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Data management plans are key measures for safeguarding the open utilization and value realization of public data.

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Abstract

Data Management Plan (DMP) constitutes a critical safeguard for ensuring the value and targeted utilization of open public data. One of its core tenets involves the identification of responsible personnel and the specification of plan contents to guarantee the rational management and sharing of public data. DMP holds significant importance for scientific research and social applications, as it ensures data accuracy and reliability, enhances data usability and shareability, and further promotes the advancement of scientific research and social applications. Data Management Plans must adhere to national and industry laws and regulations, taking into consideration issues such as data quality assurance, intellectual property, privacy protection, confidentiality, and security. In project application and review, the planning of DMP and resource investment are of paramount importance, necessitating a comprehensive consideration of the balance between data sharing and data rights protection. DMP plays a crucial role in project management by clarifying the relevant content of data management within the project framework. As an essential component of project proposals, DMP has received widespread international recognition, facilitating the open utilization and value realization of scientific data, improving data shareability and reusability, and further promoting the progress and development of scientific research.

Full Text

Data Management Plan: A Key Measure to Ensure the Open Utilization and Value Realization of Public Data

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Abstract: The Data Management Plan (DMP) is a critical safeguard for ensuring the value and objectives of open public data utilization. One of the core elements of a DMP is the identification of responsible personnel and plan content to ensure the proper management and sharing of public data. DMPs are of great significance for scientific research and social applications, as they ensure data accuracy and reliability, improve data usability and shareability, and advance the development of scientific research and social applications. Data management plans must comply with national and industry laws and regulations, addressing issues such as data quality assurance, intellectual property, privacy protection, confidentiality, and security. In project application and review, the planning and resource allocation for data management plans are crucial, requiring careful consideration of the balance between data sharing and data rights protection. DMPs play an important role in project management by clarifying the relevant aspects of data management within project administration. As an essential component of project proposals, DMPs have gained widespread recognition internationally, helping to realize the value of open scientific data utilization, enhancing data sharing and reusability, and promoting scientific research progress and development.

Keywords: Data Management Plan (DMP); Responsible personnel; Data rights protection; Open scientific data

Introduction

The Data Management Plan (DMP) is a crucial safeguard for realizing the value and objectives of open public data utilization. By considering data management approaches at the project application stage, DMPs enable research funding agencies to effectively track outputs from publicly funded projects, while also providing guidance for research institutions and universities on storing, protecting, and openly sharing data assets. More importantly, DMPs help researchers improve their efficiency in managing, utilizing, and sharing data, thereby enhancing the verifiability, credibility, and citability of research outcomes, as well as increasing the international visibility and recognition of research teams. Therefore, drawing upon the rich experiences of technologically advanced countries in formulating, implementing, and evaluating data management plans holds significant

meaning for advancing the value and objectives of open public data utilization in China.

1. Professional Information and Attachments in Project Proposals

Foreign government agencies, research institutes, and foundations have established a series of data management plan policies to promote the open utilization and value realization of public data. These policies require research project applicants to submit DMPs to ensure proper data management and sharing. For instance, the U.S. National Institutes of Health (NIH) [01] and the National Science Foundation (NSF) [02] require applicants to submit data sharing management plans and supplementary documents labeled “DMP” to demonstrate compliance with data sharing policies. The Swedish National Science Foundation (SNSF) has also issued “Data Management Plan Guidelines,” requiring researchers to provide information on the data lifecycle when submitting funding applications, covering data collection, storage, ethical, legal, and security issues, data preservation, and data sharing and reuse [03].

A core element of data management plans is identifying responsible personnel and plan content to ensure proper management and sharing of public data. The U.S. National Endowment for the Humanities (NEH) “Data Management Plan Guidelines” propose relevant principles, including clearly stating how raw data will be shared, defining roles and responsibilities of all parties, and considering contingency measures for role changes when project directors or co-directors leave their institutions or projects [04]. Additionally, project budgets must explain all costs incurred during scientific data management processes.

2. Responsible Personnel in Data Management Plans

Responsible personnel are the key to implementing data management plans, as they manage and are accountable for data quality, data sharing, and data security. In most management plan policies and guidelines, the project leader is explicitly designated as the responsible person and is permitted to use part of the funding to implement the DMP. The data management plan serves not only as the project leader’s commitment and planning tool for data management but also as a vital component of the research project. It is more than a detailed document describing how data will be handled; it represents the core of data management policies, systems, and management procedures embedded within the research process. Consequently, the UK Medical Research Council (MRC) considers that data management plans should serve as an important basis for funding applications or institutional assessments [05].

