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The role of academic libraries in supporting open access and open science

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Abstract

The evolution of scholarly communication has been profoundly influenced by the rise of open access (OA) and open science (OS), movements that emphasize transparency, collaboration, and equitable access to knowledge. Academic libraries, as central hubs of information and learning, play a pivotal role in enabling these transformations. This research explores the responsibilities, practices, and challenges of academic libraries in supporting open access publishing, research data management, institutional repositories, scholarly communication literacy, and compliance with global open science mandates. It highlights the libraries' role as facilitators of infrastructure, advocates for open policies, and educators for researchers and students. Using a literature-based analytical approach, the study identifies the strengths, weaknesses, and opportunities of libraries in advancing OA and OS, while outlining future pathways for libraries to remain relevant in the digital, open knowledge ecosystem.

Keywords

Academic libraries, Open access, Open science, Institutional repositories, Research data management, Scholarly communication, Digital scholarship, Knowledge dissemination, Library advocacy, Open knowledge.

Introduction

Academic libraries are undergoing a paradigm shift, moving beyond their traditional roles as custodians of books and subscription-based journals to active participants in open knowledge ecosystems. With the open access movement gaining global momentum, libraries are increasingly tasked with enabling unrestricted access to scholarly resources, building institutional repositories, guiding authors on copyright retention, and supporting compliance with funding agencies' mandates.

Open science broadens this responsibility further, encompassing open data, open peer review, open educational resources, and collaborative platforms that promote transparency and reproducibility in

research. Academic libraries are uniquely positioned to support these initiatives due to their infrastructure, expertise in metadata curation, and longstanding mission of equitable knowledge dissemination.

This paper explores the multi-faceted role of academic libraries in fostering OA and OS, their successes, limitations, and the emerging opportunities in shaping a future built on open knowledge. The twenty-first century has witnessed a remarkable transformation in the ways knowledge is produced, disseminated, and consumed. At the heart of this transformation are two closely interrelated global movements: **Open Access (OA)** and **Open Science (OS)**. Both advocate for transparency, collaboration, equity, and unrestricted access to scholarly knowledge. Their rise has been driven by rapid advances in digital technology, growing dissatisfaction with the high costs of subscription-based publishing, and an increasing emphasis on democratizing access to knowledge across geographies, disciplines, and communities. Within this changing scholarly landscape, **academic libraries**—historically regarded as custodians of books, journals, and cultural memory—have assumed new, dynamic roles as facilitators, advocates, and enablers of openness in research and education. Academic libraries have always been central to the intellectual life of universities and research institutions. Traditionally, their mission revolved around collecting, organizing, preserving, and providing access to information resources. In earlier decades, access to scholarly knowledge was restricted primarily through expensive subscription models, often controlled by large commercial publishers. Libraries functioned as intermediaries, negotiating licenses and subscriptions to ensure that their users had access to the latest research. However, as subscription costs escalated and budgetary constraints became pressing, libraries faced a growing crisis: they could no longer afford to subscribe to all the journals their patrons required. This phenomenon, often referred to as the “serials crisis,” set the stage for the rise of the open access movement in the late 20th and early 21st centuries.

The emergence of digital technologies, institutional repositories, and online publishing platforms further disrupted the traditional publishing model. Academic libraries, recognizing their unique position as advocates for equitable access to knowledge, began to champion OA initiatives. They established institutional repositories, supported self-archiving practices, and advised researchers on copyright and licensing issues. As the concept of open science gained traction—extending beyond publications to include open data, open peer review, and open educational resources—libraries expanded their mandates to encompass data curation, digital scholarship, and research lifecycle management. Open

Access refers to the unrestricted online availability of scholarly research outputs without financial, legal, or technical barriers. It ensures that publications are freely available to all, enabling broader visibility, higher citation impact, and greater opportunities for collaboration. Open Science, on the other hand, is a broader framework encompassing open access publications but extending further to include **open data, open methodologies, open educational resources, open peer review, and citizen science initiatives**. Together, these movements emphasize transparency, reproducibility, and inclusivity in the research process.

Libraries, with their established infrastructures, skilled professionals, and institutional trust, are uniquely positioned to advance these principles. They act as connectors between researchers, publishers, policymakers, and the public.

