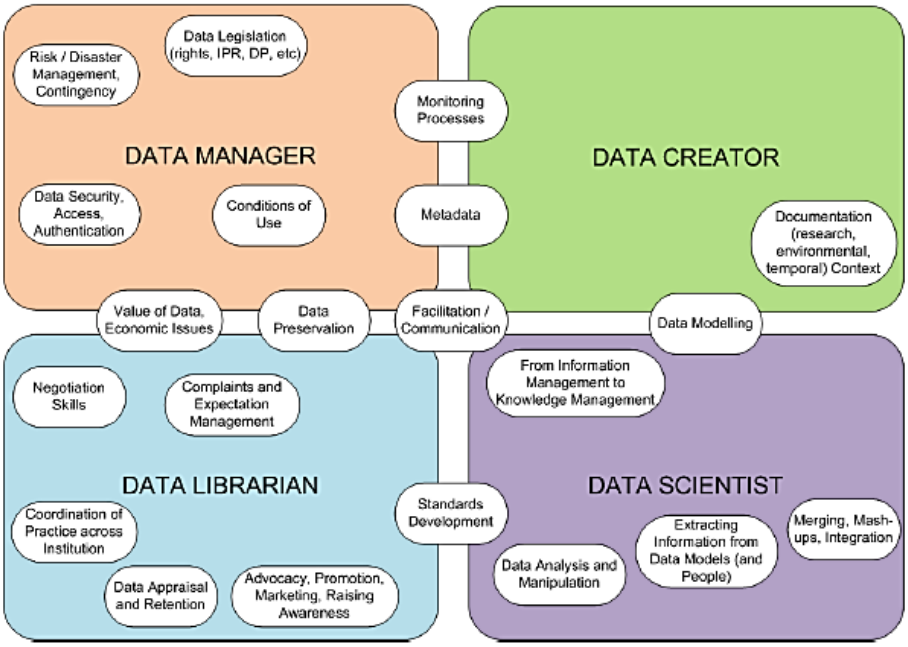

Figure 1: Core skills for data management

In the context of research data management, librarians provide a wide range of services, such as training researchers in data management, collaborating with researchers to improve data management practices, creating subject guides for data management, and supporting the data requirements of funding organizations (Serkis & Red, 2015). Therefore, librarians need opportunities for continuous education (Tenopir et al., 2014). Although the technical

infrastructure for research data management is important, increasing the knowledge and understanding of staff is equally significant (Coule & Evans, 2014). Accordingly, librarians must acquire the necessary skills to offer a wide range of service activities. These activities should be addressed in the curricula of information science and knowledge studies programs, as well as in in-service training for librarians (quoted in Orooji, 2018).

Therefore, the emerging field of data librarianship, including its specific roles and competencies, remains clearly undefined. This study aims to provide a relatively comprehensive exploration of the skills and knowledge that librarians utilize, as well as the training they need to succeed, in order to better define data librarianship. It seems that in the near future, data librarianship will be introduced as an emerging domain within information science and knowledge studies. Identifying the capabilities and benefits it offers to librarians and researchers in this field could be valuable (Vaziri et al., 2018). Consequently, the findings of this research can contribute to improving educational programs at universities and in information science disciplines, libraries—especially academic libraries—research centers, and other institutions that can play a role in this area. This can pave the way for planning to raise librarians' awareness of the essential skills needed for their role in research data management.

Research Background

By carefully examining previous studies—which will be referenced in the findings section—it becomes clear that librarians' skills have been evaluated in various articles using different populations and methodologies. However, to date, no study has employed the meta-synthesis method to systematically rank these skills. In studies such as Da Silva et al. (2019), Fuhr (2019), Ashiq, Usmani and Naeem (2020), and Das and Banerjee (2021), although the literature has been reviewed, sometimes in a systematic manner, none have utilized meta-synthesis. Instead, these studies merely listed the data librarian skills after reviewing the literature.

Despite some similarities in approach, these two methods pursue different goals. A systematic review is a structured method for collecting and summarizing findings from existing studies on a specific research question, without engaging in deep interpretation or theorization. In contrast, meta-synthesis focuses on in-depth analysis of the content of existing studies through coding and theme extraction, offering a new understanding of the phenomenon under investigation. Therefore, this study, by employing the meta-synthesis method, seeks to present an integrated and prioritized conceptual framework of these skills. Additionally, other studies, such as Khan and Du (2018), have analyzed the content of data librarian job advertisements.

Research Objectives

The main objective of this article is to examine the skills of data librarians in research data management using the meta-synthesis method. Additionally, the article pursues the following secondary objectives:

1. To identify the skills that are more frequently emphasized in the literature.
2. To identify the skills that are less emphasized in the literature.
3. To categorize the identified skills from the literature into themes, concepts, and codes.
4. To rank the reviewed themes, concepts, and codes.
5.