Responsible personnel in data management plans act as coordinators among data stakeholders, ensuring proper data management and sharing to achieve the value and objectives of open public data utilization. The UK Economic and Social Research Council’s (ESRC) “Data Management Plan: Guidance for Peer

Reviewers” recommends considering several questions when defining responsibilities: Have data management responsibilities been assigned to designated individuals or teams? Is there evidence that data management work will be effectively executed throughout the project implementation? Have multiple data management tasks been considered and addressed? For collaborative research, have data management responsibilities been allocated to each partner institution with coordinated responsibilities among all parties? [06]

Responsible personnel must effectively manage different stages of scientific data management implementation to ensure proper protection and utilization of data rights. The Dutch Data Archiving and Networked Services (DANS), an association of the Royal Netherlands Academy of Arts and Sciences and the Netherlands Organization for Scientific Research, requires submitted DMPs to clearly answer: Who is the primary person responsible for data management? Who is responsible for documentation management at each stage of the data collection project? Which individuals or institutions own the copyright of collected data? Will these rights be transferred when appropriate? [07]

During implementation, responsible personnel must follow industry practices and promote data sharing and utilization to the greatest extent possible. The NEH “Data Management Plan Guidelines” require project directors to detail how they will address: what data types the project may generate and share and under what conditions; how to manage and maintain data security and reliability before sharing with others; factors that may affect data management capabilities, such as legal and ethical constraints; the minimum level of aggregated data that project directors share with others in academic or research communities; mechanisms for data sharing and promoting sharing; and other information that should be maintained and shared, such as how data was generated, analysis and procedural information, and metadata [08].

Some data policies require DMPs to identify responsible personnel and their duties for each stage to ensure proper data management and sharing. For example, the U.S. Geological Survey (USGS) data management plan checklist details responsible personnel and their duties, including those managing data and the entire DMP, those creating and updating metadata, those migrating datasets from old/obsolete formats, those performing file checks to ensure data integrity, those handling data backups, and those supervising backup processes [09]. Although some DMP guidelines do not specify detailed requirements, they still recommend that responsible personnel consider various scenarios for scientific data management. The Australian National Data Service (ANDS) “Data Management Planning Awareness” requires responsible personnel to clearly identify data owners and stakeholders, determining who will own created data and who has interests in the data [10]. Simultaneously, data access and security must be considered, determining who has access rights and taking measures to protect sensitive data from unauthorized access.

Responsible personnel are the key to implementing scientific data management because they must not only supervise data to ensure accuracy and reliability but

also coordinate stakeholder interests to promote data sharing and utilization. Simultaneously, they must ensure compliance with industry practices and data policy requirements of funding agencies or research institutions to achieve the value and objectives of open public data utilization.

3. Content of Data Management Plans

Data management plan content primarily involves data types, data and meta-data formats, sharing and access policies, and preservation plans, serving as an implementation plan, inspection plan, and commitment to scientific data management. To ensure DMPs can be implemented across various scientific data management processes, some funding agencies have adopted detailed specifications. For example, the NSF “Data Management Plan” lists seventeen items, including data description, data format, metadata, data storage and backup, intellectual property, access and sharing, data archiving and preservation, ethics and privacy, existing data, data organization, quality assurance, data security, names of personnel responsible for data management in the research project, budget, legal requirements, audience, and selection and retention periods [11]. Among these seventeen items, various implementation details accommodate differentiated situations across disciplines. To balance and ensure DMP implementation, the plan guidelines strongly recommend adopting the first eight items, while the remaining nine are suggested as references.

Some funding agencies adopt a flexible Q&A approach and outline method, requiring applicants to answer DMP-related questions themselves. For instance, the DANS DMP template recommends that project leaders consider data storage and security, the number of copies and synchronization methods, version control arrangements, internal data access management stages, metadata selection and standards, long-term data preservation and storage locations, selection and retention periods for archived data, and archiving costs. This approach’s advantage lies in expanding adoption and accelerating DMP implementation, allowing applicants to provide DMPs based on actual circumstances and avoiding contradictions during initial policy implementation. Simultaneously, funding agencies can select best practices from these plans for future promotion.

Mature templates and tools for DMP development already exist, such as the DMP Online tool provided by UK universities and research institutions. These tools specify the core content of scientific data management plans, offering effective guidance and services for researchers [12]. Additionally, foreign DMP tools provide relevant texts, including funding agencies’ data management requirements [13] and data management policy templates from research institutions and universities [14]. These documents serve as important references for advancing DMP development.