Globally, the push toward open access and open science has been institutionalized through several landmark declarations and policy frameworks, including the **Budapest Open Access Initiative (2002)**, the **Berlin Declaration on Open Access (2003)**, and the **Bethesda Statement on Open Access Publishing (2003)**. More recently, the **UNESCO Recommendation on Open Science (2021)** has emphasized that openness is essential for achieving the United Nations Sustainable Development Goals (SDGs). Initiatives such as **Plan S**, spearheaded by the cOAlition S consortium of research funders, have mandated that research funded by public grants must be published in OA-compliant venues.

In this environment, academic libraries have taken on roles that extend far beyond their traditional responsibilities. They are expected to not only curate and preserve knowledge but also facilitate its creation, dissemination, and ethical use in open environments.

Academic libraries actively contribute to OA through multiple channels. They create and maintain **institutional repositories** that provide platforms for researchers to self-archive their work. They guide faculty and students in selecting OA journals, understanding article processing charges (APCs), and navigating copyright agreements. Libraries also negotiate **transformative agreements** with publishers, enabling institutions to transition from subscription-based models to OA publishing. Additionally, libraries serve as advocates, lobbying for national and institutional OA policies and raising awareness about the ethical, financial, and scholarly benefits of openness.

In the broader domain of OS, libraries support **research data management (RDM)** by providing infrastructure, training, and policies to ensure that research data adheres to FAIR principles (Findable, Accessible, Interoperable, Reusable). They facilitate open peer review and assist researchers in adopting

transparent methodologies. Libraries also contribute to the creation and dissemination of **open educational resources (OERs)**, thereby enhancing inclusive and lifelong learning opportunities. By integrating digital scholarship services—such as data visualization, digital humanities projects, and GIS labs—libraries extend their impact across disciplines.

Despite these advances, libraries face significant challenges. Funding limitations often prevent them from sustaining OA publishing funds or building sophisticated repositories. The uneven adoption of OA across regions, resistance from researchers due to concerns about prestige and impact, and policy gaps at institutional and national levels all pose hurdles. Furthermore, developing countries often face technological and infrastructural barriers in embracing OA and OS. These challenges highlight the need for collaborative, sustainable strategies involving multiple stakeholders—libraries, universities, governments, and global organizations. These developments, examining the role of academic libraries in supporting OA and OS is both timely and critical. This study seeks to analyze the multifaceted contributions of libraries, identify their strengths and weaknesses, and propose strategies for enhancing their effectiveness in the open knowledge ecosystem. The research not only situates libraries within the global discourse on openness but also underscores their continued relevance in a digital age where knowledge is expected to be a global public good. In essence, academic libraries are no longer passive repositories of information but active agents of change in the global knowledge economy. They embody the spirit of openness, equity, and innovation that defines the OA and OS movements. By supporting open access publishing, managing research data, curating repositories, educating researchers, and advocating for open policies, libraries are redefining their mission in ways that align with the future of scholarship. The following sections of this research will examine these roles in detail, exploring their theoretical foundations, practical implementations, and future possibilities.

Definitions of Present Research Study

1. **Open Access (OA):** Free, immediate, online availability of scholarly research outputs without financial, legal, or technical barriers.
2. **Open Science (OS):** A movement advocating openness in all stages of the research lifecycle, including data sharing, peer review, educational resources, and methodologies.
3. **Institutional Repository (IR):** A digital archive of an institution's scholarly output, maintained by academic libraries for preservation and accessibility.

4. **Research Data Management (RDM):** The process of storing, preserving, and providing access to research data in compliance with FAIR principles (Findable, Accessible, Interoperable, Reusable).
5. **Scholarly Communication:** The system through which research and scholarly works are created, evaluated, disseminated, and preserved.

Need of Present Research Study

1. To democratize access to scholarly knowledge.
2. To ensure compliance with national and international OA and OS mandates.
3. To promote research visibility and impact.
4. To enhance collaboration and innovation through open data and publications.
5. To reduce financial dependency on costly commercial publishers.
6. To equip researchers and students with knowledge about OA publishing ethics, licensing, and intellectual property rights.

Aims of Present Research Study

1. To examine the role of academic libraries in supporting OA and OS.
2. To identify challenges and opportunities faced by libraries in implementing open knowledge systems.
3. To evaluate the effectiveness of libraries' strategies in promoting openness in scholarly communication.

Objectives of Present Research Study

1. To analyze how libraries build and manage institutional repositories.
2. To explore libraries' role in research data management and open data initiatives.
3. To assess the training and advocacy roles of libraries in OA and OS.
4. To evaluate barriers such as funding, infrastructure, and copyright issues.
5. To propose strategies for libraries to strengthen their OA and OS contributions.

