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Entry

Data Management and Sharing Plans

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Definition

Data Management and Sharing Plans (DMSPs) are formal research-governance documents that describe how data and other research products will be generated or acquired, organized, documented, protected, stored, preserved, shared, and made accessible during and after a research project. DMSPs connect research products with responsible personnel, metadata and documentation practices, repository and preservation strategies, access conditions, reuse expectations, and sponsor or institutional requirements. Contemporary DMSPs increasingly address heterogeneous products—including experimental data, qualitative materials, software, computational models, multimedia, protocols, and other digital or physical outputs—rather than a single undifferentiated concept of "data." Their functions extend beyond compliance: sound planning supports research integrity, reproducibility, appropriate reuse, collaboration, and long-term stewardship. Recent U.S. federal implementations have also shifted DMSPs from free-form narrative documents to structured, product-level decision systems, increasing accountability and the need for coordinated support from investigators, research administrators, librarians, data stewards, repositories, compliance specialists, and information-technology professionals.

Keywords: data preservation; DMSP; FAIR data; metadata; open science; research data management; research governance; research products; research software

1. Introduction and Historical Development

In the United States, contemporary Data Management and Sharing Plans (DMSPs) evolved from earlier Data Management Plan (DMP) requirements. This evolution occurred as scholarly outputs became increasingly digital, computational, and collaborative, while research sponsors placed greater emphasis on the preservation, accessibility, sharing, and reuse of publicly funded research products. The National Science Foundation (NSF) required DMPs in selected programs at least as early as 2008 [1], while the NSF-wide requirement took effect for all full proposals submitted or due on or after 18 January 2011, formalizing expectations for the management and sharing of research products [2]. The 2013 Office of Science and Technology Policy (OSTP) memorandum, Increasing Access to the Results of Federally Funded Scientific Research, later expanded the federal policy context by directing major research agencies to develop plans to increase public access to federally funded publications and digital scientific data [3]. NSF responded with its 2015 public-access plan, Today's Data, Tomorrow's Discoveries [4], while the 2022 Nelson Memorandum further extended federal public-access expectations toward immediate accessibility of federally funded research results [5]. Earlier data-management practices often remained

Check for updates

Academic Editors: Kamran Munir, José Raúl Romero and Khalid Hafeez

Received: 21 September 2026
Revised: 3 November 2026
Accepted: 18 November 2026
Published: 23 November 2026

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embedded within laboratories, archives, or disciplinary conventions. Contemporary DMSPs make many of those practices explicit by requiring researchers to specify what will be produced, how it will be documented and preserved, what can be shared, under what conditions, and who is responsible for implementation [6].

Although this Entry frequently discusses DMSPs in the context of sponsored research because funder requirements have been a major driver of their formalization and adoption, data management and sharing planning is not inherently limited to grant-funded projects. DMSPs may also support independently funded research, institutional initiatives, research collaborations, consortia, and other projects in which participants need to coordinate responsibilities for creating, documenting, stewarding, accessing, preserving, and reusing research products [7].

In the United States, NSF expanded its public-access framework through the 2015 plan *Today's Data, Tomorrow's Discoveries*, which linked publication and research data dissemination to the agency's mission of advancing scientific progress [8].

The National Institutes of Health (NIH) subsequently adopted a comprehensive DMSP policy, effective in 2023, requiring plans for scientific data management and appropriate sharing across covered NIH-funded research [9]. These developments occurred within a broader open-science movement that treats research outputs as interconnected parts of the scholarly record [10,11].

NASA also situates data management within a broader open-science strategy and has described its approach as a long-term commitment to building an open-science community over the coming decade [12].

The U.S. Department of Defense (DoD) approaches data management through a formal stewardship framework that assigns defined roles and responsibilities across the data lifecycle and emphasizes accountability, access, availability, and appropriate data sharing and use [13].

Comparable data-management planning requirements have also emerged internationally, although their terminology and implementation differ across funding systems. Under Horizon Europe, research data management (RDM) is a mandatory open-science practice for projects that generate or reuse data, and beneficiaries are expected to develop and update a DMP during project implementation [14]. In Canada, the Tri-Agency Research Data Management Policy similarly treats DMPs as living documents and requires them for designated funding opportunities. Canadian [15] DMPs address data collection, documentation, formatting, protection, preservation, sharing, repository deposit, and the assignment of data-management responsibilities, while also accounting for ethical, legal, commercial, and methodological constraints. The policy further specifies that research conducted by and with First Nations, Métis, and Inuit communities should involve co-developed DMPs that recognize Indigenous data sovereignty and accommodate community-accepted research-data-management principles. In Australia, the Australian Research Council (ARC) [16] has required researchers to address the management of research data since 2014 and, since 2020, has required a data management plan to be in place before funded projects commence. ARC guidance emphasizes planning for how research data will be collected, formatted, described, stored, and shared throughout and beyond the project lifecycle.