Some DMPs specifically focus on data quality assurance to ensure accuracy and reliability. For example, the UK Data Service’s “Data Management Guide” [15] and ESRC’s “Data Management Plan: Guidance for Peer Reviewers” rec-

ommend that responsible personnel consider developing quality assurance procedures for collected data, describing relevant information such as data validation methods, data collection and input standards, research practice guidelines followed, and transcription templates used. When research applications explicitly require quality assurance, the quality assurance procedures should be mentioned, with attention to data quality issues, particularly during data collection, entry, digitization, or verification. Additionally, intellectual property issues must be considered, including rights and usage licenses for research data and copyright licenses for data sharing. These DMP guidelines are related to national laws and policies, such as the UK's Data Privacy Act. Following these guidelines enables researchers to comply with national laws and regulations to the greatest extent.

To anticipate and prepare for issues during scientific data management implementation, some DMPs adopt an outline method to comprehensively consider potential problems. The NEH "Data Management Plan Guidelines" propose that DMPs should describe data types, samples, and related materials to facilitate advance planning and preparation [16]. DMPs must also describe expected data types to be retained, data formats and media used, enabling others to access data and metadata. Furthermore, public access and sharing policies are important DMP components, including provisions on privacy protection, confidentiality, security, and intellectual property to ensure legal data use and sharing.

In the social sciences, DMPs hold significant value for promoting open public data utilization. Through DMPs, academic associations and data sharing alliances can integrate scattered research datasets into community datasets or even reference datasets, thereby improving data usability and shareability. The Inter-university Consortium for Political and Social Research (ICPSR) DMP template requires production specifications for research-grade metadata records, data citations with Digital Object Identifiers (DOIs), variable documentation, technical documentation, and related publications to better preserve and present data and improve data search efficiency and utilization.

To accommodate various data resource types, some national data management centers have adopted relatively flexible requirements for DMP content. For example, the ANDS DMP awareness points include requirements for existing data surveys, file formats, and metadata processing methods. These requirements aim to encourage researchers to submit scientific data and facilitate collection and integration by national data management platforms. Through flexible requirements, more researchers can be attracted to participate in data sharing and openness, promoting scientific research progress and development.

In some fields, DMPs follow industry rules and practices, delegating granular data management issues to established standards and processing methods. The USGS data management plan checklist exemplifies this approach, listing detailed DMP content involving data standards, storage formats, metadata rules, naming conventions, and version control. Such DMPs typically apply to fields with

mature data management and sharing practices, such as astronomy and geology, which include both large observational datasets and small experimental datasets. Following industry rules and practices can improve data standardization and consistency, promoting data sharing and open utilization.

While DMPs vary across disciplines and data processing purposes, their core objective is clear: to define responsible personnel and their duties and maximize data sharing and open scientific data. DMPs also require consideration of privacy protection, confidentiality, security, and intellectual property to ensure legal data use and sharing. Therefore, developing reasonable DMPs is crucial for realizing the value and objectives of open public data utilization.

4. Content of Project Outcome Reports

Research project outcomes include not only publications, datasets, software, and code but also scientific data management and sharing. Scientific data can be published as supplementary files or data papers, providing supporting materials for research conclusions. However, whether scientific data constitutes evaluable project outcomes depends on the formulation of scientific data management policies and the degree of association between DMPs and project outcome reports. Therefore, to enhance the value and objectives of open public data utilization, reasonable data management policies and plans must be formulated to ensure data accuracy and reliability, promote data sharing and open utilization, and advance scientific research and social application development.

Many project outcome report specifications require clear descriptions of scientific data, enumerated in DMP checklists. The USGS data management plan checklist includes content related to project outcome reports, covering data release scope, error checking, and data review. These requirements help ensure the accuracy and reliability of project outcome reports, improving data usability and shareability.

DMPs must also consider post-project data backup and secure disposal measures. The ESRC “Data Management Plan: Guidance for Peer Reviewers” and “Research Ethics Framework” recommend focusing on backup program purposes and frequency, multiple media and copy backups, methods for checking backup copy availability, and institutional backup policies [17]. For sensitive data processing and storage, appropriate protection methods must be adopted, such as data encryption, anonymization, and careful transmission, ensuring these methods reflect current best practices. Additionally, version control methods must be described to track and manage different data versions.