Hypothesis of Present Research Study

1. Academic libraries play a transformative role in advancing open access and open science, but their full potential is hindered by infrastructural, financial, and policy challenges.

Literature Search of Present Research Study

1. Suber, P. (2012). *Open Access*. MIT Press.
2. UNESCO (2021). *Recommendation on Open Science*. Paris: UNESCO.
3. Pinfield, S., Cox, A., & Rutter, S. (2017). Mapping the future of scholarly communication. *Journal of Librarianship and Information Science.*
4. SPARC (2020). *Open Access and Libraries.*
5. EIFL (2022). *Libraries driving open science.*

Findings indicate that libraries are crucial in shaping OA and OS infrastructures, but uneven global adoption and sustainability remain pressing concerns.

Research Methodology of Present Research Study

1. **Type:** Qualitative and analytical research.
2. **Approach:** Literature review, case studies of institutional repositories, analysis of OA policy frameworks.
3. **Data Sources:** Academic journals, UNESCO and SPARC reports, university library policies, and case studies of OA initiatives.
4. **Analysis:** Thematic analysis to identify recurring patterns, strengths, weaknesses, and opportunities.

Strong Points of Present Research Study

Academic libraries are uniquely positioned to lead, support, and sustain the global movements of **open access (OA)** and **open science (OS)**. Their long history of managing scholarly information, combined with their mission of democratizing knowledge, provides them with an unmatched foundation to promote openness. Below is a detailed examination of the major strengths that libraries contribute to this evolving ecosystem.

1. Established Institutional Infrastructure

Libraries already possess robust infrastructure for information collection, curation, and dissemination. This includes:

1. **Institutional repositories (IRs):** Digital platforms where faculty and students can self-archive preprints, postprints, theses, and dissertations.
2. **Digital preservation systems:** Ensuring the long-term accessibility of open resources.
3. **Cataloguing and metadata services:** Making open materials more discoverable across global scholarly databases.

This infrastructure provides an immediate advantage for implementing OA and OS initiatives without the need to build systems entirely from scratch.

2. Expertise in Metadata and Information Organization

One of the core strengths of libraries lies in their **deep expertise in metadata standards, cataloguing, and classification systems.** For OA and OS, accurate metadata is critical to ensure resources are **Findable, Accessible, Interoperable, and Reusable (FAIR).**

1. Librarians ensure research outputs are properly indexed and discoverable in global directories such as **DOAJ, OpenAIRE, or PubMed Central.**
2. They help standardize metadata for **datasets, publications, and educational resources**, thereby supporting interoperability across repositories.

3. Trusted Institutional Status

Libraries are considered **neutral and trusted entities** within academic institutions. Unlike commercial publishers, whose operations are often driven by profit motives, libraries prioritize the **interests of researchers, students, and society at large.**

1. This credibility allows them to act as honest brokers between authors, publishers, and policymakers.
2. Faculty and students often turn to libraries for **guidance on copyright, licensing, and ethical publishing.**

4. Advocacy for Policy Development

Libraries play a crucial advocacy role in shaping institutional, national, and global OA and OS policies.

1. They **raise awareness** among researchers about open publishing benefits.
2. They support **mandates from funding agencies** that require OA compliance.
3. Library consortia often negotiate with publishers for **transformative agreements**, enabling open access publishing without financial burden on authors.

5. Support for Research Data Management (RDM)

Open science extends beyond publications to include research data. Academic libraries:

1. Provide **training, infrastructure, and policies** for researchers to manage, store, and share data.
2. Develop institutional **data repositories** adhering to FAIR principles.
3. Offer guidance on **data curation, preservation, and ethics.**
4. Assist researchers in preparing **data management plans (DMPs)** required by many funding agencies.

This makes libraries central to the implementation of **open data initiatives.**

6. Promotion of Scholarly Visibility and Impact

Libraries enhance the visibility and impact of institutional research by:

1. Encouraging **self-archiving** in repositories.
2. Supporting publication in **high-quality OA journals.**
3. Training researchers on **altmetrics and impact assessment** in the open environment.

Studies show that OA publications receive **higher citations and wider readership**, which directly benefits the academic reputation of institutions.

7. Training and Capacity Building

Libraries act as educators and capacity builders for both researchers and students.

1. They conduct **workshops on copyright, Creative Commons licensing, open data sharing, and OA publishing ethics.**
2. They help young researchers navigate **predatory journals** by providing guidance on journal quality indicators.
3. They develop **information literacy programs** that incorporate OA and OS principles.