These international approaches show that data management planning is part of a broader shift toward lifecycle-based stewardship. Across funding systems, researchers are increasingly expected to clarify responsibilities, access, preservation, sharing, and reuse. Open science does not require unrestricted access to every research product; rather, DMSPs should make the conditions governing access and reuse explicit while accounting for ethical, legal, technical, security, intellectual-property, community, and contractual constraints.

Nongovernmental funders and research-data infrastructures also shape DMSP practice. Wellcome, requires applicants to consider the management and sharing of anticipated data, software, and materials and, where relevant, to provide an outputs management plan that is reviewed throughout the research lifecycle [17]. Repositories and data services further operationalize these expectations by establishing requirements for documentation, metadata, access conditions, preservation, and reuse. For example, ICPSR [18] requires deposited datasets to be accompanied by sufficient documentation and study-level metadata to support interpretation and reuse and provides mechanisms for both public and restricted access.

The Findable, Accessible, Interoperable, and Reusable (FAIR) Guiding Principles provide a widely adopted vocabulary for describing desirable characteristics of scholarly digital objects and their metadata [19]. FAIR does not mean "open"; authentication, authorization, and other access controls can coexist with FAIRness when restrictions are justified, and metadata remain sufficiently discoverable. Data management planning is therefore closely linked to FAIR stewardship, repository infrastructure, metadata standards, persistent identifiers, and data citation [20].

Restricted or controlled access does not necessarily prevent a research product from being FAIR [21]. To support Reusability, metadata should clearly describe the conditions governing reuse, including applicable licenses or terms of use, provenance, and procedures for obtaining authorized access [22]. Where direct public access is inappropriate, metadata can identify mechanisms such as access requests, controlled-access repositories, data-use agreements, eligibility requirements, or designated contact points. Accordingly, access restrictions should be accompanied by sufficient information for prospective users to determine whether, under what conditions, and through what process reuse may be permitted.

DMSP requirements and practices vary across sponsors, disciplines, and collaborative contexts. Williams et al. [23] found that funder requirements often emphasize downstream data sharing more strongly than upstream practices affecting data quality, traceability, and reproducibility. Practical guidance therefore recommends addressing data management early in a project, including responsibilities, documentation, quality assurance, preservation, and sharing procedures [24].

2. Purpose and Core Functions

DMSP structures vary across sponsors, disciplines, and project contexts, and no single organizational scheme applies universally. Federal agencies and other funders may emphasize different elements, use different terminology, or revise required formats over time. Table 1 therefore synthesizes recurring DMSP functions rather than proposing a fixed taxonomy. The categories are intended to organize common planning concerns and representative product-level questions that can be adapted to specific funder, institutional, disciplinary, or collaborative requirements (see Table 1).

Several of these components, particularly metadata, standards, rights, and accountability, require further specification because their implementation varies across disciplines, jurisdictions, and research infrastructures.

At the institutional level, public access to research data is not only an investigator concern. The AAU/APLU Guide to Accelerate Public Access to Research Data, informed by participants from 111 institutions, emphasizes that effective sharing depends on institutional systems, infrastructure, support, policy, and coordination [25]. Consequently, DMSPs can expose dependencies that proposal narratives may otherwise leave implicit: repository services, preservation capacity, privacy review, licensing, cybersecurity, storage, persistent identification, and data-curation expertise.

Table 1. Core DMSP components and their principal functions.

Component	Principal Function	Typical Questions
Roles, accountability, and rights	Identifies investigators, team members, institutional support roles, repositories, and, where applicable, data owners, rights holders, or other parties with legal or contractual authority over research products; assigns responsibility for management activities and identifies who may authorize access, licensing, sharing, or reuse.	Who manages, reviews, deposits, and monitors each product?
Data and research products	Defines what will be generated, collected, reused, or retained.	What products exist, in what volume, and with what provenance?
1-3 Formats, metadata and documentation	Specifies documentation practices, metadata schemas, persistent identifiers, data dictionaries, controlled vocabularies, taxonomies, ontologies, file-naming and versioning conventions, and relevant disciplinary or community standards to support interpretation, interoperability, discovery, and reuse.	Which formats, metadata, codebooks, README files, and naming conventions are needed?
Access and restrictions	Defines who may access products and why limitations apply.	Is access open, controlled, aggregated, embargoed, or request-based?
Storage and preservation	Separates active working storage from durable stewardship.	Where will products be stored during the project and archived afterward?
Sharing and reuse	Defines dissemination, licensing, citation, and reuse conditions.	When will products be shared, under what license, and with what identifier?
Standards and compliance	Aligns practices with disciplinary, sponsor, ethical, and institutional requirements.	Which metadata, repository, security, or regulatory standards apply?

