SMART RESEARCH DATA MANAGEMENT (SRDM) IN THE AGE OF ARTIFICIAL INTELLIGENCE

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Abstract :

The growth of digital research has resulted in the creation of large and diverse datasets. Researchers now generate and use data from surveys, interviews, experiments, institutional repositories, online databases, digital platforms, and other sources. Proper management of such data is important because research findings depend not only on the quality of analysis but also on how the underlying data are organized, documented, stored, preserved, and shared.

This paper discusses the concept of SRDM and examines the potential contribution of AI at different stages of the research data lifecycle. It also considers major opportunities and challenges associated with AI supported RDM and highlights the changing responsibilities of academic librarians. The paper SRDM environment requires an appropriate balance between technological capabilities, human expertise, ethical practices, and institution support

Keywords : Research Data Management(RDM), Artificial Intelligence, Academic Libraries, Research Data Services, Data Literacy.

Introduction :

The research environment has changed considerably with the increasing use of digital technologies. Researchers working in different disciplines generate data in many forms, including numerical datasets, interview records, survey responses, experimental observations, digital documents, social media content, and information collected through online platforms. The growing volume and diversity of research data have made systematic data management an important part of the research process. RDM includes a range of activities associated with research data throughout its lifecycle. These activities may begin with planning and collection and continue through organization. Documentation, storage, preservation, sharing, and possible reuse. Effective management of these activities contributes to the accessibility, reliability, reproducibility, and long-term value of research data.

Traditionally, many RDM activities depended largely on researcher's individual

practices and institutional procedures. The emergence of Artificial Intelligence has introduced additional possibilities for improving several of these activities. AI applications can assist with tasks such as classifying large datasets, identifying duplicate or inconsistent records, generating descriptive metadata, detecting unusual patterns, and improving the discovery of research information.

The use of AI, however, should not be considered only from the perspective of efficiency. Research data may include confidential, sensitive, or personally identifiable information. The application of AI therefore raises important questions concerning privacy, Security, Ownership, bias, transparency, accountability, and responsible use. Decisions involving research data still require human oversight and professional judgment.

In this context, the concept of SRDM goes beyond the simple automation of existing procedures. It refers to an integrated approach in which digital technologies, AI applications, human expertise, ethical principles, and institutional policies work together. Academic libraries can become important partners in this environment by providing guidance on data organization, metadata, preservation, data literacy, open science, and responsible use of AI.

Review of Literature :

* **Research Data Management** : Academic libraries are increasingly involved in helping researchers organize, preserve, manage and reuse research data through the research process. Earlier studies mainly focused on how research data can be collected, organized, stored, preserved, shared, and reused. With the growth of AI, researchers and academic libraries are now exploring new more effective.

* **Cox and Pinfield (2014)** examined the development of RDM services in academic libraries. Their study showed that libraries were gradually becoming involved in research data support. Librarians can help researchers with data organizations can help researchers with data organization, documentation, storage, preservation, and related guidance. The study also pointed out that libraries need suitable skills and institutional support to provide effective RDM services.

* **Tenopir et al. (2012**) discussed the role of academic libraries in providing research data services. Their work showed that libraries can support researchers in areas such as data management planning, data storage, access, preservation, and sharing. The study also suggested that research data services can become an important part of the future role of academic libraries.

* **Pryor et al. (2013)** discussed the practical aspects of developing RDM services. Their work emphasized the importance of institution an, preservation, and cooperation between researchers and information professionals. This shows that RDM requires a coordinated approach rather than a single library activity.

Overall the literature shows that RDM, AI, academic libraries, and ethical data use are closely connected. However, an integrated framework that brings these areas together is still need. This provides the basis for the proposed smart Research data management framework in this paper.

Research Gap :

Several studies have discussed AI applications in libraries and research environments. Other studies have focused on RDM and the changing role of academic librarians. However, these areas are often discussed separately. There is still a need for a simple and integrated approach that connects AI, RDM, academic libraries, human knowledge, and ethical governance in one framework. Another important gap is that many discussions focus on what AI can do, but give less attention to how academic libraries can practically implement AI supported RDM services. Issues such as librarian competencies, data management planning, privacy, security, human oversight, and institutional policies also need more attention.

Therefore, this paper attempts to address this gap by presenting a conceptual framework for smart research data management. The proposed framework connects AI-supported data activities with human expertise, library services, and responsible data governance.

Objective of the Study :

The main objectives of this paper are :

1. To explain the meaning of smart research data management in the AI era.
2. To understand how AI can support different stages of research data management.
3. To identify the major benefits of AI-supported research data services.
4. To discuss the main challenges of using AI with research data
5. To understand the changing role of academic libraries and librarians.
6. To suggest practical steps for responsible and sustainable research data management.