Materials and Methods

This study is applied in nature and has been conducted using the meta-synthesis method. Meta-synthesis is a qualitative research approach that typically involves the systematic analysis and integration of findings derived from similar and related qualitative studies. However, some researchers (such as Baghmirani, 2018, and Sharafi, Noruzi, Esmaeili Givi & Heidary Dahooie 2020) also incorporate findings from quantitative studies.

Given that a large portion of the literature on data librarian skills is qualitative in nature—and that no comprehensive source has yet been provided to identify the full set of these skills—the meta-synthesis method was deemed appropriate for addressing the research objective. Nonetheless, due to the limited number of qualitative sources, findings from quantitative studies have also been utilized. Specifically, the skills identified in the findings sections of quantitative studies were extracted and imported as codes into MAXQDA software to be used in the processes of coding, conceptual analysis, and categorization.

Therefore, in this study, meta-synthesis refers to the analysis of published sources on librarians' skills in research data management. A total of 26 sources were selected for analysis and final meta-synthesis, of which 17 employed qualitative and mixed methods, and 9 used quantitative approaches. This study applied the documentary method alongside the seven-step meta-synthesis process outlined by Sandelowski and Barroso (2007). The seven stages of Sandelowski and Barroso's method are as follows (Figure 2):

1. Formulating research questions
2. Systematic review of texts
3. Searching for and selecting appropriate resources
4. Extracting information from the resources
5. Analyzing and synthesizing findings
6. Quality control
7. Presenting the findings

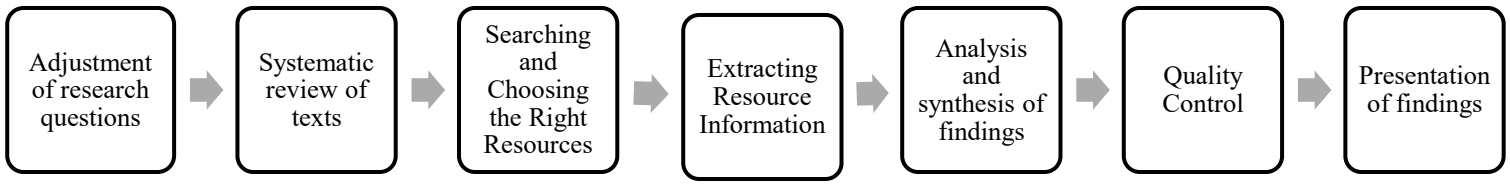

Figure 2: Stages of the Sandelowski and Barroso Method

Results

Adjustment of research questions

The first step in this process is to determine the questions the researcher seeks to answer. The main research question, which guided the article search and the meta-synthesis process, is: What skills should a data librarian possess for effective research data management? (Table 2)

Table 2
The questions of the first stage of meta-synthesis

Qualitative research questions of Fartrak B	parameter
Determination and identification of Data librarian skills in published works	What (what kind of work)
Articles published in the field of data librarianskills inresearch data management	Who (Study community)
All the works published in Zamye Neh Data librarian since 2000 until the May2024	When (period)
Methods and criteria for selecting sources, examiningthe subject of sources, taking notes, analysisThe categories and categories of the studied concepts	How (how to do it)

Systematic review of the texts

The second step of the meta-synthesis process is to systematically review the texts. To do this effectively, the scope of the search must be defined in advance. At this stage, an effort was made to extract and review collections of articles published in journals and dissertations from all available scientific databases. These include ScienceDirect, Scopus, ProQuest, Emerald, Springer, JSTOR, EBSCO, Web of Science, SAGE, Taylor & Francis, as well as the Google Scholar and Semantic Scholar search engines. The search covered the time period from 2000 to 2024.

In this stage, the keywords for searching for articles were a combination of words (librarian skills, librarian competencies, data librarian, data librarian, data management librarian, and data services librarian) and (research data management, research data services, data management, research data, and data services).

("skills" OR "competencies") AND ("librarian skills" OR "librarian competencies" OR "data librarian" OR "data librarianship" OR "data management librarian" OR "data services librarian") AND ("Research data management" OR "Research data services" OR "data management" OR "Research data" OR "data services")

Searching and choosing the right resources

The third step of meta-synthesis is to select appropriate articles, and for this purpose, the following criteria have been used to select related articles:

1. Articles published in 2000 to 2024
2. Presented in reputable databases, there are databases with reputable international indexes such as Science Direct, Scopus, and ProQuest, which were mentioned earlier
3. Articles in the field of data librarians that have dealt with this phenomenon in the field of research data management
4. Full-Text Access
5. Having the necessary quality for scientific extraction of analysis and synthesis in research.

At the screening stage, to assess the relevance of the retrieved articles to the research questions, the studies were reviewed multiple times by the research team. The evaluation

criteria included the relevance of the title to the research objectives, accessibility of the full text, relevance of the abstract and content, and finally, the quality of the research methodology. A summary of this process is presented in Figure 3.

