Transformation of Librarians' Roles in the Data Era: The Rise of Data Librarians (Postprint)

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Abstract

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Full Text

The Changing Role of Librarians in the Data Age: The Rise of the Data Librarian

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Abstract:
[Purpose/Significance] By comparatively analyzing the position capabilities of foreign data librarians and subject librarians, this paper proposes talent cultivation strategies for data librarians in China. [Method/Process] This study investigates recruitment announcements from typical foreign university libraries,

comparing and analyzing differences between subject librarians and data librarians across five dimensions: position title, educational background, job responsibilities, skill requirements, and comprehensive abilities, and identifies the qualifications that data librarians should possess. [Result/Conclusion] The paper summarizes the position capabilities of data librarians in foreign universities, points out the necessity of role expansion from subject librarian to data librarian, and provides references for cultivating data librarians in domestic university libraries.

Keywords: data librarian; subject librarian; data services; capability requirements
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The development of information technology and the emergence of massive datasets have gradually made university libraries and research institutions realize the value of data and the importance of data management, recognizing that scientific data supports scientific and technological development and innovation. To maximize the value of scientific data, systematic management is required to further promote research activities and resource sharing, thereby improving research efficiency. Currently, many foreign university libraries have begun establishing scientific data management platforms and assigning librarians to provide data services including data acquisition, storage, management, reuse, and open sharing, which has effectively advanced scientific data management. However, the arrival of the big data era has also brought challenges to library development. The contradiction between massive data management and utilization and librarians' service capabilities has become increasingly prominent, and traditional subject librarians can no longer meet user needs. To address this challenge, libraries have proposed higher requirements for librarians' technical capabilities, service content, and job responsibilities, giving rise to a new type of librarian—the data librarian. This paper explores the capability requirements for data librarians in big data environments through a comparative analysis of subject librarians and data librarians, aiming to provide references for the cultivation and development of data librarians in China.

1. Definition and Job Description of Data Librarians

1.1 Definition of Data Librarian

In recent years, scientific data services have developed rapidly, and research on data librarians has increased, with different scholars offering various understandings and definitions. As early as 1997, J. Liscouski proposed preliminary thoughts on the design and function of digital libraries, pointing out the importance of data librarians in scientific research and defining them as librarians who could provide storage, retrieval, search, and access recording services for laboratory data [1]. J. Read stated that data librarians are librarians who provide

data services [2]. A. Swan and S. Brown argued that the academic community's naming of data scientists was inaccurate and proposed four data-related professional roles: data scientist, data manager, data creator, and data librarian, noting that data librarians are library staff trained and specialized in data management, preservation, and archiving [3]. Meng Xiangbao et al. defined data librarians as personnel who have undergone systematic and specialized training in data management, preservation, and storage and possess professional qualifications [4]. Luo Xiaolan pointed out that as library technical environments change and functions expand, the roles and images of librarians have been given new orientations, gradually transforming from traditional subject librarians and reference librarians to embedded librarians, teaching librarians, etc., with new types of librarian roles such as social media librarians and data librarians emerging [5]. In 2016, the Association of Research Libraries (ARL) and other institutions jointly issued the *Librarians' Competencies Profile for Research Data Management*, which states that data librarians should have data awareness and capabilities in providing data access services, data management, and dataset management [6]. Based on this, this paper argues that data librarians are librarians who have undergone systematic data literacy training, possess professional skills in data processing aspects such as data management, storage, and curation, and can provide specialized data services to users.

1.2 Data Librarian Job Description

When providing data services, most foreign university libraries choose to establish dedicated positions and cultivate or employ professionals in data management to ensure the specialization and systematization of data management and service work. To understand data librarian job responsibilities in detail, this study selected the eight Ivy League universities as research subjects, conducted web surveys of each university's official website and library website, and combined this with recruitment information from the American Library Association JobLIST to summarize position titles and capability requirements for subject librarians and data librarians at these universities (see), conducting in-depth research on data librarian positions from five aspects: position title, educational background, job responsibilities, skill requirements, and comprehensive abilities.