Methodology :

The paper use a conceptual and descriptive approach**.** It is based on secondary information collected from research papers, reports, guidelines, another scholarly sources related to research data management, Artificial Intelligence, research libraries, and AI ethics.

The paper mainly focuses on how AI can support RDM and how academic libraries can contribute to this process.

Meaning of Smart Research Data Management :

RDM means taking care of research data from the beginning of a research project to its final use and preservation.

SRDM mans adds AI and other digital technologies to this process. It combines technology with human knowledge and institutional rules.

The concept can therefore be represented through five interconnected dimensions.

Data + Technology + AI + Human Expertise + Governance= Smart Research Data Management

A normal RDM system mainly helps researchers store and organized data. A smart RDM system can also help them classify data, search large collections, create metadata, check data quality, and identify useful patterns. The main purpose of SRDM is not to replace researchers or librarians. Its purpose is to reduce repetitive work and provide useful support. Human beings should continue to make important research decisions.

AI in different Stages of Research Data Management :

AI can support several stages of the research data process.

1. Data Collection :

The first stage is data collection. Large research projects may collect thousands of responses or records. AI - supported tools can help identify incomplete responses and unusual patterns. They can also help researchers organized large amounts of collected information However, automated collection must follow appropriate consent, privacy, and ethical requirements.

2. Data Organization and Classification :

Research projects often create many files and records. Finding and groaning these file manually can take a lot of time. AI can help make the data easier to manage and reduce routine manual work.

3. Metadata Creation :

Metadata is information that describes dataset. It helps users understand what a dataset contains and how it can be used. AI can suggest keywords, descriptions, and other basic metadata it can also help identify missing information. However, AI-generated metadata should be checked by a researcher or librarian before it is accepted. Human review is important because AI may not always understand the exact meaning of research data.

4. Data Quality and Cleaning :

Research datasets may contain missing information, duplicated records, inconsistent formats, or unusual observations. Al and machine learning tools can help identify these problems. They can point out unusual records and support the cleaning process. This can save

time and improve the quality of research data.

5. Data Storage and Preservation :

Research data should be stored safely and preserved for future use. Al can contribute to smarter storage management by identifying frequently accessed datasets, detecting unusual access patterns, and supporting preservation workflows. Combined with institutional repositories and trusted digital preservation practices, intelligent systems can strengthen long-term access to research outputs.

6. Data Discovery and Reuse :

One of the major advantages of intelligent RDM is improved discoverability. Al-powered search and recommendation systems can connect researchers with relevant datasets and related scholarly resources.

This can encourage interdisciplinary research and reduce unnecessary duplication of data collection.

Opportunities for Academic Libraries :

The growth of Al and research data creates significant opportunities for academic libraries. Libraries are traditionally known for providing books, journals, databases, and information services. Today, their role can extend to research data support. Research data management has become an important area for academic libraries. Earlier research also found that libraries were developing new research data services and policies, although skills, resources, and institutional support were important challenges

Academic libraries can provide the following services:

- Research Data Management guidance
- Data management plan support
- Metadata and data documentation services
- Metadata support
- Institutional repository services
- Research data discovery support
- Digital preservation service
- Data literacy programmes
- AI literacy programmes
- Guidance on responsible use of AI

These services can help researchers manage their data effectively.

Challenges of Smart Research Data Management :

AI can provide many benefits , but its use in RDM also creates challenges.

- **Privacy and Confidentiality :** Research datasets may contain personal, institutional, or sensitive information. Feeding such information into external Al systems without appropriate safeguards may create privacy risks. Researcher should understand which information can be used with AI tools and which information needs stronger protection.
- **Algorithmic Bias :** Al systems learn from available data. If training data contain bias, automated systems may reproduce or amplify that bias. Researchers therefore need to understand the limitations of Al-generated outputs.
- **Data Security :** Research data may move between computers, cloud storage, repositories, and AI applications. This increases the need for good security practices. Institutions should use suitable access controls, secure storage, and regular security checks.
- **Lack of Transparency :** Researchers should know when AI is being used in their research data process. They should also understand, as far as possible , how AI has influenced classification, cleaning, recommendations, or analysis.
- **Research Integrity :** Al can generate or modify research-related content and data. Therefore, institutions need clear policies concerning Al use, authorship, documentation, verification, and accountability.
- **Lack of Skills** : Researchers and librarians may have strong subject knowledge but may not have enough knowledge about AI and RDM. Training and continuous professional development are there for necessary.
- **Cost and Infrastructure** : SRDM requires appropriate hardware, software, secure storage, technical expertise, institutional policies, and financial resources. Smaller institutions may face difficulties in establishing such infrastructure.