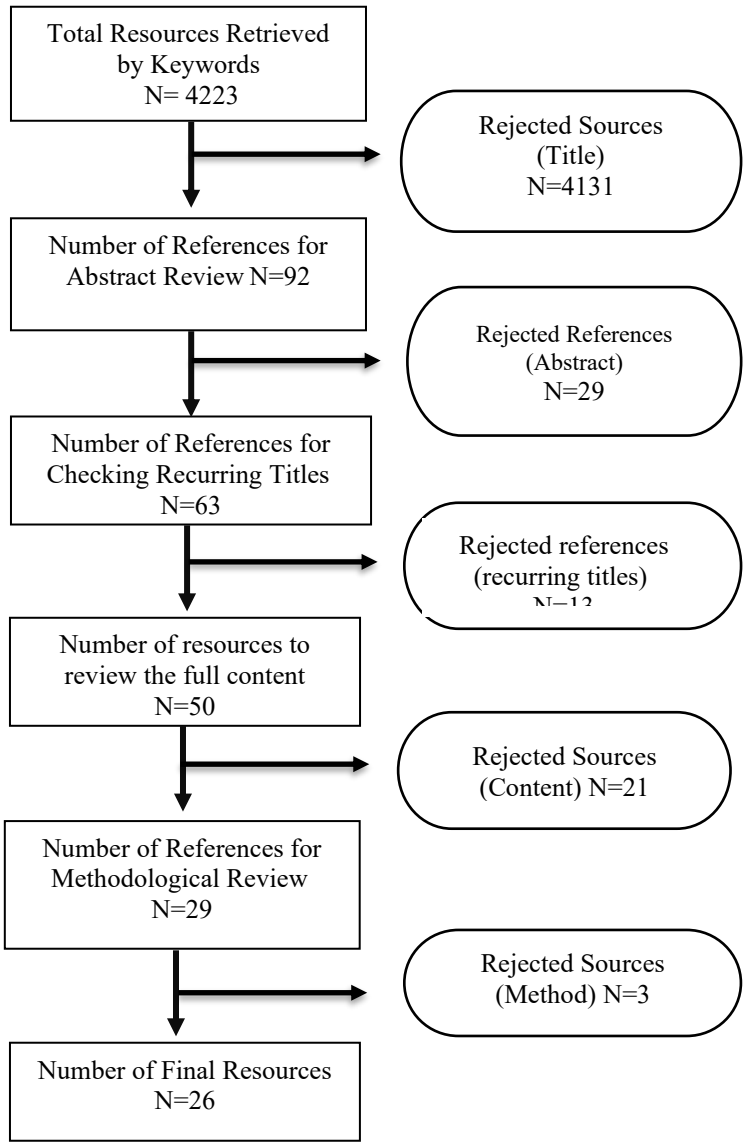

Figure 3: How to Choose Final Sources

Extraction of resource information

In the fourth step, the information from the selected articles—including the research title, author(s), year of publication, research method, statistical population, and identified librarian skills—was extracted and organized into Table 3 for further analysis.

Table 3
Selected Research on Data Librarian Skills

Results - data librarian skills	Research community	Research tool	research method	researcher (year)
Excellent knowledge of bibliographic and other finding tools - information literacy- skills in information discovery, literature searching etc- Knowledge to advise on citing and referencing, and the use of bibliographic management software- Ability to pro-actively advise on and market appropriate library services to researchers- Good knowledge of data sources available in the discipline/subject- Excellent knowledge of content available in the discipline/subject- Awareness of current and changing local research interests- Ability to gain an appreciation of individual researcher/project needs.	Library staff-workshop participants	Questionnaire-interview	Mixed (focus groups-(questionnaire	Mamtora (2013)
Subject knowledge - knowledge of research processes - knowledge of research methods - data processing skills - technical skills - information and communication technology - academic environment - bibliometric services - knowledge of policies (such as copyright, open data), ethics) - very specific skills (such as metadata, setting DOI and working with research data)	219 librarians in Australia, NewZealand, Great Britain	Online questionnaire with open questions	mixed	Kennan, Corrall & Afzal (2014)
Communication skills- statistics - project management- metadata standards- environmental change- geographic data - numerical data - data analysis - problem solving- data management- data sources- HTML and XML- academic library- information systems- collection development - spatial data	Data librarian job advertisements	Browsing texts	qualitative (content analysis)	Xia & Wang (2014)

Results - data librarian skills	Research community	Research tool	research method	researcher (year)
Interpersonal skills and behavioral characteristics - Background knowledge - Data specific knowledge and skills - Information technology - Education and rights - Teamwork	25 data specialists in universities and research centers	interview	Qualitative method	Kennan (2016)
Data management, including description, planning, storage, preservation, archiving - legal and regulatory frameworks - data description, metadata - training and advocacy skills - knowledge of a wide range of data formats - domain and context knowledge E-understanding of programming and program development - data management, data visualization and some data analysis skills	36 data specialists and their employers	interview	Qualitative method	Kennan (2017)
Information literacy - familiarity with data sources - research assistance - contact us - teaching - statistical software - data visualization, standard-based metadata knowledge - quantitative and qualitative data analysis - critical thinking/problem solving - geographic technologies - programming languages Writing - data management - financier - project management - data encryption, data reuse, data encryption - institutional repositories - current technologies	Data librarian job advertisements	Browsing texts	Qualitative (content analysis)	Khan & Du (2018)
Understanding sensitive data vs. open data (privacy, confidentiality and secure data storage) - Reinforcement of best practices (in data collection/storage and secure transfer)	28 researchers in 4 focal groups (Faculty postdoctoral students and (librarians	Interview-Questionnaire	Mixed (focus groups-(questionnaire	Perrier & Barnes (2018)
Communication skills-information management-advanced education-interpersonal skills-information science- social sciences - research data -	Data librarian job advertisements	Browsing texts	qualitative content) (analysis	Eclevia, Fredeluces, Maestro. & Eclevia (2019)