(1) Position Title. The naming of subject librarians is relatively consistent across universities, while the title for "data librarian" has not yet been standardized. As detailed in Table 1, there are five main types: Data Librarian, focusing on data management, such as the Data Librarian at Yale University; Data Specialist, emphasizing the functional description of data librarians, such as the Data Analyst at the University of Pennsylvania; Research Data Librarian, focusing on research data management functions, such as the Research Data Librarian at Dartmouth College; Data Services Librarian, emphasizing the application and analysis of research data, such as the Data Services Specialist at Princeton University; Metadata Librarian, focusing on metadata management and other functional descriptions, such as the Metadata Management Supervisor

at Columbia University. Additionally, some universities use other descriptions beyond "data," such as Harvard University's Digital Content Management Librarian.

(2) Educational Background. These universities have relatively high educational requirements for data librarians, primarily requiring a master's degree. In terms of professional background, beyond library and information science, data librarian requirements extend to statistics, computer science, social sciences, and other fields, reflecting that data librarians are comprehensive, interdisciplinary talents.

(3) Job Responsibilities. Summarizing data librarian job requirements reveals four main components: data management services, data support services, information literacy services, and user services. For data management services, two of the surveyed universities require data librarians to have technical capabilities across the data lifecycle, including data collection, management, archiving, publishing, and sharing; four require familiarity with data cataloging, metadata schemas and cataloging standards, and management of data repositories and knowledge bases. For data support services, all eight universities require data librarians to be able to develop data management plans, possess basic qualitative and quantitative tool analysis and guidance capabilities, data analysis technical skills, and certain programming abilities; two also require familiarity with database technologies and developing database-supported applications. For data literacy education, some recruitment announcements require data librarians to have information literacy teaching experience and other relevant work experience. Universities increasingly emphasize the cultivation of data awareness, integrating data literacy into library information literacy training by adding data management process instruction, data analysis, and visualization tool training beyond traditional information retrieval capabilities. For user services, some recruitment announcements require data librarians to provide data tool guidance and reference consultation services, proactively conduct information push services, and provide teaching and research guidance.

(4) Skill Requirements. Analysis reveals that data librarian skill requirements are comprehensive, with relevant capabilities required across all aspects of the data management process:

First, **data management skills.** Data librarians need to understand data lifecycle theory and have practical experience, including data resource organization capabilities, institutional repository construction skills, database design and management skills, and data discovery and storage skills. They also need metadata management knowledge, familiarity with metadata schemas (such as MARC) and cataloging standards (RDA, AACR2, etc.), Dublin Core, OAI, DDI, and encoding languages such as DC and XML to achieve standardized metadata management, promote data preservation and description, and provide embedded research support throughout the data lifecycle.

Second, **technical tool skills.** Data librarians need to master one or more

statistical tools, including qualitative analysis software (such as QGIS, ArcGIS, Atlas.ti, and NVivo), quantitative data analysis software (such as SPSS, MATLAB, and SAS), and database technologies (such as Oracle and MySQL). Additionally, they need to master basic data visualization tools such as Excel, Tableau, and Google Charts. Some recruitment announcements also propose skill requirements for development languages such as JavaScript, Python, and Ruby.

Third, **project management skills.** Data librarians need to be familiar with the entire project management process, including project development, evaluation, implementation, and management, as well as project management tools and techniques, mastering both theoretical knowledge and practical experience in project management.

Fourth, **research skills.** Data librarians should understand research workflows, pay attention to disciplinary frontier information, and be familiar with research management policies and regulations. Additionally, they should master professional knowledge in information ethics, intellectual property, copyright, data security, and privacy to provide comprehensive and legal reference consultation and research project guidance services.

(5) Comprehensive Abilities. Analysis shows that data librarians need not only basic professional competencies but also good comprehensive qualities. In terms of comprehensive abilities, foreign university libraries require data librarians to have certain communication, coordination, and interpersonal skills, as well as independent and teamwork capabilities. This is because as library services continue to develop, data librarians need to cooperate with other functional departments, research institutions, and project teams. Universities also value planning and organizational analysis abilities, independent work capabilities, and proactive service awareness. Additionally, autonomous learning ability, innovation capability, leadership, and environmental adaptability are all important components of comprehensive abilities.

