A Review of Data Governance Policy Research

Authors: Zhang Mengxia, Gu Liping

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Abstract

[Objective] To explore the implementation details of data governance policies and facilitate their establishment. [Method] The implementation details of data governance policies were analyzed through a literature review approach. [Results] The policy elements of data governance primarily include: data selection criteria (compliance with data submission process requirements, priority selection principles, declarations of data authenticity and availability, non-controversial data sources); data storage specifications (adherence to relevant policies, ensuring data integrity, meeting general technical standards, guaranteeing long-term sustainable development); dissemination and communication mechanisms (compliance with laws, regulations, and industry guidelines, open access dissemination licensing agreements, disclaimers for dissemination activities, documentation for data reuse), etc. [Limitations] Future work should further refine the details of the policy framework in conjunction with China' s actual conditions. [Conclusion] Research organizations, academic societies, and funding agencies should actively promote and formulate data governance policies.

Full Text

A Review of Policy Research on Data Curation

Zhang Mengxia[1],[2], Gu Liping[1]
[1] National Science Library, Chinese Academy of Sciences, Beijing 100190, China
[2] University of Chinese Academy of Sciences, Beijing 100049, China

Abstract

[Objective] This study explores the implementation details of data curation policies to facilitate the establishment of effective data curation frameworks. **[Methods]** Through a literature review, we analyzed the implementation specifics of data curation policies. **[Results]** The key policy elements of data

curation primarily include: data selection criteria (compliance with submission processes, priority selection principles, declarations of data authenticity and usability, and non-controversial data sources); data storage specifications (adherence to relevant policies, ensuring data integrity, meeting common technical standards, and guaranteeing long-term sustainability); and dissemination mechanisms (compliance with laws and industry guidelines, open access licensing agreements, disclaimers for distribution activities, and documentation for data reuse). [**Limitations**] Future work should refine the policy framework details in accordance with China' s specific context. [**Conclusion**] Research institutions, professional associations, and funding agencies should actively promote and formulate data curation policies.

Keywords: Digital curation; Data management service; Policy research; Digital archives management; Data rights management; Data selection; Long-term preservation

1. The High-Quality Reuse Value of Scientific Data Under Digital Curation

Sharing scientific data through data papers lays the foundation for data discovery, reuse, and for researchers to gain recognition and trust for their contributions within their fields [1]. In e-Science environments, there is a growing demand for high-quality, assured datasets to support data-driven research [2]. Consequently, the scientific community widely recognizes the need for proactive curation throughout the data lifecycle to make data more suitable for utilization and reuse in this new environment, while also promoting data sharing and exchange within academic communities [3]. Digital curation refers to the active management of scientific data throughout its lifecycle (through data annotation, evaluation, selection, transformation, etc.) to add value and enable broader data sharing [4].

The Association of College and Research Libraries (ACRL) identified data curation as a major trend in the library field in 2012 [5], prompting numerous initiatives in library and information science both domestically and internationally [6-8]. These include: (1) the development of data repositories, with well-established examples such as Edinburgh DataShare, Dryad, and figshare; (2) the implementation of data curation education, with the University of Illinois at Urbana-Champaign (UIUC) launching data curation courses as early as 2006, followed by the University of North Carolina, the University of Michigan, and others; (3) the creation of lifecycle-based data management planning tools, such as the Data Management Plan Online tool from the California Digital Library; and (4) the development of data management infrastructure and curation practices, including Johns Hopkins University' s Data Conservancy, Purdue University Research Repository, Rutgers University' s RUresearch Data Portal, and Cornell University Library' s Datastar project.

While these efforts have achieved notable successes, several new challenges have

emerged [10], including quality control issues for curated data, the formulation of institutional data policies, and reference guidelines to support data managers in curation activities. These issues will become increasingly prominent as data curation work continues to expand.

Data curation has undoubtedly become a crucial development strategy for libraries and archives. However, its implementation involves a series of policy questions: What standards must data meet for curation? How should data be stored? What mechanisms should govern data dissemination and exchange? This study addresses these questions through policy research, examining the policy elements of data curation to provide references for policy formulation and decision-making in practical curation work.