Results - data librarian skills	Research community	Research tool	research method	researcher (year)
academic library- research life cycle- data management planning- data visualization tools- professional experience- data science- data management- library Research- data recovery- content management systems- project management -				
Helping researchers in preparing a data management plan- curation planning- research method- identification of resources and infrastructure- identification and selection of appropriate tools for data analysis, processing and visualization- development of a preservation policy- assistance in formulating data policies Organizational research- getting to know the legal aspects of research data and copyright laws- determining access policies	12 Articles from different databases in the field of librarians ' skills in data management	Browsing texts	Qualitative method	da Silva et al (2019)
Data management, regulatory requirements, funders, data management programs, data storage, infrastructure, security, software, ethics, consulting, training, GitHub development and metadata.	Librarians from Harvard Medical School, etc	Online interview- questionnaire	mixed method	Shipman & Tang (2019)
Explained about all the skills and methods of filling the skill gap in research data management.	2142 Scopus Medline Web of Science articles	Browsing texts	qualitative method	Fuhr (2019)
Consulting, training and teaching, ability to manage data, skill in writing data management programs	Literature produced in research data management in 2016-2020	Browsing texts	qualitative method	Ashiq et al. (2020)
Management skills, knowledge of policies, procedures, issues and standards, knowledge of information resources, technology skills, professional search skills, communication skills, presentation skills, customer service, commitment to lifelong learning, evaluation skills, marketing and	Literature produced by research data management services in 2019-2000	Browsing texts	qualitative method	Das & Banerjee (2021)

Results - data librarian skills	Research community	Research tool	research method	researcher (year)
promotion of library services., improving skills and new knowledge about new technologies, collaboration, research, education				
Training in RDM activities and data training, metadata, IT tools and equipment, writing legal policies, DMP, financial assistance, security and data storage, ethical considerations, participation	5 librarians	interview	Qualitative method	Masinde, Chen, Wambiri & Mumo (2021)
Communication skills, teaching, diversity, inclusion, and equity, data management, data tools	75 US job advertisements - survey of 105 data librarians	Text review-questionnaire	Mixed (content analysis-(questionnaire	Park & Park (2021)
Creating or managing data systems, maintaining data, developing workflows, consulting on data management programs, analyzing or interpreting data, developing applications, ethical issues, documenting procedures, developing security assurance or control policies Quality, metadata standards, programming languages, promoting open access or data sharing, data literacy training, needs assessment, intellectual property consulting, providing access support, managing or training personnel, indexing datasets.	Browsing the web pages of university - libraries Survey Online from the staff of 13 institutes of research data management services	Browsing web pages of university libraries-questionnaire	Mixed (content analysis-(questionnaire	Chiware (2020)
Data life cycle knowledge, subject specific knowledge, communication, networking and reference skills issues, metadata skills, software or computer skills, research process knowledge, other OTH, funding agency knowledge, experience assisting with data management, IR or DR experience, willingness to do continuing education, grant writing experience, knowledge of legal issues	A survey of 175 librarians of institutions affiliated with the Association of Research Libraries	questionnaire	Quantitative method	Antell, Foote, Turner & Shults (2014)

Results - data librarian skills	Research community	Research tool	research method	researcher (year)
Data management, information technology, assessment, education, marketing and communication, library skills, professional participation, personal skills and attributes, education.	A survey of librarians	questionnaire	Quantitative method	Federer (2018)
Development and training of educational content of data services, data management planning, data ethics, familiarity with different types of data structure and file formats, data citation, identification of data repositories for different subjects of regions, metadata standards, data visualization, building a system Repository, GIS mapping, working with semi-structured document data format, skills in statistical analysis, web APIs and crawling, skills in qualitative analysis, computer programming, digitization of physical materials, text mining and natural language processing, database management , big data analysis, website development, machine learning	Survey of university library librarians	questionnaire	Quantitative method	Joo & Peters (2019)
Data/file documentation, metadata, DMPs, collaboration with other partners, investor requirements and regulations, data retention, copyright laws and policies, data repository, information management, data reproducibility, data/file formats, tools/systems/ Software/infrastructure, version control, data life cycle, data sharing, data reuse, needs assessment, principle of justice, research data management, standards	A survey of 240 librarians at the international level	questionnaire	Quantitative method	Tang & Hu (2019)
Development and training of educational content of data services, data management planning, data ethics,	Survey of librarians of university libraries	questionnaire	Quantitative method	Joo & Schmidt (2021)