8. Collaborative Networks and Partnerships

Academic libraries frequently collaborate at institutional, national, and global levels.

1. Library consortia pool resources to negotiate better publishing terms.
2. International partnerships (e.g., **EIFL, SPARC, IFLA**) strengthen their global role in OA advocacy.
3. Libraries form part of **cross-disciplinary collaborations** that promote OS, including citizen science initiatives.

9. Integration with Digital Scholarship Services

Modern academic libraries increasingly provide digital scholarship services, which naturally align with OA and OS.

1. They support **digital humanities projects**, **GIS labs**, **data visualization**, and **open educational resources (OERs).**
2. They host **open publishing platforms** powered by open-source software (e.g., **OJS – Open Journal Systems**).
3. They facilitate **open peer review platforms** and ensure transparency in scholarly evaluation.

10. Contribution to Equity and Global Knowledge Sharing

Libraries ensure that **research outputs are not limited to privileged groups** but are made freely available across borders.

1. OA allows researchers from developing countries, who may lack access to expensive subscriptions, to participate fully in global scholarship.
2. Libraries help institutions **contribute to global repositories** that promote inclusive development and innovation.

This aligns libraries with the **United Nations Sustainable Development Goals (SDGs),** especially Goal 4 (Quality Education) and Goal 9 (Industry, Innovation, and Infrastructure).

11. Long-standing Mission of Knowledge Preservation

While publishers may be driven by short-term profit goals, libraries maintain the long-term mission of **knowledge preservation.**

1. They ensure that OA materials remain accessible for future generations.
2. Libraries guard against "digital obsolescence" by maintaining archival standards.

This preservation role is fundamental to sustaining the OS movement.

12. Cost-effectiveness and Financial Sustainability

Though OA and OS initiatives require investment, libraries can ultimately **reduce institutional costs**:

1. By supporting **green OA (self-archiving)**, they reduce reliance on costly subscriptions.
2. By negotiating **consortial agreements**, they leverage collective bargaining power.
3. By promoting OA, they help institutions **maximize return on investment** in publicly funded research.

13. Ethical and Legal Guidance

Librarians are experts in **intellectual property rights (IPR), copyright, and licensing.**

1. They guide researchers in retaining rights through **author addenda.**
2. They promote the use of **Creative Commons licenses** for open content.

3. They help institutions develop **ethical policies for data sharing and reuse.**

14. Alignment with Global and National Frameworks

Libraries play a crucial role in aligning institutions with:

1. **International frameworks:** UNESCO Open Science Recommendation, Plan S, FAIR Data principles.
2. **National frameworks:** National Digital Library of India (NDLI), ICSSR data-sharing policy, UGC mandates for open repositories.

Weak Points of Present Research Study

While academic libraries play a pivotal role in advancing **open access (OA)** and **open science (OS)**, their contributions are hindered by several structural, financial, cultural, and policy-related challenges. These weak points highlight the limitations that prevent libraries from realizing their full potential in supporting a truly open knowledge ecosystem.

1. Financial Constraints and Sustainability Issues

1. **Limited budgets:** Most academic libraries operate on restricted budgets, which limits their ability to fund OA initiatives, pay article processing charges (APCs), or develop institutional repositories.
2. **APC burden:** Shifting from subscription models to "author-pays" OA models transfers costs from libraries to researchers, often creating inequity.
3. **Unsustainable funding models:** Many OA initiatives rely on short-term grants or donor funding, leading to instability when external support ends.
4. **Competition for resources:** Libraries must balance OA funding against other pressing needs like digital infrastructure, e-resources, and staff training.

2. Infrastructural and Technological Barriers

1. **Underdeveloped repositories:** Many institutional repositories lack advanced features for discoverability, interoperability, or long-term preservation.
2. **Digital divide:** Institutions in developing countries often lack high-speed internet, advanced servers, or robust digital preservation systems.
3. **Fragmentation of platforms:** OA repositories and OS tools are often scattered, leading to duplication of effort and poor integration.

4. **Cybersecurity risks:** Open infrastructures are vulnerable to data breaches and unauthorized manipulation of scholarly data.

3. Uneven Global and Regional Adoption

1. **North–South divide:** Libraries in developed countries have stronger infrastructure and support, while those in developing regions struggle to implement OA and OS.
2. **Policy inconsistency:** Lack of uniform global mandates results in fragmented adoption. Some countries enforce strong OA mandates while others have none.
3. **Language barriers:** Most OA content is in English, limiting inclusivity for non-English-speaking scholars and institutions.