2. Research Framework Design for Scientific Data Management Standards Under Digital Curation

Under a data curation framework, scientific data must be identified, selected, stored, evaluated, analyzed, reused, and shared. These are not merely engineering issues but also policy matters. Research inquiries into the rights and interests involved in these services should include: (1) What management procedures are required for scientific data generated during research activities? (2) What management approaches should apply to selected scientific data stored on data infrastructure? (3) What consensus or conventions should academic communities follow when disseminating and sharing data submitted to and stored in data repositories?

Accordingly, this paper discusses the research framework from both "research questions" and "observation questions," as shown in Table 1 .

Table 1. Research Framework

Research Questions	Observation Questions
What selection criteria must scientific data meet under digital curation?	(1) Does the data comply with submission process requirements? Does the dataset cover content that should be preserved? Does the metadata meet specifications? (2) Which data should be prioritized for selection? Is the data content original and non-reproducible? Does it have preservation value? (3) Is the data authentic and usable? Is it verifiable and reusable? Does it contain false information? (4) What requirements should apply to data sources? Are there legal or ethical disputes?

Research Questions	Observation Questions
How should scientific data under digital curation be stored?	(1) Are there policies to follow for data storage? What should these policies regulate? (2) Is data stored completely? Are there measures to prevent tampering or unintentional modification? Is data securely backed up? (3) Does the dataset meet common technical standards? What requirements exist for data formats, software, and hardware? (4) Is data preservation sustainable? Is there sustainable funding? How should force majeure incidents be handled?
What mechanisms should govern the dissemination and exchange of curated scientific data?	(1) Does data dissemination follow legal guidelines or industry codes of conduct? (2) How are intellectual property issues resolved in data dissemination? Are open access licensing agreements obtained? (3) How are issues involving human subjects addressed? Are disclaimers for dissemination obtained? (4) Does data have documentation supporting sharing and reuse? Are there files explaining data structure, access, and citation norms?

3. Selection Criteria for Scientific Data

The International Council for Scientific and Technical Information (ICSTI) Information Lifecycle Process Framework identifies selection as an indispensable component of the entire workflow [11]. Data curation similarly cannot proceed without data selection for several reasons: (1) Data backup and mirror site maintenance incur costs, necessitating the selection of data with preservation value; (2) Without selection, stored data may grow uncontrollably, become redundant, and make discovery, mining, and utilization difficult [12]; (3) Valuable data may be lost when research project lifecycles end, and sound selection practices can preserve such data in a timely manner; and (4) Research funding terms and educational institutions have requirements for data retention periods, and data selection provides a means to evaluate whether data should continue to be stored after these periods expire.

3.1 Compliance with Data Submission Process Requirements

There are at least three implementation scenarios for data curation [13]: (1) data contributors generate, describe, and submit data themselves; (2) data curators

collect, evaluate, select, store, and preserve data; and (3) data contributors submit data that is then screened, reviewed, and managed by data curators before being made available for use. The most common practice adopts the third approach, with both parties following a standardized workflow. Principles that both data contributors and curators must jointly observe include: (1) datasets should cover all content requiring preservation, as the completeness and richness of preserved content significantly impact data understanding, utilization, and curation; and (2) metadata should be as detailed and complete as possible to enable efficient use by others.

3.2 Principles for Priority Data Selection

Under equivalent conditions, data curation must not only ensure long-term preservation but, more importantly, facilitate knowledge exchange. Prioritizing credible, usable, and valuable data better serves this objective [14]. Priority selection principles include: (1) original, non-reproducible data, such as weather observations, volcanic eruption records, or rainfall measurements; (2) data from observations where the subject may still exist but the measured variables change over time, making the original experimental data non-reproducible; (3) non-redundant data, meaning data that is not duplicated or useless within computer systems; and (4) data with scientific research, historical documentation, and socioeconomic value.

When implementing the fourth principle, data curators require operable conceptual definitions. Scholars reviewing reports from the US National Research Council (NRC), DDC, and ANDS [10,15] have identified: (1) scientific value as data' s ability to support scientific activities and provide verifiable scientific results; (2) historical value as data' s usefulness not only to researchers but also to social groups and individuals; and (3) social value as data' s reflection of contemporary societal interests and its contribution to future socioeconomic development through reuse.