Results - data librarian skills	Research community	Research tool	research method	researcher (year)
familiarity with different types of data structure and file formats, data citation, identification of data repositories for different subjects of regions, metadata standards, data visualization, building a system Repository, GIS mapping, working with semi-structured document data format, skills in statistical analysis, web APIs and crawling, skills in qualitative analysis, computer programming, digitization of physical materials, text mining and natural language processing, database management , big data analysis, website development, machine learning				
Data cleaning and processing skills, principles and skills of data visualization, knowledge of statistical analysis, a statistical software, programming language, Geospatial and AR and 3D software, research data principles, database management	A survey of US university library librarians	questionnaire	Quantitative method	Luo & Tang (2024)
,Soft skills, instructions programming languages and software, general data services skills	A survey of 120 librarians in university libraries	questionnaire	Quantitative method	Fuhr (2022)
Data literacy training, development and management of organizational repositories, data management, metadata and data preservation, data storage and security, data organization (including documents and metadata), data rights and access, database management skills, data analysis and data visualization, statistical software analysis	Survey of 132 librarians of university libraries	questionnaire	Quantitative method	Ashiq & Warraich (2024)
Information and data management practices, data center management, funder policies, research methods and	The librarian of the university libraries	Semi-structured interview	Qualitative	Badenhorst & Raju (2023)

Results - data librarian skills	Research community	Research tool	research method	researcher (year)
research processes, information and communication technology skills, digitization skills, preparing data sets for deposit and dominant personal characteristics are: flexibility, adaptability technical knowledge, willingness to learn continuously				
Legal skills, policy and advice, institutional knowledge and external resources, familiarity with the principles of RDM and technologies and metadata, knowledge of the research life cycle, data management and metadata skills, technical skills and information and communication technology, knowledge of researchers' needs. and available resources, data description and documentation, data ethics, data visualization, metadata standards, data management planning, familiarity with various data structures and file formats, big data analysis, identification of data repositories for different subject areas, deep learning techniques Mastery of qualitative analysis and statistical analysis	180 librarians	questionnaire	Quantitative method	Subaveerapandiyan & Ugwulebo (2024)

Analysis, analysis and synthesis of findings

In this step, the researcher interprets and synthesizes the emerging themes identified during the meta-synthesis process. Using an interpretive approach, the researcher examines the thematic content and categorizes the identified themes under broader topics that best describe them (Sandelowski & Barroso, 2007). Through this process, research concepts are formed, and related concepts are grouped under overarching categories known as “themes” or “categories.”

Quality control

In the sixth step, the quality, validity, and reliability of the extracted codes were assessed. For evaluating validity, the Glynn tool was used, which allows for the evaluation of both qualitative and quantitative studies (Catalano, 2013). Due to its comprehensiveness and applicability across various types of studies, this tool has been widely used in many meta-synthesis studies. It helps researchers determine the accuracy, credibility, and significance of

the included studies. Glynn provides a checklist for assessing study quality. The questions in Glynn's tool are categorized into four main areas: 1) Statistical population, 2) Data collection, 3) Research design, and 4) Results (Glynn, 2006; cited in Sheikhshoaei, Naghshineh, Alidousti & Nakhoda, 2017). Using this tool makes it possible to exclude weak or low-quality studies based on these four criteria, thereby enhancing the overall credibility of the meta-synthesis results.

According to the results obtained from the Abza Glynn questions, there are 4 options: "non-practical", "no", "unclear", and "yes". We divide the number of "yes" answers by the total number, and if this value is greater than 75%, we can confidently conclude that the section in question does not have the necessary validity. According to the results, 26 selected products obtained a confidence number of more than 75%.

Also, in order to investigate the reliability of the codes, the views and confirmation of a number of authors were reviewed. In this way, the extracted codes were sent to 4 of the authors of the sources and approved.

Presentation of the findings

Step 7: In this stage, the findings were presented using the codes extracted from previous studies. To achieve this, duplicate codes from various sources were first identified and thematically integrated. Codes that conveyed the same or highly similar meanings were merged into broader concepts. In the next step, these concepts were grouped into overarching categories based on semantic proximity, overlap, and level of abstraction. This categorization process was carried out recursively, involving continuous evaluation of codes and concepts in MAXQDA software and repeated review of the sources to ensure internal coherence and conceptual validity of the classifications. In general, 64 codes were extracted from the studied sources, which were placed in 19 concepts and 9 main categories, the information of which is given in Table 4.