4. Limited Researcher Engagement and Resistance

1. **Perception of quality:** Many researchers perceive OA journals as lower quality compared to traditional subscription journals, despite evidence to the contrary.
2. **Prestige publishing:** Academic reward systems still prioritize publications in high-impact, subscription-based journals.
3. **Lack of awareness:** Many researchers remain unaware of OA and OS opportunities or believe they are irrelevant to their disciplines.
4. **Fear of predatory journals:** The rise of unethical publishers has made some researchers skeptical of OA publishing.

5. Staffing and Skill Gaps

1. **Insufficient training:** Many librarians lack adequate training in data curation, digital preservation, open-source platforms, and copyright law.
2. **Workload pressure:** Libraries often operate with limited staff, making it difficult to allocate time to OA/OS activities alongside routine operations.
3. **Need for new skill sets:** Supporting OS requires expertise in data science, digital scholarship, and IT, which are often missing in traditional library staff profiles.

6. Policy and Governance Challenges

1. **Lack of institutional mandates:** Not all universities have OA/OS policies, leading to inconsistent researcher participation.
2. **Ambiguity in copyright laws:** Conflicting copyright frameworks across countries create confusion about what can legally be shared openly.

3. **Weak enforcement:** Even where OA policies exist, enforcement is often poor, and compliance rates are low.
4. **Dependence on publisher policies:** Libraries' ability to promote openness is constrained by restrictive publisher embargoes and licenses.

7. Inequality in Access to APC Funding

1. **Disciplinary imbalance:** STEM fields often receive funding for APCs, while humanities and social sciences are neglected.
2. **Institutional inequity:** Wealthy universities can afford APC support, while smaller institutions cannot, deepening inequalities.
3. **Researcher exclusion:** Independent scholars or researchers from underfunded institutions are often excluded from OA publishing due to costs.

8. Sustainability of Repositories

1. **Low deposit rates:** Despite repository availability, many researchers do not deposit their work.
2. **Duplication:** Multiple repositories exist without effective coordination, leading to redundancy.
3. **Preservation risks:** Without sustainable funding, repositories risk data loss or obsolescence.
4. **Discoverability issues:** Poor indexing and metadata inconsistencies reduce the visibility of repository content.

9. Technological Dependence and Vendor Lock-in

1. **Commercial dominance:** Even in OA, large publishers dominate hybrid models and APC-funded publishing, undermining the library's negotiating power.
2. **Vendor dependence:** Many libraries depend on third-party vendors for repository platforms, leading to financial and technological vulnerability.
3. **Opaque pricing models:** "Transformative agreements" sometimes result in hidden costs, making true cost transparency elusive.

10. Open Data and Privacy Concerns

1. **Ethical dilemmas:** Sharing sensitive data (e.g., medical, social science) raises privacy and consent issues.
2. **Data misuse risks:** Open datasets may be misinterpreted, misused, or exploited for commercial gain.

3. **Lack of standards:** Data management practices differ across disciplines, complicating interoperability.
4. **Low researcher compliance:** Many researchers are reluctant to share data due to fear of being "scooped" or losing competitive advantage.

11. Lack of Global Collaboration and Interoperability

1. **Fragmented initiatives:** Many OA/OS projects are localized and fail to align with global infrastructures.
2. **Poor interoperability:** Different metadata standards and repository platforms hinder global data sharing.
3. **Duplication of efforts:** Without coordination, institutions repeat similar projects, wasting resources.

12. Predatory and Low-quality Publishing

1. **Proliferation of predatory journals:** Many researchers, especially early-career ones, fall prey to unethical publishers.
2. **Damage to credibility:** Association of OA with predatory publishing undermines the reputation of legitimate OA platforms.
3. **Difficulty in identification:** Even with blacklists and whitelists, distinguishing between credible and predatory journals remains a challenge.

13. Institutional Cultural Barriers

1. **Conservatism in academia:** Many universities remain tied to traditional publishing prestige systems.
2. **Faculty resistance:** Senior academics may resist OA due to lack of incentives.
3. **Evaluation systems:** Promotion and tenure processes rarely reward OA or OS contributions.

14. Inadequate Awareness among Students and Early-career Researchers

1. **Information gap:** Students often lack training in OA/OS principles.
2. **Limited guidance:** Faculty mentors may not encourage OA publishing due to unfamiliarity or skepticism.
3. **Exclusion from OS:** Early-career scholars may lack access to training in data sharing, open peer review, and collaborative tools.