3.3 Declaration of Data Authenticity and Usability

Data contributors should submit a declaration confirming the authenticity and usability of their data. This includes: (1) data interpretability; (2) data verifiability and reusability, meaning data can effectively validate research findings and confirm the credibility of scientific conclusions through data provenance; (3) absence of fabricated information, allowing the dataset to serve as scientific evidence and support for relevant conclusions; and (4) no deliberate screening or withholding of information. Such declarations demonstrate the data contributor' s willingness to assume responsibility and help data curators quickly understand the data.

3.4 Non-Controversial Data Sources

The primary principle of data curation is legality, encompassing the basis, process, and content of curation. Therefore, data selected for curation should not be generated through illegal, unreasonable, or unethical means. Data curation should avoid legal, moral, and ethical controversies, such as issues related to data ownership, experiments involving human subjects, personal information, national security, confidentiality, and preconditions for sharing required by data providers [16]. These principles require clarification of: (1) compliance with academic ethics, scientific ethics, and existing laws and regulations during data generation; (2) adherence to legal, ethical, and social practice norms for scientific data from research activities, with discipline-specific information management guidelines prioritizing such principles; and (3) consideration of legitimate rights and interests of all stakeholders in data dissemination.

Industry standards provide important reference value for implementing these principles [17]. In crystallography, for instance, data users developing new products, conducting new research, or applying for new projects must communicate with data contributors to obtain formal or informal consent or participation. In geobiology, scientific data from nationally funded observation instruments and research projects generally require open sharing, while large research institutes and commissioned companies often retain their rights and propose different embargo periods for open access.

4. Data Storage Specifications

Data infrastructure includes but is not limited to [19]: (1) large-scale instruments and their information platforms; (2) domain-specific data exchange networks; (3) data centers: big data resource bases or project repositories; (4) data banks: knowledge bases providing data storage for contributors based on agreements or terms; (5) data archives: data knowledge bases offering specific resources to interested end-user groups; and (6) libraries: electronic document platforms, data repositories, and institutional repositories.

Although these infrastructures serve different purposes, stakeholders (research funders, research managers, project leaders, data contributors, data curators, and data users) must reach consensus or adhere to a common set of conventions when facing data curation challenges.

4.1 Priority Compliance with Funding and Institutional Data Policies

Funding agency policies, terms, and management regulations stipulate how project leaders should handle data. As infrastructure supporting data curation, these systems must naturally comply with, respect, and follow such data policies to require, invite, and solicit data submissions that meet selection criteria for review and determination of availability to research communities and the public.

Based on preliminary research [20-22], funding and research institutions require data from funded projects to be preserved long-term and openly shared in compliance with institutional management methods. Such policies typically address: (1) disciplinary scope; (2) submission timing, generally within 6-12 months after project completion; (3) minimum retention periods, with research data preserved for at least 3 years for inspection and 10 years for secure preservation; (4) open access dates, implemented within 12 months after official publication of research results; and (5) storage locations, such as institutional repositories or third-party data centers that can demonstrate preservation and dissemination capabilities while protecting stakeholder rights.

4.2 Pursuit of Data Integrity

Data integrity is a crucial quality metric. Unlike the data contributor' s declaration of authenticity and completeness in Section 3.2, data storage specifications for infrastructure emphasize concrete measures to strictly ensure integrity. For example, the Inter-university Consortium for Political and Social Research (ICPSR) developed a social science data repository based on the OAIS model that specifically emphasizes contextual information, preservation description information, and user access permissions to ensure data integrity within the repository.

Basic integrity requirements include: (1) **Tampering prevention**. If data modification is necessary, three options should exist: when data contributors modify, update, or adjust data, they should provide documentation to clarify different versions for users; when data curators need to correct data within a small scope for format standardization, preservation, or other reasons, they must inform data contributors or have clear prior specifications; and when third parties raise objections about dataset issues in storage, dissemination, or content, data contributors, curators, and even research managers should conduct evaluations. In all cases, data must not be tampered with by anyone without consent or permission. (2) **Prevention of unintentional modification**. For data curation, data should only be revised, supplemented, or corrected when errors exist, whether from original submission flaws, data loss during format migration, or other accidental damage. (3) **Secure backup**. For long-term preservation and to prevent data loss from natural disasters, accidents, or personnel changes, data should be copied or migrated according to fair use principles.