Note. Personal elaboration.

A useful way to interpret the DMSP is to distinguish three related but different objects. First, the research product is what is being managed (for example, survey responses, source code, images, interview transcripts, computational models, samples, or presentations). Second, the management action is what is done to that product (for example, document, validate, de-identify, version, convert, back up, preserve, license, or disseminate). Third, the infrastructure is the technical or organizational environment through which the action occurs (for example, institutional storage, GitHub version 2026-03-10, a disciplinary repository, an institutional repository, or a data enclave). Confusing these levels can produce weak plans: placing files in a cloud drive is not itself a preservation strategy, and using GitHub does not by itself establish openness or archival persistence.

3. Data and Research Products

The scope of a DMSP begins with a clear definition of the products subject to management. Traditional discussions often use "data" as shorthand for measurements, observations, survey responses, or experimental results. Contemporary research, however, produces a broader range of objects, including datasets, samples, images, audio, video, qualitative transcripts, software, algorithms, computational notebooks, simulation outputs, machine-learning models, protocols, workflows, curricula, documentation, and publications. The specific products encompassed by a DMSP may vary across funders, disciplines, and project contexts. For example, NSF Engineering (NSF Directorate for Engineering. *ENG Data Management and Sharing Plan Guidance-Directorate for Engineering (ENG)*. National Science Foundation, 2024. Source: https://www.nsf.gov/eng/data-management-sharing-plans.

Accessed 2 November 2026) provides discipline-specific guidance that explicitly asks investigators to identify data, metadata, samples, software, algorithms, curricula, documentation, publications, and other materials generated during a project.

This broader framing matters because different research products require different management pathways. A survey dataset containing personally identifiable information may require restricted access and de-identification. A physical artifact may require digitization, chain-of-custody documentation, or eventual disposal. Source code may require version control, dependency documentation, a license, and an archival release. A computational model may require parameter definitions, configuration files, validation routines, and the simulated outputs needed to reproduce published figures. Treating all products as one generic category can hide these differences and can cause restrictions that apply to one product to be incorrectly extended to unrelated products.

Research software illustrates the shift particularly clearly. FAIR4RS extends FAIR concepts to source code, algorithms, scripts, computational workflows, and executables created for research purposes, emphasizing unique identifiers, version-specific identification, rich metadata, standardized retrieval, interoperability, licensing, and reuse [26]. This treatment recognizes software as a first-class research object rather than merely a technical accessory to "the data."

Provenance is equally important. A project may combine newly generated products, previously collected datasets, public data resources, licensed commercial data, collaborator-supplied materials, or products derived from shared facilities. These sources can have different reuse rights, documentation quality, confidentiality obligations, and repository options. A DMSP therefore benefits from recording not only what a product is, but where it came from, what conditions follow it through the research lifecycle, and what collaborative responsibilities or dependencies may shape its management and reuse (see Table 2).

Table 2. Examples of research products and typical management considerations.

Research Product	Typical Management Considerations	Possible Dissemination Outcome
Experimental or observational data	Calibration, quality assurance, units, instrument metadata, file formats, provenance.	Repository deposit with metadata and DOI or accession number.
Survey or interview data	Consent, PII, de-identification, codebooks, controlled access, retention.	De-identified dataset, controlled repository, or aggregated findings.
Multimedia and artifacts	Digitization, descriptive metadata, copyright, accessibility, storage capacity.	Repository or institutional collection with rights metadata.
Software and code	Version control, dependencies, license, documentation, testing, release archiving.	Public or controlled repository plus stable archival release.
Computational models and simulations	Model definitions, parameters, configuration, uncertainty, validation, reproducibility scripts.	Model/code release plus archived outputs supporting publications.
Commercial or proprietary inputs	IP, patent timing, contracts, partner permissions, confidentiality.	Restricted raw inputs; public derived products when permitted.

Note. Personal elaboration.