15. Legal and Intellectual Property Complexities

1. **Conflicting copyright laws:** Variations across jurisdictions complicate cross-border open dissemination.
2. **Institutional liability:** Libraries risk legal challenges if they share copyrighted works without proper permissions.
3. **Patent restrictions:** In fields like biotechnology, openness may conflict with intellectual property rights and commercialization goals.

16. Technological Obsolescence

1. **Software sustainability:** Open-source repository platforms require continuous updates and technical expertise.
2. **Hardware limitations:** Smaller institutions cannot afford the latest digital preservation infrastructure.
3. **Risk of digital decay:** Without strong preservation strategies, digital files may become unreadable over time.

17. Mismatch Between Library Missions and Commercial Publishing Models

1. **Hybrid OA traps:** Many publishers use "double-dipping," charging both subscriptions and APCs.
2. **Commercial dominance:** Big publishers (Elsevier, Wiley, Springer) continue to dominate, limiting libraries' ability to shape the OA agenda.
3. **Conflict of interest:** Libraries' mission for openness often clashes with publishers' profit motives.

Current Trends of Present Research Study

The role of academic libraries in supporting **open access (OA)** and **open science (OS)** is rapidly evolving, influenced by global policy changes, technological innovations, researcher behaviors, and collaborative initiatives. Below are the major **current trends shaping the future of libraries in OA and OS**:

1. Institutional Repositories Expansion

1. Academic libraries are increasingly creating and managing **institutional repositories (IRs)** to preserve and disseminate research outputs.
2. Many repositories now include not only journal articles but also theses, dissertations, preprints, research data, and multimedia materials.
3. Libraries are adopting **FAIR data principles (Findable, Accessible, Interoperable, Reusable)** to enhance global visibility.

2. Transformative Agreements with Publishers

1. Libraries are negotiating **Read-and-Publish** and **Publish-and-Read agreements** that combine subscription access with OA publishing rights.
2. These agreements are growing globally but raise concerns over affordability and equity for smaller institutions.
3. Academic consortia (e.g., **Plan S Coalition**, **Projekt DEAL in Germany**) are leading the movement.

3. Growth of Preprint Culture

1. Preprint servers (e.g., **arXiv, bioRxiv, SocArXiv**) are gaining popularity across disciplines.
2. Libraries are supporting researchers in understanding preprint policies, DOI assignment, and version control.
3. Preprints accelerate knowledge dissemination, especially in health sciences (as seen during COVID-19).

4. Open Data Mandates

1. Governments, funding agencies, and institutions increasingly require **research data to be openly shared**.
2. Libraries are providing **data management services, training, and data repositories** to support compliance.
3. Integration of **research data repositories with IRs** is a growing trend.

5. Open Educational Resources (OER) Integration

1. Libraries are at the forefront of promoting **OERs** as part of OS practices.
2. Many universities are adopting policies encouraging faculty to create and share textbooks, lecture notes, and multimedia openly.
3. This reduces costs for students and aligns with libraries' mission of democratizing knowledge.

6. Increasing Focus on Metadata Interoperability

1. Libraries are working towards **metadata harmonization** using standards like **Dublin Core, MARC, OAI-PMH, and schema.org**.
2. Interoperability improves global discoverability of OA materials.
3. Collaboration with **CrossRef, DataCite, and ORCID** is becoming standard practice.

7. Research Data Management (RDM) Services

1. Libraries are expanding their role in providing **RDM services**, including data curation, storage, metadata creation, and long-term preservation.
2. Training workshops on **data sharing, data ethics, and FAIR principles** are common.
3. Libraries are positioning themselves as **data stewards** within the research ecosystem.

8. Open Peer Review and New Publishing Models

1. OA platforms are experimenting with **open peer review systems**, increasing transparency in scholarly publishing.
2. Academic libraries are supporting these initiatives by hosting platforms and guiding researchers.
3. Models such as **overlay journals, diamond OA (no APCs)**, and **community-led publishing** are gaining traction.

9. Researcher Identity and Impact Tracking

1. Libraries are helping researchers manage **digital identities** through tools like **ORCID, ResearcherID, and Scopus Author ID**.
2. They also provide training on **altmetrics** (downloads, social media mentions, citations in policy papers).
3. Trend toward **open metrics** challenges reliance on journal impact factor.

10. AI and Machine Learning in Open Science

1. AI tools are increasingly used to **index, classify, and recommend OA resources**.
2. Libraries are exploring **text and data mining (TDM)** services for researchers.
3. AI-driven analytics are helping track research visibility and detect predatory publishing.