Ethical Issues in Smart Research Data Management :

Technology alone cannot make RDM successful. Ethical practices are also necessary**.** Some important principles are :

- **Transparency** : Researchers should know when and how Al is being used.
- **Accountability** : Human responsibility should remain clear even when automated systems are involved.
- **Privacy** : Personal and confidential information must be protected.
- **Fairness** : Al-supported processes should avoid unfair treatment or biased outcomes.
- **Data Control** : Institutions and researchers should understand where their data are stored and who can access them.
- **Human oversight** : Important research decisions should not be delegated blindly to automated systems.

These principles are particularly important in social sciences and humanities, where research data may involve individuals, communities, social identities, and sensitive experiences.

Changing Role of Academic Librarians :

The role of academic librarians is changing with the growth of digital research and AI. Traditional library skills such as classification, cataloguing, reference service, and information retrieval continue to be important, However, librarians now also need knowledge of RDM, digital tools, and AI.

The academic librarian can work in several roles :

1. Research data Advisor : assisting researchers in planning and organizing data.
2. Data Literacy Educator : developing researcher competencies in responsible data practices.
3. Metadata Specialist : supporting consistent and meaningful dataset description.
4. Digital Preservation Partner : helping ensure long-term accessibility of research data.
5. Al Literacy Facilitator : educating researchers about responsible Al use.
6. Research Integrity Supporter : promoting ethical and transparent research practices.
7. Data Governance Collaborator : participating in institutional policies concerning data access, sharing, privacy, and preservation.

This changing role suggests that libraries should increasingly become active participants in institutional research ecosystems.

Towards a Smart Research Data (SRD) Ecosystem :

A successful RDM model requires collaboration among researchers, librarians, IT professionals, research administrators, institutional leaders, and ethics committees. The proposed ecosystem can be understood through four stages

Create → Manage → Analyses→ Share & Preserve

At every stage, Al can provide assistance, while human expertise and institutional governance provide oversight. For example, during data creation, researchers establish ethical and methodological requirements. During management, librarians and data specialists can support documentation and metadata. Al can assist in classification and quality checking. During analysis, researchers remain responsible for interpreting results. Finally, repositories and libraries can support responsible sharing and preservation.

Such a model balances technological innovation with human accountability.

Proposed Smart Research Data Management (SRDM) Framework :

This paper proposes a simple framework based on five major components:

- Research Data : The first component is the research data itself. Data may come from surveys, interviews, experiments, databases, digital platforms or other sources,
- Technology : Digital tools are required to collect, store, organize, preserve, and share research data.
- Artificial Intelligence : AI provides support for classification, metadata creation, quality checking, search, pattern identification, and data discovery.
- Human Expertise : Researchers and librarians provide professional judgment. They check AI outputs, make important decisions, and ensure research quality.
- Governance : Policies related to privacy, security, ethics, access, preservation, and responsible AI use guide the complete process.

The framework is based on the idea that AI should work with researchers and librarians rather than instead of them. This model can help academic libraries develop a balanced approach to AI-supported research data management.

Practical Implementation in Academic Libraries :

The proposed framework can be implemented through a simple step-by step approach

Step 1 - Develop of an RDM Policy

Step 2 - Identify Library Services

Step 3 - Develop of staff skills

Step 4 - Provide Researcher Training

Step 5 - Introduce Suitable AI Tools

Step 6 - Strength Repository Services

Step 7 - Maintaining Human oversight

Step 8 - Monitoring and Improvement

This practical approach can help academic libraries gradually develop smart research data services without trying to change the entire system at once.

Recommendations :

Academic institutions should consider the following measures:

1. Development of institutional research data management policies.

2. Establish dedicated research data services within academic libraries.
3. Providing regular Al and research data literacy programmes.
4. Develop clear guidelines for ethical use of Al with research data.
5. Strengthen digital preservation and institutional repository infrastructure.
6. Promote interoperable metadata and open research practices.
8. Ensure appropriate privacy and security mechanisms.
9. Encourage collaboration between libraries, researchers, IT departments, and ethics committees.
10. Provide continuous professional development for librarians.
11. Maintain human oversight over critical Al-supported research decisions.

Conclusion :

Artificial Intelligence is changing the way research data is managed. It can help researchers organize large datasets, identify errors, create metadata, improve data discovery and reduce repetitive work. However, smart research data management is not only about using AI. Privacy, security, fairness, transparency, research integrity, and human responsibility are equally important. Academic Libraries have a valuable role in this changing environment, Librarians have experience in organizing information, creating metadata, preserving resources, providing access, and teaching information literacy. These skills can be extended to research data services and AI literacy.

The future of RDM will require a balance between technology and human judgment. AI can make data management faster and more efficient, but responsible research will depend on skilled researchers, knowledgeable librarians, ethical practices, and proper institutional support. Therefore, SRDM should be understood as a partnership between AI, data, researchers, librarians and institutional governance, not as a replacement of human knowledge by machines.

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