4.3 Compliance with Common Technical Standards

Data curation relies on appropriate technical standards because: (1) unified standards improve efficiency and reduce costs during data migration [23]; (2) similar tools, methods, procedures, and professional skills reduce data noise during backup; and (3) standardized conversion prevents implementation by only a few vendors or skilled groups, increasing solution options.

Common technical standards generally include: file formats, reference standards

like OAIS, permanent unique identifiers, and standards supporting remote access, storage, and verification. Characteristics include: machine readability, human interpretability, easy access, format convertibility, and openness compatible with these conditions. Considering that data curation requires regular migration and conversion, open technical standards are flexible, adaptable to multiple technical strategies, and cost-effective [24].

4.4 Ensuring Long-Term Sustainable Development

A core objective of data curation is maintaining high-quality data for open sharing and preventing loss of important data. Open access enables full data utilization, provenance tracking, and recognition of research contributions, requiring long-term sustainable development mechanisms to ensure such records truly exist.

Long-term sustainability in data curation addresses three concerns: (1) **Non-project-based engineering**. Data management often faces loss of valuable scientific data when projects end, making long-term sustainable curation mechanisms essential solutions; (2) **Non-profit business models**. Data curation involves cost-benefit considerations, and high standards require selected data to be objective, complete, and consistent without interference from profit motives, prioritizing non-commercial operational models; and (3) **Contingency measures for force majeure**. Standard operating procedures are needed to address losses from natural disasters or human-caused accidents [25].

5. Dissemination and Exchange Mechanisms

A key objective of data curation is providing open access to scientific data [26]. Data infrastructure establishes internal management mechanisms for early curation stages (data submission, organization, processing, storage, and sharing), but faces various obstacles when promoting actual data sharing, such as unclear communication with data contributors about data utilization and how to respect and protect contributor rights. From a policy planning perspective, complete data curation requires dissemination mechanisms as an essential component alongside selection standards and storage specifications [27,28].

5.1 Compliance with National Laws and Industry Best Practices

In prioritizing dissemination mechanisms, national laws and regulations come first, followed by industry best practices. Specifically, this includes: (1) compliance with legitimate rights in copyright and related rights [29] (moral rights rightfully enjoyed by data contributors and allocation of property rights), intellectual property commercialization (IPCs) [30] (requirements from funders and managers for free access to data with market value), and institutional and/or repository policies; and (2) scientific record management standards, such as the *Australian Code for the Responsible Conduct of Research* [31] and the *RCUK Policy and Code of Conduct on the Governance of Good Research Conduct* [32],

which specify regulations on scientific data storage, retention periods, storage methods, and sharing provisions.

5.2 Open Access Licensing Agreements

Licenses are normative specifications by copyright holders on how content may be used. Open access licensing agreements are crucial in digital and networked environments for protecting data contributor rights while granting user permissions. The most common agreement is CC-BY, requiring users to respect contributors' moral rights through attribution. Additionally, CC0 agreements can license objective facts like government statistical data that do not require specific attribution.

Since data collection, processing, selection, and submission meeting selection criteria involve intellectual labor, datasets are generally licensed under CC-BY or more restrictive agreements. Metadata, as data describing these facts (datasets), is recommended for CC0 licensing. Thus, digital curation plans can clarify dissemination licenses by implementing CC-BY for datasets and CC0 for metadata.

5.3 Disclaimers for Dissemination Activities

The primary ethical issues in data sharing involve sensitive data about individuals or organizations and data security controls [33]. Disclaimers for dissemination activities inform users that data selected, stored, and provided with open access by curators meets certain quality standards. While data contributors declare non-controversial sources, curators have obligations and responsibilities to inform users about proper data sources and legitimate usage. For example, data involving human subjects requires informed consent documentation; sensitive or political data requires ethics committee approval; and third-party contract data requires authorization letters.

Such disclaimers not only fulfill notification obligations but also promote good academic exchange atmospheres, encourage self-regulated ethical practices, and enhance positive cycles of open access.