11. Open Access Policy Strengthening

1. National and institutional OA policies are expanding (e.g., **India's Draft National OA Policy 2020**, **US OSTP 2022 Memorandum**, **European Union's Horizon Europe OA mandate**).
2. Libraries are aligning their strategies with these policies and acting as compliance advisors for faculty.

12. Citizen Science Integration

1. Libraries are engaging in **citizen science initiatives** by providing platforms for public participation in research.
2. Open science is broadening beyond academia, involving local communities, NGOs, and industries.

3. Academic libraries are helping curate citizen-generated datasets.

13. Cross-institutional Collaborations

1. Libraries are forming **consortia** to negotiate transformative agreements, build shared repositories, and reduce duplication.
2. Examples include **SHERPA services (UK), OpenAIRE (Europe), and LA Referencia (Latin America)**.
3. Trend toward **global library networks** promoting OS.

14. Expansion of Diamond and Platinum OA

1. **Diamond OA (no APCs, funded by institutions or consortia)** is being recognized as more equitable.
2. UNESCO's **2021 Open Science Recommendation** advocates diamond models.
3. Libraries are increasingly hosting **community-driven journals** that follow this model.

15. Library Publishing Programs

1. Many academic libraries are launching **library-led publishing platforms** using **Open Journal Systems (OJS)** and **DSpace**.
2. These initiatives reduce dependency on commercial publishers.
3. Trend toward **community-owned publishing ecosystems**.

16. Integration with Global OA Platforms

1. Libraries are contributing content to global discovery systems like **CORE, BASE, DOAJ, and OpenAIRE**.
2. Trend toward federated repositories that interconnect institutional platforms globally.
3. Increased participation in **data commons initiatives** (e.g., **European Open Science Cloud**).

17. Blockchain for Scholarly Communication

1. Pilot projects are exploring **blockchain** for research integrity, version control, and copyright tracking.
2. Libraries are monitoring blockchain applications for **authorship verification** and **peer review transparency**.
3. Still experimental but growing.

18. Advocacy and Researcher Training

1. Libraries are running **OA/OS awareness programs** for students, faculty, and administrators.

2. Training covers **copyright, licensing (Creative Commons), research visibility, data ethics, and predatory publishing**.
3. Trend of **embedding OA literacy in information literacy curricula**.

19. Global South Participation in Open Science

1. Increasing participation of African, Asian, and Latin American libraries in OA and OS.
2. Initiatives like **AmeliCA (Latin America)** and **African Open Science Platform** highlight regional leadership.
3. Focus on **equitable knowledge sharing and linguistic diversity**.

20. Integration with National and International Research Assessment Systems

1. Libraries are contributing OA/OS metrics to **research evaluation frameworks**.
2. Shift from journal-based metrics (impact factor) to **open science indicators**.
3. Governments increasingly require evidence of OA/OS compliance for research funding.

History of Present Research Study

The history of academic libraries' engagement with **open access (OA)** and **open science (OS)** is closely tied to the evolution of scholarly publishing, digital technologies, and policy movements for democratizing knowledge. Libraries have transitioned from **custodians of print resources** to **active agents in knowledge dissemination, preservation, and advocacy for openness**.

1. Early Foundations (17th – 19th Century)

1. **Birth of scholarly publishing (1600s):** The launch of *Philosophical Transactions of the Royal Society* (1665) marked the beginning of formal scholarly communication. Academic libraries emerged as the **primary repositories** of these printed journals and books.
2. **Subscription-based publishing model:** For centuries, libraries relied on expensive journal subscriptions and book purchases, reinforcing knowledge silos accessible only to wealthy institutions.
3. **Public library movement (1800s):** Although not academic in scope, the idea of **knowledge as a public good** began to influence higher education institutions.

2. The Serial Pricing Crisis and Early Calls for Openness (1960s – 1980s)

1. **Journal cost inflation:** The "serials crisis" began in the 1960s–70s, with journal subscription costs rising faster than library budgets.

2. Libraries were forced to **cancel subscriptions**, limiting access even for top universities.
3. Scholars began discussing the need for **alternative publishing and distribution systems**.
4. Early library networks experimented with **interlibrary loans** and **document delivery systems**, laying the groundwork for later digital sharing.