Table 4

Classification of meta-synthesis findings of data librarian skills with more than 2 repetitions

/Frequency sources of code extraction	code	concepts	category
9	1. Familiarity with data sources	1. Getting to know the data	Data management and familiarization
8	2. Familiarity with data types		
4	3. Familiarity with data life cycle		
5	4. Data description		
6	1. Data collection	2. Data management	
3	2. Data processing		
18	3. Analysis and analysis Data		
19	4. Metadata organizer and standards		
14	5. Data object		
9	6. Documenting data		
13	7. Data retention		
6	8. Accessibility and data sharing		
5	9. Data reuse		
4	10. Quality control		
5	1. Database management	3.Database	

/Frequency sources of code extraction	code	concepts	category
		management	
15 12 7 9 8 6 3 6	1. Softwares 2. The new program of S.Y 3. Technological tools and equipment 4. Creation of digital repositories 5. Database structure and designer 6. Data storage security 7. Digitization of physical materials 1. Information systems	1. Information technology 2. Information systems	Information technology and Information systems
4 2 2 2 2 2 2 2 10 11	1. Willingness to learn 2. Information update 3. Flexibility 4. Awareness of local research needs 5. Awareness of local research needs 6. Independence at work 7. Professional experience 8. Cultural competencies 1. Individual communication skills 2. Group work	1. behavioral characteristics 1. And the signs communicational	Behavioral and communication characteristics
17 2 17 6	1. Intellectual property 2. Data privacy 1. Oh Jad Khatmesh 2. planning	1. Legal skills 2. policy making skills	Legal and policy making skills
7 8 8 5 2	1. Knowing the research method 2. Knowing the life cycle of A 1. Project Management 2. The value of the project 3. Needs assessment	1. method and Life cycle of education 2. management and Assessment	Research and management methods and evaluation
10 2 4 2 3 4 3	1. Data management training 2. Data service training 3. A teacher of literacy 4. Teaching people 5. Staff training 1. A guide in research data management 2. A guide to spiritual ownership	1. Education 2. Consultation	Education and advice

/Frequency sources of code extraction	code	concepts	category
5 3 2 6 2	1. Scientific artefacts 2. Marketing 3. Networking ability and social media 1. Public Service 2. Special services	1. Troy c services 2.Providing services	Promote and provide services
9 8 6 5 2	1. Knowledge of the subject 2. Text mining and data mining 3. Literacy and information management 1. University library 2. Research library	1. Specialized knowledge 2. Getting to know the organization	Required knowledge and familiarity with the organization
2 3 3 4 3	1. Specialty training certificate 2. Degree in information science 1.Search skills 2. Collection development 3. Cataloging	1. Educational records 2. Library skills	Educational backgroundand skills

According to Table 4, the concepts were organized into nine overarching and fundamental categories, each representing a core dimension of the data librarian's role in research and academic environments. Categories such as "Data Management and Literacy" and "Information Technology and Information Systems" reflect the need for technical and knowledge-based expertise, whereas categories like "Behavioral and Communication Traits" and "Instruction and Consultation" emphasize interpersonal, communicative, and support-related skills.

This multifaceted classification illustrates that the role of the data librarian is not confined solely to technical or informational tasks; rather, it requires a combination of specialized knowledge, communication skills, legal awareness, and capabilities in instruction and consultation. Overall, these nine categories provide a theoretical foundation for designing the final model of data librarian competencies and contribute to explaining the complex, multidimensional nature of this profession within today's data-driven research centers.

On the other hand, the variety and high frequency of some codes can also be interpreted as indicators of their significance in the existing literature. Skills such as "Data Analysis" and "Metadata Standards", which have been repeatedly highlighted across various sources, signal a gradual shift in the data librarian's role—from traditional information services toward technical and analytical support throughout the research data lifecycle. These skills have become especially important in areas such as data optimization for sharing, quality assurance, and enhancing research productivity. This trend indicates that the professional trajectory of data librarians is moving toward a more active role in advancing open science and managing research data. Figure 4 is a pie chart that shows the percentage of each category of data librarian skills. This chart clearly illustrates the relative importance of each category and helps to focus more on the key areas of data skills.