In summary, unlike subject librarians, university libraries have more professional and stringent requirements for data librarians' data skills. The data librarian position demands very high qualifications in educational background, professional skills, and comprehensive abilities. Its job responsibilities are embedded throughout the entire data lifecycle management process and impose high requirements on capabilities in data management, technical tools, project management, and research skills. Data librarians must not only master professional theoretical knowledge but also possess substantial practical experience to support data management and service work.

2. Practice Cases of Data Librarians in Foreign University Libraries

Foreign scientific data management is relatively mature, and data literacy training for data librarians has been successfully implemented. Domestic university

libraries have not yet fully recognized the importance of data services, and positions explicitly named "data librarian" have not emerged. This paper selects Cornell University Library, Purdue University Library, and Johns Hopkins University Library, which have achieved certain success in scientific data management and services, to introduce their data librarian arrangements in detail.

2.1 Cornell University Library

Cornell University Library's (hereinafter "Cornell Library") data management services are provided by the institutional repository eCommons@Cornell, which was jointly created and managed by subject librarians and researchers. This institutional repository serves as Cornell's scientific data management technology platform, not only showcasing information resources and academic achievements but also encouraging researchers to collect and upload various research data, effectively ensuring the long-term preservation and sharing of research data. Additionally, Cornell Library attaches great importance to data curation services, providing data storage centers through the DataStaR project to further ensure scientific data management and sharing.

Cornell Library's "2011-2015 Strategic Plan" explicitly states that support and services should be provided to faculty and students at every stage of the research process, emphasizing that subject librarians should participate in the entire data lifecycle of research activities. For example, during the research preparation stage, they promote interdisciplinary and inter-institutional research collaboration and provide grant application consultation and support services; during the research implementation stage, they provide disciplinary literature consultation and various research tool application services; during the research output stage, they provide academic publishing and digitalization services; and during the research completion stage, they provide data management and storage services. The service content of Cornell's subject librarians has been further extended. Beyond basic disciplinary services, subject librarians play important roles in integrating into research activities and providing data curation services. Through the DataStaR project and data management services, they provide various services including collaboration tools, data collection, analysis, storage, backup and recovery, data sharing, high-performance computing, intellectual property and copyright, security, privacy and confidentiality services, metadata services, and online publishing consultation. To promote the development of scientific data management, Cornell Library also established research data expert positions while fully leveraging the role of subject librarians.

2.2 Purdue University Library

Purdue University Library's scientific data management work gradually developed alongside institutional repository construction, using the institutional repository as a foundation to advance scientific data repository construction and scientific data management development, thereby completing scientific data collection, management, storage, and sharing [7]. In building institutional reposito-

ries including e-Archives (archive storage), e-Pubs (storage for e-books, theses, reports, and other literature resources), and PURR (Purdue University Research Repository, a research collaboration and data management platform), the library continuously explored and practically applied scientific data management processes, achieving fruitful results. Beyond this, the library also established a virtual Distributed Data Curation Center (D2C2) as the core management institution for scientific data management work [7], promoting institutional repository construction on one hand and facilitating cooperation between researchers, technical experts, and librarians on the other, while advancing research in data management by the Purdue University Library Science School and its collaborators [8].

In terms of librarian services, the library actively promotes collaborative cooperation among subject librarians, researchers, and data librarians, and establishes specialized scientific data management institutions to jointly promote the development of scientific data management. Specifically, first, subject librarians provide technical support for research work and specialized, personalized disciplinary services for users through cooperation with researchers from different disciplines and specialties. Second, the library combines disciplinary services with scientific data management, fully leveraging the role of subject librarians in scientific data management and promoting their transformation into data librarians. Finally, the university also attaches importance to data librarian cultivation, establishing an associate librarian position responsible for supporting research services, and creating positions such as data specialist, digital collections services librarian, digital planning librarian, metadata services librarian, and research data librarian, covering the entire data lifecycle process from data acquisition to storage, management, and services.

2.3 Johns Hopkins University Library

The library established the Digital Research and Curation Center (DRCC), focusing on system management and software development related to institutional repositories, data archiving, and custom user interfaces. Additionally, the university implemented the Data Conservancy (DC) project, using existing software and technology to establish deeper connections with research and technical communities to better understand the challenges of collecting, preserving, and curating different types of research data [9].