4. Documentation, Metadata, and Standards

Documentation makes a research product intelligible beyond the immediate team. At minimum, documentation should explain what a product represents, how it was created or collected, relevant variables or parameters, units, file structure, software requirements, transformations, quality-control procedures, and known limitations. README files, data dictionaries, codebooks, workflow descriptions, laboratory protocols, and provenance records are common mechanisms. In computational research, documentation may addi-

tionally include package versions, operating-system assumptions, random seeds, training configurations, checkpoint descriptions, and instructions for reproducing figures or tables.

Metadata standards improve consistency and machine interpretability. The FAIR principles emphasize persistent identifiers, rich metadata, searchable registration, formal knowledge representation, qualified references, usage licenses, provenance, and domain-relevant standards [19]. FAIRsharing documents relationships among community standards, repositories, and policies and highlights a practical problem researchers face: many standards exist, adoption is uneven, and selection often requires disciplinary expertise [27]. Interpretive work on FAIR further emphasizes that implementation depends on context and community practice rather than on a single universal technical recipe [28].

Interoperability involves more than the use of nonproprietary file formats [29]. Where appropriate, DMSPs should identify disciplinary metadata schemas, controlled vocabularies, taxonomies, and ontologies that provide shared meanings and machine-readable relationships among concepts. Such semantic resources support the FAIR Interoperability principles by enabling data and metadata to use formal knowledge-representation languages, shared vocabularies, and qualified relationships with other digital objects. They are particularly important when research products are expected to move across repositories, computational systems, disciplines, or research communities.

FAIR assessment has itself become more systematic. Wilkinson and colleagues proposed a scalable, community-governed approach based on measurable maturity indicators and compliance tests [30], while the Research Data Alliance FAIR Data Maturity Model provides indicators intended to harmonize assessment approaches [31]. These developments are relevant to DMSPs because they make previously implicit quality expectations more explicit and machine-evaluable.

Descriptive practice also draws from older traditions in libraries, archives, museums, and special collections. Cataloging guidance for cultural objects demonstrates the importance of consistent descriptive fields, shared vocabularies, and context for unique materials [32]. Archival practice likewise emphasizes appraisal, organization, description, custody, and long-term access [33]. DMSPs extend these stewardship traditions into contemporary research workflows, where many products are born digital and may need to remain interpretable across changing software and platforms.

5. Storage, Preservation, and Repository Infrastructure

Active storage and long-term preservation serve different purposes. Active storage supports day-to-day research, collaboration, backup, and access control. Preservation seeks to maintain the usability, integrity, authenticity, and accessibility of selected products beyond the immediate project. A DMSP should therefore avoid treating a laboratory file server, cloud drive, or development platform as automatically equivalent to an archival repository.

The TRUST Principles provide a useful framework for evaluating digital repositories through Transparency, Responsibility, User Focus, Sustainability, and Technology [34]. Preservation guidance also emphasizes risk assessment, file-format sustainability, checksums, replication, documentation, migration, and organizational responsibility [35]. These considerations are especially important when a project promises availability for periods extending beyond the grant, the employment of particular personnel, or the commercial life of a specific software platform.

Repository selection should reflect the product type, disciplinary expectations, access requirements, metadata support, preservation policy, licensing, identifier practices, and cost. Disciplinary repositories are often preferable when they provide community-specific metadata and discovery. General-purpose or institutional repositories can be appropriate when no disciplinary repository exists. Persistent identifiers such as DOIs or accession

numbers support durable citation and linking between publications and research products. Fenner and colleagues provide a repository-oriented roadmap for implementing data citation, including machine-readable metadata and persistent landing pages [36]. Empirical work has also identified a citation advantage for publications linked to research data, although citation effects vary by field and should not be treated as the sole justification for sharing [37].

Preservation decisions also require appraisal. Not every temporary, intermediate, or redundant file must necessarily be retained indefinitely. The DMSP should identify which products are necessary to validate findings, reproduce analyses, enable legitimate reuse, document provenance, meet legal or contractual obligations, preserve outputs of continuing scholarly value, and support the governance, traceability, agreements, and collaborative responsibilities established among project participants. The retention period should then be aligned with repository policies, sponsor requirements, consent, institutional policy, community of practice agreements, and disciplinary norms.

6. Access, Sharing, Reuse, and Restrictions

Data sharing is not a binary choice between fully open and fully closed. DMSPs may describe open access, controlled access, restricted access, embargoes, request-based access, or public dissemination of aggregated or de-identified derivatives. The appropriate model depends on the nature of the product and the basis for restriction. Privacy, confidentiality, informed consent, intellectual property, patent strategy, commercial agreements, export controls, national security, community governance, and technical feasibility can all influence access.