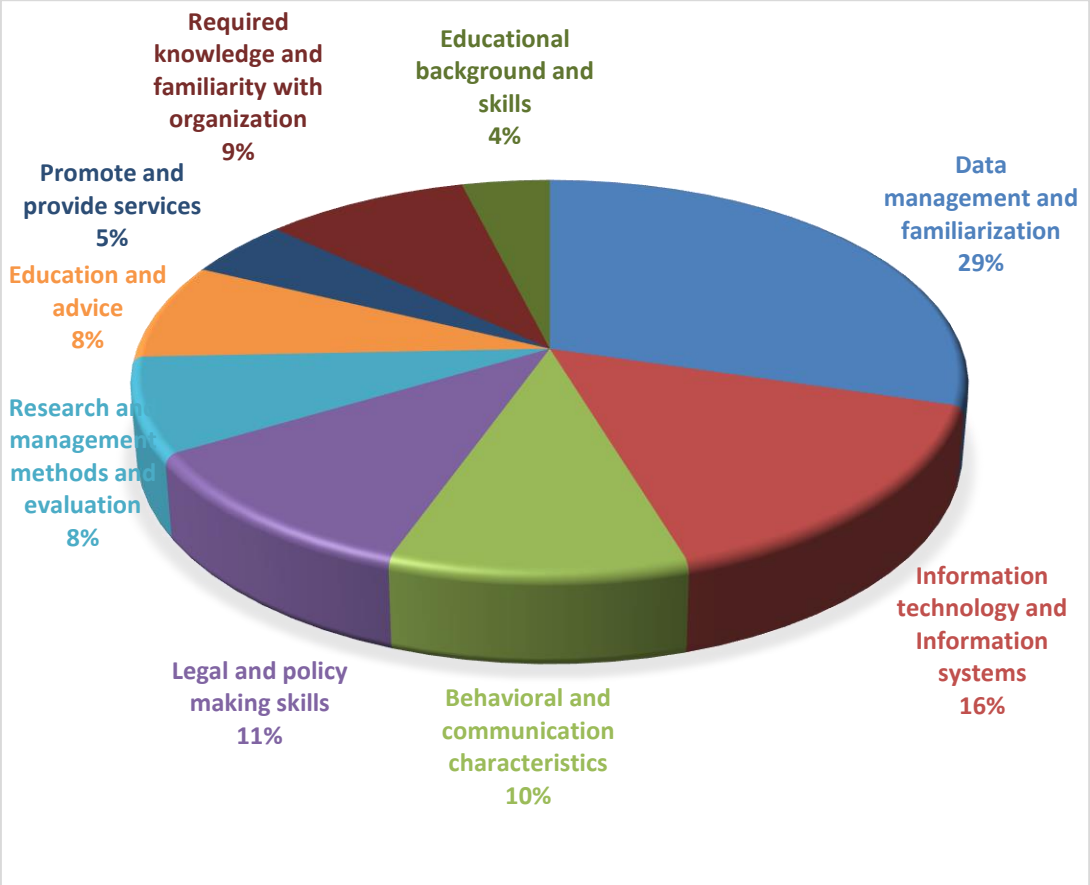

Figure 4: Percentage distribution of skills

As shown in Figure 1, the highest percentage of frequency belongs to "Data management and familiarization" with 29%, indicating the high importance of this area within the dataset. Other categories, such as "Information technology and Information systems" and "Behavioral and communication characteristics," also have significant shares that should be considered in planning and analysis.

Discussion

This study, through a meta-synthesis of existing literature, investigated the skills required by librarians for managing research data. The findings (Table 4) revealed that among the 64 codes extracted from the reviewed articles, codes such as *metadata organization and standards*, *data analysis*, *policy development*, and *intellectual property* appeared with the highest frequency and recurrence in the sources related to research data management. The authors of the reviewed studies also emphasized these as essential skills for data librarians.

In the next step, in order to better organize the extracted codes and make them more accessible for readers, the skills were categorized into 9 themes, 19 concepts, and 64 codes (Table 4). These 9 overarching themes are as follows:

1. Data Management and Familiarity
2. Information Technology and Information Systems
3. Behavioral and communicative characteristics
4. Legal and Policy Skills
5. Research Methodology and Project Management

6. Training and counseling
7. Promote and provide services
8. Subject Knowledge and Familiarity with the Organization
9. Education and skills

Overall, the findings indicate that the literature has placed greater emphasis on concepts related to *data management and data familiarity* compared to the category of *education and skills*. This aligns with the findings of Khan and Du (2018), Park and Park (2021), Xia and Wang (2014), Kennan (2016), and Ashiq et al. (2022), who have identified research data management as a key competency for data librarians.

According to the principles of *open science*, which emphasize data accessibility, researchers are increasingly expected to pay particular attention to how their data is organized, documented, and made available. These practices require familiarity with data and the ability to manage it effectively. As a result, opportunities for developing new roles and services within libraries are emerging, while at the same time necessitating the creation of dedicated infrastructures for data stewardship.

Librarians' skills in data management are among the most influential factors in this context, making it the most frequently cited skill for data librarians in the reviewed literature. As Borgman et al. (2015) point out, research data management is a complex task that demands new and diverse forms of expertise for effective implementation (as cited in da Silva et al., 2019). Data management requires specialized knowledge and skills in identifying various data sources, describing data, collecting data, processing data, analyzing and visualizing data, preserving data, and enabling its access and reuse.

The second key competency identified for data librarians pertains to *information technology (IT) and information systems*. A data librarian must be capable of performing a range of tasks in research data management, particularly in light of evolving technologies. Undoubtedly, given that most research data exists in electronic formats, IT knowledge is essential, influencing every stage of the data management process. Ignoring the role of technology in research data management would render the process unfeasible. Special attention to this skill set can enhance librarians' proficiency in other aspects of research data management. A librarian with knowledge of various information systems can function as an effective intermediary between data, digital infrastructure, and users. The IT knowledge and skills frequently highlighted in the reviewed literature include: creating enterprise repositories, standards, infrastructure, data security, software tools and equipment, programming, and database architecture.