Meanwhile, the emergence of various disciplinary datasets has made scientific data management increasingly urgent. To address this, the university established a scientific data management model based on institutional repository infrastructure, developing the Johns Hopkins University Data Management Services (JHUDMS) through decades of research and development. On this technical framework foundation, the library developed new roles and relationships between the library and academia, particularly advancing the relationship between data librarians and researchers through the establishment of “data scientist” or “data humanist” positions [10].

To promote JHUDMS and advance university research and teaching, the library specially recruited data librarians to provide a series of resource services for researchers, faculty, and students. These resources include four aspects: data management and sharing, GIS and geospatial data usage, data discovery and access, and data processing based on tools and software. Data librarians participate in the entire scientific data lifecycle process through collaboration with different subject librarians, providing professional disciplinary services and data services, reducing the cost of scientific data management, promoting the rapid development of JHUDMS, and ultimately influencing the culture of data storage and sharing.

2.4 Comparison of Data Librarian Position Settings at Three Foreign University Libraries

Based on the above investigation, differences exist among universities in position titles, position settings, and job responsibilities. To further understand the job requirements for data librarians at each university, this study also investigated recruitment announcements on university library websites and the ALA JobLIST to collect and organize recruitment information for data librarians at these three universities. The specific analysis results are shown in .

Table 2. Comparison of Data Librarian Position Settings at Three Foreign University Libraries

Aspect	Cornell University	Purdue University	Johns Hopkins University
Position Title	Scientific Data Management Specialist, Metadata Librarian, etc.	Data Specialist, Digital Collections Services Librarian, Digital Planning Librarian, Metadata Services Librarian, Research Data Librarian, etc.	Data Scientist, Data Humanist, Data Librarian, etc.
Position Setting	Integration and development of existing positions with separate departments	Integration and development of existing positions with separate departments	Independent department with Digital Research and Curation Center

Aspect	Cornell University	Purdue University	Johns Hopkins University
Job Responsibilities	Embedded in entire research lifecycle, providing data collection, analysis, storage, backup, and recovery	Providing services covering entire data lifecycle; promoting cooperation among subject librarians, researchers, and data librarians	Supporting all stages of research lifecycle; providing research consultation services; supporting cooperation between data librarians and subject librarians
Skill Requirements	Master's degree or above; technical knowledge related to data management, metadata standards, etc.; computer skills; research skills; comprehensive abilities	Master's degree or above; knowledge of data discovery, usage, and management; service awareness; independent and collaborative work abilities	Master's degree or above; relevant work experience; skills in data repositories and data management; teamwork and interpersonal abilities

As scientific data management work develops, university libraries have made corresponding adjustments in position settings and librarian responsibility requirements. In terms of position titles, there is no unified name for data librarians; all three universities set relevant titles according to actual needs, with different titles corresponding to different job responsibilities. Regarding position settings and careers, foreign university libraries currently have two main forms: first, transforming and reconstructing existing positions with subject librarians assuming data librarian responsibilities, such as at Cornell University; second, establishing completely new departments and positions and introducing professional data librarians, such as at Johns Hopkins University. The investigation found that most university libraries adopt the second form, establishing independent positions or departments and setting up professional data librarians. In terms of support services, data librarians at all three universities provide relatively comprehensive support services aimed at covering the entire data lifecycle. Among them, Cornell University and Purdue University emphasize communication and cooperation between librarians and research users, with relatively in-depth data services. In terms of job requirements, the three universities' requirements for data librarians mainly involve four points: having a relevant master's degree or above, mastering knowledge related to data lifecycle management, having data service capabilities, and possessing good teamwork

and interpersonal skills. Additionally, Cornell University also proposes certain requirements for data librarians' research skills. Overall, the three university libraries have relatively high requirements for data librarians.

3. Analysis of Position Capabilities of Subject Librarians and Data Librarians

As shown in Table 1, compared with subject librarians, universities have more numerous and comprehensive requirements for data librarians. Data librarian position capability requirements basically cover those of subject librarians. Therefore, it can also be considered that the data librarian role evolved from the subject librarian role, representing a further extension of capability requirements. To deeply explore the evolution from subject librarian to data librarian, this paper summarizes and analyzes the position functions and skill requirements in each recruitment announcement, specifically examining the similarities and differences between subject librarians and data librarians across four dimensions: educational background, job responsibilities, skill requirements, and comprehensive abilities (see).