5.4 Documentation for Data Reuse

Ultimately, the eleven policy elements concerning selection standards, storage specifications, and dissemination mechanisms all aim to ensure good management and dissemination of scientific data. To achieve these goals, the final checkpoint in data curation is documentation for data reuse, explaining how to understand data structures, field names, and other elements when reproducing results, replicating products, or creating anew. Such documentation primarily includes: data dictionaries; contextual information about the data creation environment, such as project nature and data collection/processing methods; and recommended approaches for data access and citation.

6.1 Summary of Policy Elements for Data Management Standards in Data Curation

In summary, the three research questions posed in this paper are operationalized into observable questions and policy elements, encompassing three management priorities: data selection criteria, data storage specifications, and dissemination mechanisms, as shown in Table 2 .

Table 2. Policy Elements for Scientific Data Management Standards in Data Curation

Policy Element	Specific Requirements
Data Selection Criteria	(1) Compliance with data submission process requirements (datasets covering necessary content, metadata meeting specifications and being detailed); (2) Priority selection principles (original non-reproducible data, non-redundant data, prioritizing data with scientific research, historical documentation, and socioeconomic value); (3) Declaration of data authenticity and usability (interpretable, verifiable and reusable, no fabricated information, no deliberate screening or withholding); (4) Non-controversial data sources (data generation and research activities not violating academic ethics, scientific ethics, or laws; data dissemination considering legitimate rights of all stakeholders)
Data Storage Specifications	(1) Priority compliance with funding and institutional data policies (disciplinary scope, submission timing, minimum retention periods, open access dates, storage locations); (2) Pursuit of data integrity (tampering prevention, unintentional modification prevention, secure backup); (3) Compliance with common technical standards (machine-readable, human-interpretable, easily accessible, format-convertible, open and compatible); (4) Ensuring long-term sustainable development (non-project-based engineering, non-profit business models, contingency measures for force majeure)

Policy Element	Specific Requirements
Dissemination Mechanisms	(1) Compliance with national laws and industry best practice guidelines (copyright and related rights, intellectual property commercialization, institutional/repository policies, scientific record management); (2) Open access licensing agreements (metadata under CC0, datasets under CC-BY unless special circumstances apply); (3) Disclaimers for dissemination activities (informed consent for human subjects data, ethics approval for sensitive/political data, authorization letters for third-party contract data); (4) Documentation for data reuse (data dictionaries, project nature, data collection/processing methods, recommended access and citation methods)

6.2 Practical Significance

In e-Science environments, discussions on research and publication workflows are extensive, and while important achievements in digital curation have been discussed [34-36], most focus on technology, systems, and education/training perspectives. Policy perspectives, particularly regarding data policies, remain in preliminary exploration domestically.

Data curation is a systematic project involving data objects and their integrity, technical measures, legal and organizational factors, and other elements such as policies, standards, and metadata [37]. Therefore, this paper provides appropriate supplementation to previous research, and the research framework (Table 1) and policy framework summary (Table 2) encompass the basic rights and interests of all stakeholders, offering references for policy formulation.

6.3 Research Limitations

It should be noted that the questions listed under the research framework in Table 1 require further specification based on current realities, with focused analysis of existing practical problems in data curation. The operational data curation plan outlined in Table 2 must also be implemented in coordination with data management policies of funding agencies, research institutions, and information service organizations. Moreover, effective advancement of this work requires integration with scientific data management plans (DMPs) to achieve good results.

When generalizing these findings, case studies should be incorporated, and

actual needs of research funders, research managers, project leaders, and researchers must be considered when developing relevant management standards.

6.4 Future Research

Future work should conduct field research on research teams and analyze policy elements of data management plans, rights management for data and derived data, open access licensing agreements, and coordination with research management departments. Combining this study with future research will enable the development of a complete workflow solution.

Author Contributions

Zhang Mengxia: Drafted the manuscript, compiled policy details, and interviewed experts and scholars.
Gu Liping: Designed the research, provided information sources, analyzed policy elements, and revised the final manuscript.

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(Corresponding author: Gu Liping, ORCID: 0000-0002-2284-3856, E-mail: gulp@mail.las.ac.cn)

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