In addition to competencies in data management and familiarity with information technology, data librarians must collaborate efficiently and effectively with researchers and provide services to users. Therefore, effective communication skills and appropriate behavioral characteristics are considered among their essential skills. These include understanding environmental changes, professional experience, willingness to learn, awareness of individual researchers' needs, sensitivity to cultural differences, and the ability to establish scientific communication.

Among the essential skills for data librarians are knowledge of data security, privacy, ethical considerations, and intellectual property rights. According to the thesis by Mrs. Dardmandeh (2016), these are considered challenging topics in research data management. Additionally, having a coherent strategy to ensure the consistent development of research data

management services is essential. Each research institution and university must develop a comprehensive policy for managing research data and specify all necessary aspects in this plan. Research data policies "provide transparency about what is expected and who is responsible for which activities" (Jones, 2014, pp. 91-92).

For this reason, national and university policies on research data management have emerged. Some university policies are strongly influenced by external factors such as national funding agency policies, governmental organizational policies and priorities, and in some cases, international agency orientations (e.g., OECD declarations). There are many examples like Griffith University, where information professionals have led or participated in policy-making (cited from Serle et al., 2015). Data librarians have the opportunity to demonstrate their role in supporting researchers by addressing new policies and ethical issues in research.

Borowitz (2012) showed that the best way to understand researchers' information needs is to use the "research lifecycle" approach. Familiarity with the research data lifecycle is essential knowledge for managing research data. A librarian who is not aware of the research process and data lifecycle cannot properly recognize the necessary steps to fulfill their duties. Researchers in various studies have emphasized that support should be provided at every stage of the research lifecycle.

The Queensland University Library Collaboration Office (2012) developed a comprehensive research lifecycle model that reflects the role of the research librarian at each stage. Examples of activities that may require support include:

1. Idea discovery: writing literature reviews, developing collections, providing research training, and increasing information literacy
2. Funding/approval: support with grants and budgeting
3. Experimentation: data management, research data management, and metadata
4. Results dissemination: institutional repositories, open access, bibliometrics, theses, research evaluation, and publication support (cited in Mametura, 2013).

Another skill that researchers have highlighted is project management and leadership. Additionally, evaluation skills help in assessing the impact and quality of the support services provided, as well as reviewing and improving them.

Training researchers and research groups on how to use data and providing consultation is another essential skill for data librarians. Jones (2014, p. 106) suggests that data services should be complemented by general consultation and personalized advice for individuals or research teams, as these services are very important for researchers (Searle, Wolski, Simons & Richardson, 2015). Examples include consultation knowledge about citation and referencing, using bibliographic management software, and more. Moreover, to properly implement and practice data analysis, librarians should conduct training sessions and workshops related to research data.

Marketing skills and knowledge for promoting data services in academic and research libraries are also among the responsibilities of data librarians. To gain the necessary support for acquiring resources and services for the research community, libraries may need to better market their research activities. Data librarians should therefore be familiar with marketing principles and their implementation.

Jones, Prior, and Wright (2013) categorize research data management services into three phases:

Pre-Project: Assistance in developing data management plans, including guidance on data

cost management and expertise in using online tools.

Throughout the Project: Advice on data documentation formats and standards for reuse; guidance on data storage, management, and analysis to comply with legal requirements and best practices; and advice or provision of research data storage facilities that accommodate a wide range of data types, platforms, and accessibility needs.

Post-Project: Consulting on data of long-term value; support for creating research data that is visible or accessible to defined audiences; and assistance to researchers on how to archive data at the end of the project (cited in Sekouzadeh, 2019).

In addition to these research data management skills, librarians also need a high level of education and proficiency in traditional library skills.

Conclusion

As the role of librarians evolves over time according to user needs and expectations, we must continue to review and innovate our profession in response to new and changing conditions and demands. Research data management poses a significant challenge for universities and research centers. This study identifies the necessary skills for librarians to acquire the capabilities required for providing effective services in the future.

In conclusion, it is expected that the findings of this research will raise awareness among decision-makers to enhance the research data management abilities of students in information science and knowledge studies, as well as academic and research librarians. This will enable librarians to effectively contribute to research and help reduce the challenges related to data services in the country. It is hoped that this study will be a starting point for focusing on data librarian skills in the future services of academic and research libraries. However, this research also poses further questions, such as: Do our library science programs prepare specialists adequately for providing data services in the future?

suggestions

1. Utilize the skills identified in this article to train librarians in research data management.
2. Apply the skills introduced in this article to revise and improve educational curricula in knowledge and information science, aiming to prepare specialists in research data management.
3. Recommend future studies to explore effective ways to integrate these skills into relevant training programs.

Limitation

Although a comprehensive search strategy was designed to extract the maximum number of relevant articles, there is a possibility that some articles were not retrieved due to search limitations. Additionally, conference papers, proceedings, theses, reports, discussions, and similar sources were not included in the study. Furthermore, this study was limited to 26 studies that met the described inclusion and exclusion criteria.

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