The distinction between access level and restriction basis is important. Two products can both be "restricted" while requiring different governance. Human-subject data may be restricted to protect participants; commercially sensitive data may be restricted to protect contractual or patent interests. Good DMSPs therefore explain why a restriction applies and, where possible, whether transformation can permit broader dissemination. Common transformations include de-identification, aggregation, removal of restricted fields, digitization, format conversion, and creation of derived datasets.

Open-science literature emphasizes that sharing should increase the availability and usability of research products while maintaining responsible governance [38]. The CARE Principles for Indigenous Data Governance demonstrate why openness cannot be treated as an unconditional universal value: collective benefit, authority to control, responsibility, and ethics may need to be considered alongside FAIR objectives [39]. Thus, "as open as possible, as closed as necessary" is best understood as a governance problem rather than a slogan.

Licensing and citation further shape reuse. A product without an explicit license may be technically accessible but legally ambiguous. A product without sufficient provenance or documentation may be downloadable but not reusable. DMSPs should therefore coordinate access with licensing, metadata, identifiers, and citation expectations. These elements help users understand what may be done with a product and how credit should be assigned.

7. Roles, Accountability, and Research Support

DMSPs distribute responsibility across the participants, institutions, and infrastructures involved in a project or research ecosystem. Investigators remain responsible for ensuring that the plan is scientifically appropriate and implemented, but effective stewardship may involve co-investigators, research staff, data managers, librarians, archivists, compliance personnel, information-security specialists, research software engineers, institutional repository staff, sponsored-research administrators, and external collaborators. The

composition of this support network should reflect the risks and products of the project rather than a fixed organizational template.

The growing specificity of DMSP requirements increases the relevance of librarians and data stewards. Repository selection, metadata standards, preservation policies, data citation, persistent identifiers, and licensing are specialized areas that may fall outside faculty's routine methodological training. The AAU/APLU guide treats data sharing as an institutional systems problem [25], and the machine-actionable DMP literature explicitly identifies data librarians, research administrators, repository managers, funders, and investigators as stakeholders in the DMP ecosystem [40].

In collaborative proposals, investigators are also expected to describe the roles and responsibilities of all parties and contingency plans for changes in personnel. This does not make every collaborator legally responsible for the award; rather, it makes product-level stewardship responsibilities explicit within the project's governance structure.

Structured DMSP systems can clarify what information researchers are expected to provide, but they do not eliminate the expertise required to make high-quality stewardship decisions. A "yes" response to public archiving, for example, still requires decisions about repository suitability, metadata, licensing, preservation duration, cost, accessibility, and deposit responsibility. Research institutions therefore need more than templates or structured forms; they also require training, consultation, and cross-functional support that enable investigators and project participants to interpret requirements and translate them into appropriate management practices.

This distinction becomes increasingly important as DMSPs evolve from narrative documents to structured, machine-actionable forms. Such systems can improve consistency, interoperability, and integration with research workflows, but their effectiveness still depends on the quality of the decisions, responsibilities, and metadata they represent.

The Contributor Roles Taxonomy (CRediT) provides a related but distinct approach to documenting responsibility [41]. CRediT defines 14 standardized contributor roles, including Data Curation, Project Administration, Software, Resources, and Validation, and is primarily intended to make individual contributions to research outputs more transparent [42]. DMSPs generally serve a different function: they assign or describe responsibility for the stewardship of data and other research products rather than provide a standardized taxonomy of scholarly contributions. Some DMSP platforms allow contributors to be identified through roles such as Principal Investigator, Data Manager, or Project Administrator, but these roles are not equivalent to the CRediT taxonomy. In sponsored research, detailed personnel roles and levels of effort may also be documented elsewhere in the proposal or project documentation. CRediT can therefore complement, rather than replace, the accountability mechanisms established through a DMSP.

Integrating clearer role descriptions into DMSP practice could therefore strengthen accountability, particularly in collaborative projects where stewardship responsibilities are distributed across multiple participants.

8. Structured and Machine-Actionable DMSPs

DMSPs are evolving from free-form narrative documents toward structured and machine-actionable representations. Machine-actionable DMPs (maDMPs) are designed so that information can be exchanged among proposal systems, funders, repositories, institutional systems, and research workflows rather than being trapped in a PDF [40]. The RDA DMP Common Standard provides a metadata application profile intended to support interoperability across systems over the full DMP lifecycle [43].

This evolution has become visible in U.S. federal implementation. In 2026, NSF replaced the uploaded PDF workflow for new proposals with a web-based Research.gov DMSP tool

organized around data or research-product categories and structured fields (NSF. *Preparing Your Data Management and Sharing Plan-Funding at NSF*. National Science Foundation, 2023. Source: https://www.nsf.gov/funding/data-management-plan. Accessed 2 November 2026). NIH also introduced a simplified 2026 DMS Plan format in which several central requirements are expressed as yes/no questions, with narrative explanation required when sharing will be limited or when other details are necessary [44,45].