Data management plans are essential components of scientific data management and core content of project outcome reports, holding significant importance for improving the value and objectives of open public data utilization.

5. Review Content in Project Applications

The U.S. National Science Foundation explicitly includes data management plans as part of its review content in its project application guidelines, covering equipment requests, conference applications, high-performance computing, massive data storage, data visualization, and required budgets. Additionally, the NEH “Data Management Plan Guidelines” require applicants to detail how they will ensure timely data access and data retention periods [18]. These measures aim to plan and design scientific data management in advance, ensuring data accuracy and reliability, improving data usability and shareability, and promoting the value and objectives of open public data utilization.

In project applications, DMP planning and resource allocation are critical components. The USGS data management plan checklist covers review content related to project applications, including project timelines, data collection plans and budgets, data management funding, data sharing restrictions, and deadlines for accessing shared data. This review content essentially plans and arranges the resources and expenditures needed for effective scientific data management. Therefore, adequate consideration and planning of DMP content in project applications are essential.

Data management requires certain funding and human resources, making the demonstration of data management’s role and function an important rationale for supporting data sharing. Data sharing is not only conceptually reasonable but also maximizes the utilization of scientific data management outcomes, improving data usability and shareability. The ESRC “Research Data Policy” and “Data Management Plan: Guidance for Peer Reviewers” recommend considering anticipated difficulties in data sharing and proposing solutions whenever possible. For example, discussing data sharing and reuse with research participants to obtain explicit consent; anonymizing data by removing personal and disclosive information; and managing data access permissions [19]. These measures protect data rights while promoting data sharing and utilization, achieving the value and objectives of open public data utilization. Therefore, the balance between data sharing and data rights protection must be fully considered during data management to maximize data utilization and value.

Data management plans play an important role in project management by clarifying relevant content, including data submission and storage, sharing and openness, and rights protection. The ANDS DMP awareness points require detailed descriptions of data cleaning methods, budgets, and bibliography management approaches. The tenth requirement asks: What bibliography management tool will be used? How will reference information be shared with other group members? These requirements help ensure data accuracy and reliability, improving data usability and shareability, and promoting the value and objectives of open public data utilization. Therefore, these aspects must be fully considered when developing DMPs to ensure effective data management and value.

As an essential component of project applications, data management plans

have gained widespread adoption and recognition internationally, integrated with project management. This management approach has been validated through practical experience in scientifically advanced countries. Through detailed DMPs, the value of open scientific data utilization can be better realized, improving data sharing and reusability, and promoting scientific research progress and development.

6. Regulations on Project Data Collection

Debates exist regarding whether data is worth collecting, processing, storing, and investing project resources in. Some argue that excessive support for data management resources consumes resources needed for scientific research itself, while others believe that scientific data, as an essential component of scientific research, currently receives insufficient investment. However, in actual research practice, project data collection issues are unavoidable, involving project application review, negotiation conditions, and policies supporting and encouraging data cleaning, archiving, dissemination, and storage practices. Therefore, a balance must be struck between the value and objectives of open public data utilization to ensure data accuracy and reliability, improve data usability and shareability, while avoiding resource waste and reduced research efficiency.

In some DMPs, evaluating existing data and potentially new data is significant for both project management and scientific data management. The ESRC “Data Management Plan: Guidance for Peer Reviewers” recommends evaluating existing data, including considering whether secondary data sources have been assessed, whether reusable existing data resources are available, and whether copyright licenses have been obtained to share data or derived data. Simultaneously, new data-related information must be considered, such as data collection methods, data analysis, and storage formats, to ensure data accuracy and reliability and improve data usability and shareability. The focus of data evaluation in DMPs is determining what data exists and how data sharing and reuse will be conducted in the future, helping to achieve the value and objectives of open public data utilization.

Another core issue in project data collection is data sustainability—whether data can be collected and supplied long-term. This involves data reproducibility and the ease of data generation. The USGS data management plan checklist addresses project data collection issues, including data collection methods, data types and sources, and data storage and backup arrangements. These issues relate not only to project data collection but also to pre-planning and preparation for data value and generation. In the process of open public data utilization, data sustainability and long-term utilization value must be fully considered to ensure data accuracy and reliability, improve data usability and shareability, and further promote the value and objectives of open public data utilization.