Table 3. Position Functions and Technical Requirements for Subject Librarians and Data Librarians in Foreign University Libraries

Dimension	Subject Librarian	Data Librarian
Educational Background	ALA-accredited MLS, MIS, or equivalent	ALA-accredited MLS, MIS, or equivalent, plus other relevant fields such as data or computer science
Job Responsibilities	Department liaison; information push; collection development; reader services; reference consultation; mastering disciplinary development trends, providing SDI services for research groups; user education, etc.	Data management services; research data lifecycle; data statistical analysis and visualization services; data consultation services; standardizing metadata standards; open access, etc.

Dimension	Subject Librarian	Data Librarian
Skill Requirements	Computer operation and data processing abilities; Excel and statistical analysis software packages; information retrieval, analysis, and organization abilities	Ability to conduct qualitative or quantitative analysis using one or more statistical tools; mastery of metadata standards and applications, familiarity with coding languages and visualization tools, etc.
Comprehensive Abilities	Strong interpersonal communication skills, good teamwork spirit and service awareness	Strong interpersonal communication skills, good teamwork spirit and service awareness; independent work ability and collaborative ability

(1) Similarities. In educational background, both basically require a master's degree. In terms of majors, both show a trend toward diversification, involving library and information science, engineering majors (mechanical, electronic, software, transportation, materials), statistics, computer science, and social sciences. In comprehensive abilities, both require librarians to have strong interpersonal communication skills, good teamwork spirit, and service awareness.

(2) Differences. In job responsibilities, subject librarians' main duties are disciplinary services, such as liaising with corresponding departments, literature resource construction, following disciplinary frontiers, and providing SDI services. Data librarians' job responsibilities are data services based on data management, such as research data lifecycle, data statistical and visualization analysis, and standardizing metadata standards.

In skill requirements, both require computer application abilities and mastery of one or more statistical tools for qualitative or quantitative analysis. Subject librarians only need basic data processing abilities, while data librarians have higher skill requirements, needing to master metadata schemas and coding standards, data visualization tools, and development languages.

In comprehensive abilities, data librarians need independent work ability and collaborative ability, as well as experience in data management and database usage and management.

Through analysis of subject librarians and data librarians, it is evident that although the two positions' functions and technical requirements overlap, universities have higher and more comprehensive requirements for data librarians' position capabilities. Overall, subject librarians are specialized talents, while

data librarians are comprehensive, interdisciplinary talents. To meet the challenges brought by data-intensive environments and satisfy research users' data needs, the role transformation of librarians must be promoted, and dedicated data librarian positions should be established.

4. Development Strategies for Data Librarians in Chinese University Libraries

Currently, many foreign university libraries have established dedicated data librarian positions. Although the position titles are not unified, the job responsibilities are relatively clear. In contrast, data librarians are still an emerging profession in China, with no complete data librarian system established, and only a few universities have set up relevant positions, such as Fudan University, Shanghai Jiao Tong University, and Wuhan University, but with uneven job requirements. Therefore, based on foreign university libraries' position capability requirements for data librarians, this paper proposes development strategies for data librarians in the big data era to provide reference suggestions for domestic university libraries.

4.1 Develop Librarian Training Programs to Enhance Data Literacy

Domestic universities should recognize that smooth data management and service work cannot be accomplished without professional librarians. Currently, all universities still focus on subject librarians' work, emphasizing literature resource organization and reference consultation, and have not established dedicated data librarian positions. Therefore, university libraries can adopt a gradual development approach. For situations with few data resources and limited data service work, they can temporarily refrain from establishing dedicated data librarian positions and instead reshape existing positions, having subject librarians perform data librarian duties. For universities with abundant data resources and high data service demands, they can consider cooperating with university information offices or computing centers to establish completely new departments and positions, providing professional and in-depth data services. Regardless of which approach is chosen, libraries need to develop reasonable data librarian training programs to enhance data librarians' data literacy.