Structured planning can reduce administrative burden, improve consistency, support monitoring, and create information that can be reused in repositories or reporting systems. It can also expose new governance questions. When institutions assign responsibility at the product level, they must consider how accountability persists when personnel change, how commitments are monitored during and after a project, and which support units manage metadata, repository deposit, preservation, or controlled access. NSF connects DMSP implementation to subsequent reporting and proposal review. Current NSF policy integrates research products and persistent identifiers into project-reporting systems, while the PAPPG [46] requires applicable future proposals to document the availability of research products arising from prior NSF support, including products described in a DMSP [47,48]. Directorate-level guidance may provide additional implementation detail; for example, NSF MPS requires annual and final project reports to describe how the DMSP was carried out and to document changes made during the project [49].

Artificial intelligence may become part of the DMSP environment by helping researchers interpret requirements, apply terminology, suggest metadata, document workflows, or draft responses. However, automation does not transfer accountability. Investigators and recipient institutions remain responsible for the accuracy, feasibility, ethical appropriateness, and implementation of commitments represented in a DMSP. AI-generated language not grounded in actual project practices may therefore increase, rather than reduce, compliance and governance risks. The effective use of AI in DMSP development is thus not only a technical issue but also a matter of training, oversight, and institutional responsibility.

These considerations vary across disciplines, funding environments, and collaborative settings. The following section examines how DMSP principles are applied across different research contexts.

9. Applications Across Research Contexts

DMSPs are inherently contextual. Their structure may be sponsor-defined, but the substantive content should reflect the research products, risks, disciplinary conventions, collaborators, and intended uses of a particular project. A transdisciplinary collaboration may need to coordinate heterogeneous outputs and vocabularies across institutions; an educational conference may generate surveys, participatory artifacts, presentations, and recordings; an innovation or commercialization project may collect customer-discovery interviews subject to confidentiality or intellectual-property constraints; and a computational project may generate code, models, parameters, workflows, and large simulation outputs.

Transdisciplinary research makes the communicative role of DMSPs especially visible. Effective transdisciplinary collaboration depends on integrating heterogeneous expertise and sustaining communication across disciplinary and stakeholder boundaries [50]. Communication processes, trust, group dynamics, definitions, and shared understandings shape teams' ability to integrate knowledge [51]. Transdisciplinarity has also been described as both a mode of inquiry and a practice that requires negotiation across disciplinary boundaries [38], while reviews across applied fields show continued variation in how multi-, inter-, and transdisciplinary collaboration are defined and implemented [52].

From this perspective, the DMSP can function as a boundary-spanning coordination artifact. It externalizes decisions about what counts as a research product, how products

are named and organized, which standards apply, who may access them, and who is responsible for specific activities. These explicit representations can reduce ambiguity among collaborators. They do not eliminate conflict or guarantee effective collaboration, but they create a shared reference point for managing research products across organizational and disciplinary boundaries [53].

Publicly available DMSPs illustrate this contextual variation (see Supplementary Materials). For example, one DMSP developed for a transdisciplinary communication network identifies scholarly articles, systematic-review resources, multimedia, communications, protocols, templates, and bibliographic products, emphasizing organization, metadata, role assignment, and dissemination [54]. A second example, developed for a conference-focused project, distinguishes confidential survey responses, digitized World Café artifacts, and public presentation materials, applying different access and transformation pathways to each [55]. A third example, developed for an NSF I-Corps project, centers on customer-discovery interviews, notes, surveys, and market intelligence, with particular attention to personally identifiable information, confidentiality, intellectual property, controlled access, and an eventual public report [56]. These examples show that the scientific domain alone does not determine a DMSP's structure; the project activities and research products involved shape the relevant stewardship requirements.

In collaborative projects not organized primarily around a funding requirement, a DMSP can also serve as a governance document for coordinating stewardship of shared research products. Project participants may use the plan to define responsibility for documentation, storage, access, preservation, sharing, and reuse, while complementary governance agreements can establish broader decision-making and collaborative responsibilities. In these contexts, CRediT can provide an additional structured vocabulary for documenting individual participants' contributions. Combining stewardship responsibilities with contributor-role information may improve transparency and traceability in projects where data, analysis, writing, software, and other responsibilities are distributed across multiple collaborators. CASRAI further notes that machine-actionable DMP implementations can encode persistent identifiers and contributor-role vocabularies, including ORCID, ROR, and CRediT, as structured metadata that can be reused across repositories and research-information systems [57].