7. Third-Party Storage Regulations

Public data storage locations can be diverse, possibly stored in researchers' laboratories or studios, backed up in institutional repositories or data centers, or stored in disciplinary repositories or domain data centers after processing. According to scientific data management policies and implementation measures, data can also be submitted to national-level data management platforms. These different storage methods reflect the value and objectives of open public data utilization—improving data usability and shareability. When selecting storage methods, data characteristics, usage frequency, and security requirements must be considered to ensure data accuracy and reliability while facilitating data sharing and reuse.

Some DMPs list requirements and eligibility criteria for data storage platforms or remind researchers to reference these requirements when developing DMPs. For example, the “UK Data Archive Guidelines” and ESRC “Data Management Plan: Guidance for Peer Reviewers” recommend adapting to the UK Data Service’s data sharing and storage preparation and archiving plans, ensuring proper data documentation to provide high-quality environmental information and structural metadata for secondary users [20]. These requirements aim to improve data usability and shareability, promoting the value and objectives of open public data utilization. Therefore, these requirements must be fully considered when developing DMPs to ensure data accuracy and reliability for better data sharing and reuse.

Some third-party data management platforms also commit to scientific data management based on DMPs to safeguard the value and objectives of open public data utilization. For example, the Inter-university Consortium for Political and Social Research (ICPSR) DMP template includes storage and backup statements to protect information security and ensure data usability [21]. By storing original digital files in archives and institutional repositories and storing multiple copies with partner organizations at designated locations, off-site synchronization is achieved, further improving data reliability and shareability. These measures help ensure long-term preservation and open utilization of public data, promoting scientific research progress and development.

Some DMP guidelines propose requirements for selecting appropriate third-party storage and open sharing options or require researchers to at least consider and explain these options. For instance, the NEH “Data Management Plan Guidelines” require DMPs to describe various resources and facilities for effectively preserving research data, including third-party facilities and institutional repositories, to facilitate data storage and access [22]. These requirements aim to ensure long-term preservation and open utilization of public data, improving data sharing and reusability, and further promoting scientific research progress and development. Therefore, these factors must be fully considered when selecting third-party storage and sharing platforms to ensure data accuracy and reliability while maximizing data utilization and value.

For DMPs, third-party storage's core lies in whether data can be securely backed up and access services provided externally. The USGS data management plan checklist emphasizes the importance of data storage and backup strategies when addressing project data collection, including data storage locations, backup storage media and locations, backup retention periods, and data access timing. These issues reflect the value and objectives of open public data utilization—ensuring data accuracy and reliability, improving data sharing and reusability. Third-party storage must also consider the feasibility of long-term data preservation and how to store data in secure and reliable data centers. The ANDS DMP awareness points require describing data storage locations, hardware cost payers, and data managers, and propose reliable regular backup strategies, including off-site backups, to ensure long-term preservation and open utilization of data.

Some DMPs focus primarily on data generation and dataset formation requirements and how to incorporate these requirements into project management to form scientific data management processes. Other DMPs emphasize the convenience and reliability of scientific data submission, storage, management, long-term preservation, open access, and use. These plans reflect main considerations in some DMPs, while specific details are embodied in data storage platform evaluations. During evaluation, considerations must include specifications for submitting and transferring to national data center platforms, including metadata and dataset requirements, as well as disciplinary differences and characteristics of data center dataset processing. Overall, these requirements are compatible and aim to improve the value and objectives of open public data utilization, promoting scientific research progress and development.

Conclusion

The Data Management Plan (DMP) is a safeguard measure for implementing national scientific data management regulations, holding significant importance for realizing the value and objectives of open public data utilization. During project application, the management approach for data generated during and after project execution must be considered to ensure data standardization and usability.

The core elements of a DMP are identifying responsible personnel and plan content. Responsible personnel are key to implementation, needing to manage different stages of scientific data management to ensure standardization and security. Plan content should include data types, data and metadata formats, sharing and access policies, and preservation plans to ensure data usability and sustainability.

DMP formulation and implementation facilitate the execution and evaluation of project outcome reports and serve as important content in project application reviews. Additionally, project data collection regulations must consider data evaluation, data sustainability, and third-party storage regulations to ensure

data quality and reliability.

During evaluation, specifications for organizing and transferring to national data center platforms must be considered, along with disciplinary differences and characteristics of data center dataset processing. This helps ensure data standardization and normalization, improving data utilization efficiency and effectiveness.

Data management plans and evaluation are crucial components of open public data utilization. Through developing comprehensive systems and standards, data quality and reliability can be ensured, data sharing and circulation promoted, and the value and objectives of open public data utilization realized.

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