University libraries should develop training plans from three aspects: basic abilities, technical abilities, and comprehensive abilities. First, libraries should regularly organize courses on cataloging, classification schemes, and institutional repository management to cultivate data librarians' basic competencies in cataloging, classification, and metadata encoding. Second, university libraries should regularly offer data management courses and hold periodic expert lectures and other academic presentations, comprehensively covering data collection, storage, management, processing, and analysis to enhance data librarians' data management and technical capabilities. Finally, university libraries should focus on cultivating data librarians' comprehensive abilities by organizing

academic exchange activities or project management work to develop independent work and collaborative abilities, comprehensively improving data librarians' data literacy and capabilities.

4.2 Cultivate Data Service Awareness Based on User Service Needs

Through comparative analysis, we find many differences between subject librarians' and data librarians' service content. Service content design depends on users' actual needs. Subject librarians' services mainly focus on disciplinary services, while data librarians' services are more comprehensive, including data management and data support services. To design more reasonable service content, university libraries must base their work on users' actual needs. With the rise and development of big data and cloud computing, scientific data is growing exponentially, becoming more complex and diverse in type and broader in distribution, and researchers' needs are becoming increasingly diversified. Traditional service content can no longer satisfy users' actual needs. Currently, researchers are concerned about the validity of obtained research data and whether scientific data services can support research work. Therefore, university libraries should promptly transform their service thinking, prioritize users' actual needs, shape data service awareness, and provide relevant service content and quality.

On the one hand, university libraries should advance the improvement of traditional service content to meet users' basic needs, including scientific novelty searches, interlibrary loan, reference consultation, and intelligence analysis. On the other hand, considering the diversity and dynamic nature of data demand services, libraries should also provide more data service content, including data retrieval and navigation services, data management services, data processing services, and data analysis services. University libraries must base their work on researchers' research activities, obtain and mine users' actual needs through various research methods, clarify users' data needs through data analysis methods, develop reasonable and comprehensive service content, and establish relevant data service models and systems accordingly.

4.3 Formulate Data Management Standards to Create a Data Service Environment

Professional technical ability is the foundation for data librarians to carry out their work, while scientific data management standards are the guarantee for smooth work. Only by establishing good data management standards can libraries ensure the effectiveness of data management work and guide data librarians to correctly conduct data services. First, metadata is the foundation of research data management. Libraries should select appropriate metadata standards and encoding standards, formulate unified metadata specifications, guide data librarians in metadata description and management, and ensure encoding compatibility and standardized metadata creation. Second, libraries should formulate scientific research data management policies, proposing relevant regulations and requirements for the entire research data lifecycle to standardize

data submission, storage, opening, and sharing processes, ensuring standardized research data management. Finally, libraries should also formulate data service policies to guide data librarians in providing specialized data support services, enabling research users to obtain standardized data.

The rise of the data librarian role represents an expansion and transformation of traditional librarian responsibilities, technical capabilities, comprehensive abilities, and service thinking. To promote data management and service work, domestic libraries can establish corresponding data librarian positions, provide comprehensive and systematic data service content by developing data librarian training programs and data management standards based on users' data service needs. Additionally, as domestic libraries are still in the initial exploration stage of data services, they can draw on foreign data librarians' practical experience and combine it with the current state of Chinese library construction to further promote the development of data librarian services in domestic universities.

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The Change of Librarian's Role in the Data Age—The Rise of Data

Librarian

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Abstract: [Purpose/significance] Through the comparative analysis of the post abilities of foreign data librarians and subject librarians, this paper provides development strategies for the personnel training of data librarians in China. [Method/process] This paper investigated the recruitment information of some foreign university libraries, compared and analyzed the differences between subject librarians and data librarians from five aspects of position name, education background, post responsibility, skill requirements and comprehensive ability, and pointed out the qualifications that data librarians should have. [Result/conclusion] Summarized the post ability of foreign university data librarians, pointed out the necessity of role expansion from subject librarian to data librarian, and provided reference suggestions for domestic university libraries to train data librarians.

Keywords: data librarian; subject librarian; data service; capability requirements

Note: Figure translations are in progress. See original paper for figures.