These principles become especially visible in computational research, where data, code, models, documentation, repositories, and reproducibility requirements must be coordinated across the research lifecycle.

10. Practical Example: Computational Research

A computational research project provides a useful practical example because its principal products may not resemble a conventional laboratory dataset. Consider a project that develops stochastic mathematical models, numerical simulations, neural surrogate models, parameter sets, configuration files, validation routines, and model-generated outputs. An appropriate DMSP category could be "Computational Models, Simulation Code, and Model-Generated Data." The category should then identify the products needed to understand and reproduce reported findings rather than listing every temporary file generated during computation.

Documentation should describe the model purpose, equations or computational formulation, software dependencies, parameter definitions, units, configuration structure, inputs and outputs, validation procedures, and instructions for reproducing principal analyses. Use open, nonproprietary formats when practical: CSV or plain text for tabular outputs, JSON or YAML for structured configuration, native source formats for code, and Markdown or PDF for human-readable documentation. Git or an equivalent version-control system

can preserve development history, while tagged releases identify stable states associated with publications.

Select the infrastructure based on function. GitHub or a comparable development platform can support collaborative coding, version control, issues, and documentation, but it should not automatically be treated as the long-term preservation environment. A stable release can instead be deposited in an archival repository such as Zenodo or another disciplinary or institutional repository that provides persistent identifiers and preservation commitments. FAIR4RS reinforces the importance of version-specific identifiers, rich metadata, licensing, and reusability for research software [26].

The example also demonstrates why product categories should be separated when their access conditions differ. Publicly shareable simulation code and model-generated data may coexist with proprietary industrial parameters, licensed calibration datasets, or confidential experimental inputs. The DMSP should not apply a project-wide restriction merely because one input is restricted. Instead, it should specify the restriction basis for the affected product and identify what derived products can still be documented, archived, and shared.

A concise product pathway for the computational example is therefore: research product → documentation and metadata → versioning and validation → active storage and development → stable release → archival deposit → persistent identification → public or controlled access. Assign accountability to the investigator or senior personnel responsible for ensuring the release, documentation, and archival commitments are completed. This sequence is not a new standard; it is a practical synthesis of established DMSP, FAIR, software-stewardship, and repository practices [19,26,34].

11. Practical Issues and Limitations

Several recurring challenges limit the effectiveness of DMSPs. First, sponsor requirements and technical infrastructures evolve rapidly. A plan written at proposal submission may need revision when repositories change, new standards emerge, collaborators leave, or the scientific direction changes. NIH's 2026 implementation explicitly recognizes that plans should be updated over the project lifecycle [44,45], while NSF directorate-level guidance may require investigators to document DMSP implementation and changes during project reporting.

Second, researchers vary substantially in data-management expertise. Structured forms can improve consistency but may encourage superficial completion when investigators do not understand the implications of metadata, repository policy, licensing, access control, or preservation. Capacity building is therefore a necessary complement to automation [20,40]. Institutions that expect investigators to manage complex research products without access to data stewardship expertise risk creating plans that are formally complete but operationally weak.

Third, preservation has costs. Data preparation, documentation, curation, storage, controlled-access services, and long-term repository stewardship can require personnel and financial resources. Anticipate these costs during proposal development rather than discovering them at the end of an award. Repository sustainability also matters: long-term availability depends on organizational commitments, not simply on the existence of a web link [34,35].

Fourth, openness can conflict with legitimate ethical and legal obligations. Human-subject research, Indigenous data governance, commercial collaborations, and security-sensitive research may require limits on access or reuse. Responsible DMSPs document these limitations and, where possible, identify transformed or derivative products that can be shared without violating rights or agreements [39].

Finally, the relationship between DMSP quality and research quality should not be overstated. A detailed plan does not guarantee valid research, just as a brief plan does not necessarily imply poor science. Quality assurance, methodological validity, and appropriate interpretation remain discipline-specific responsibilities. In qualitative research, for example, validity, reliability, and generalizability require criteria appropriate to the research design rather than mechanical application of quantitative standards [58]. DMSPs support these practices by documenting them; they do not substitute for sound methodology.

12. Current Status and Future Directions

The current trajectory of DMSPs is toward greater integration with the research lifecycle. Machine-actionable standards make it possible for information entered during proposal development to be reused in institutional systems, repositories, reporting environments, and preservation workflows [40,43]. Persistent identifiers can connect investigators, awards, datasets, software, publications, organizations, and repositories. FAIR and FAIR4RS provide shared principles for data and software, while TRUST focuses attention on the repositories that sustain access [19,26,34].

The next challenge is organizational rather than purely technical. As structured DMSP systems make product-level decisions and accountability more explicit, research institutions must determine how investigators obtain appropriate support and how responsibilities are distributed across the award lifecycle. Librarians and data stewards are likely to remain important because metadata, repository selection, preservation, and citation are core professional competencies; research administrators can connect these requirements to proposal and award management; compliance and information-security personnel can address regulated or sensitive products; and research software specialists can support computational reproducibility.

Artificial intelligence may reduce some drafting and classification burden, but its productive use depends on reliable source information and human review. The mature goal for DMSP automation should therefore not be to generate persuasive text, but to improve the accuracy, consistency, traceability, and interoperability of stewardship decisions. DMSPs are increasingly better understood as maintained and versioned governance records rather than static documents fixed at the beginning of a project. They can function prospectively as planning instruments and retrospectively as living records that document changes in research products, responsibilities, access conditions, and stewardship decisions as a project evolves.

This function is particularly important in international and multi-institutional collaborations, where participants may operate under different legal, institutional, ethical, or funder frameworks. The DMSP provides a place to identify these requirements, determine which provisions govern particular research products or activities, document how potentially conflicting requirements will be reconciled, and establish agreed procedures for access, transfer, preservation, sharing, and reuse. In this sense, data governance becomes an explicit component of collaboration rather than an assumption left unresolved until data are exchanged or disseminated.

This does not imply that all elements of a DMSP are equally mutable. Legal and ethical constraints, participant-consent conditions, contractual obligations, funder requirements, and established rights may remain fixed or change only through formal approval, whereas operational details such as personnel assignments, repository selection, file formats, timelines, or technical workflows may require revision as project conditions change. When revisions are documented and appropriately governed, the DMSP can also support communities of practice by increasing transparency, preserving institutional

knowledge, and facilitating the induction of new participants into established project procedures and responsibilities.

13. Conclusions and Prospects

DMSPs have developed from relatively brief compliance documents into increasingly structured instruments for research governance. Their mature function connects research products with documentation, standards, infrastructure, access conditions, preservation, reuse, accountability, and reporting. This broader interpretation aligns with open-science and FAIR principles while accommodating legitimate limitations arising from privacy, confidentiality, community governance, intellectual property, security, and contractual obligations.

The growing diversity of research products makes product-specific planning essential. Experimental datasets, interviews, multimedia, software, models, and commercially sensitive materials cannot be managed through a single generic pathway. Likewise, infrastructure should not be confused with stewardship: cloud storage, version-control platforms, and repositories each support different functions. The quality of a DMSP therefore depends on the alignment among research products, management actions, infrastructure, standards, and accountable personnel.

Current NSF and NIH implementations illustrate a broader movement toward structured decision systems. This evolution can reduce ambiguity and administrative burden, but it also increases the need for researcher education and institutional support. Effective DMSPs are consequently best understood not as documents written by one investigator in isolation, but as maintained research-governance artifacts that coordinate investigators and specialized support professionals across the lifecycle of research products.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/encyclopedia6120266/s1, S1: DMSP for 'HSIELPSE; S2: DMSP for RCN; S3: DMSP for 'I-Corps.

Author Contributions: Conceptualization, C.L. and J.M.L.; investigation, C.L. and J.M.L.; resources, C.L.; writing—original draft preparation, C.L.; writing—review and editing, C.L. and J.M.L.; visualization, C.L.; supervision, J.M.L.; project administration, C.L. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: No new research data were created or analyzed for this encyclopedia entry. Publicly available policy documents, scholarly literature, and illustrative DMSPs cited in the reference list are available from their respective publishers, agencies, repositories, and persistent identifiers.

Acknowledgments: The authors acknowledge the research-data-management and scholarly communications communities whose public guidance and infrastructure support the development and implementation of Data Management and Sharing Plans. They also acknowledge the support of the staff at the Robert W. Van Houten Library at the New Jersey Institute of Technology. During the preparation of this manuscript, the authors used Grammarly version 6.8.263 and Microsoft Copilot version 2108 for language and grammar review and OpenAI ChatGPT version 5.6 for syntax, editorial refinement, and assistance in improving the organization and clarity of selected passages. These tools were not used to generate or analyze research data or determine the Entry's scholarly conclusions. The authors reviewed and edited all AI-assisted output and take full responsibility for the publication's content.

Conflicts of Interest: The authors declare no conflicts of interest.

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