3. Emergence of Digital Libraries and Early OA Initiatives (1990s)

1. **Internet revolution:** With the spread of the internet, academic libraries began digitizing catalogs and collections.
2. **Preprint archives:** The launch of **arXiv (1991)** for physics and related fields was a landmark in OA history. It showed the viability of **self-archiving and rapid dissemination**.
3. **SPARC (Scholarly Publishing and Academic Resources Coalition, 1998):** Libraries worldwide collaborated to **challenge commercial publishers** and promote affordable alternatives.
4. **Institutional repositories (late 1990s):** Universities started experimenting with digital archives to host faculty publications.

4. The Open Access Movement Gains Momentum (2000 – 2010)

1. **Budapest Open Access Initiative (BOAI, 2002):** Defined OA as free, immediate, and unrestricted access to scholarly literature. Libraries became **signatories and implementers**.
2. **Berlin Declaration on OA (2003):** Expanded the OA vision across Europe and beyond.
3. **Bethesda Statement (2003):** Strengthened the case for institutional and funder mandates.
4. **Institutional repositories growth:** Software like **DSpace (2002)** and **EPrints (2000)** empowered libraries to host OA content.
5. **DOAJ (Directory of Open Access Journals, 2003):** Libraries contributed to building this critical global resource.
6. **Rise of OERs:** Libraries began curating and advocating **open textbooks and teaching materials**.
7. **Mandates begin:** The NIH Public Access Policy (2008) required federally funded research to be made publicly accessible.

5. Consolidation and Policy Advocacy (2010 – 2020)

1. **OA publishing models diversify:** Gold OA (publisher-provided), Green OA (repository-based), and Hybrid OA emerged, with libraries guiding researchers through choices.
2. **Plan S (2018):** Coalition S funders mandated immediate OA for publicly funded research. Libraries aligned institutional policies with Plan S principles.

3. **Transformative agreements:** Consortia of libraries negotiated Read-and-Publish deals (e.g., Germany's **Projekt DEAL** with Springer Nature and Wiley).
4. **Open data movement:** Libraries expanded roles in **research data management (RDM)**, FAIR data principles, and data curation services.
5. **Rise of altmetrics:** Libraries supported the use of new impact indicators beyond the journal impact factor.
6. **Citizen science and OER:** Libraries became facilitators of **community engagement and open pedagogy**.

6. The UNESCO 2021 Recommendation on Open Science

1. **Global policy milestone:** In November 2021, UNESCO adopted its **Recommendation on Open Science**, endorsed by 193 countries.
2. It defined OS as inclusive, equitable, and transparent, calling for **libraries, repositories, and infrastructures** as central enablers.
3. Academic libraries' roles were explicitly recognized in **preserving, curating, and providing equitable access to scientific knowledge**.

7. The COVID-19 Pandemic and the Acceleration of OA (2020 – 2022)

1. **Open science in crisis response:** COVID-19 created an urgent need for rapid access to research.
2. Publishers temporarily lifted paywalls on pandemic-related studies, showing the power of OA.
3. Libraries facilitated **preprint adoption**, especially in health sciences (e.g., medRxiv, bioRxiv).
4. Data sharing for vaccine research underscored the need for **open, global collaboration**.
5. This period cemented libraries' role as **critical infrastructure providers in emergencies**.

8. Recent Developments and Current Trajectory (2022 – Present)

1. **US OSTP 2022 Memorandum ("Nelson Memo"):** Mandates free public access to federally funded research from 2026 onwards. Libraries are preparing compliance systems.
2. **Diamond OA growth:** UNESCO and regional initiatives (e.g., AmeliCA in Latin America) promote community-owned publishing. Libraries increasingly lead these platforms.
3. **Integration of AI and big data:** Libraries are deploying AI tools for metadata enhancement, research discovery, and text and data mining.
4. **Decolonizing open science:** Libraries advocate for **indigenous knowledge inclusion, multilingual publishing, and equity** in OA practices.

5. **Open research infrastructures:** Federated platforms like **European Open Science Cloud (EOSC)** and **National Digital Library initiatives (India, Africa)** involve libraries as partners.
6. **Blockchain experiments:** Emerging pilots test blockchain for **authorship verification, peer review transparency, and copyright tracking**.

Discussion of Present Research Study

Academic libraries are both facilitators and stakeholders in the OA and OS ecosystem. They provide infrastructure, advocate for open policies, and build researcher awareness. However, challenges such as limited funding, uneven adoption, and researcher resistance persist. The balance between sustaining subscription models and embracing OA remains contentious. Libraries must align their strategies with global initiatives while adapting to institutional contexts.

Results of Present Research Study

1. Academic libraries significantly enhance the visibility and impact of institutional research.
2. Libraries are key players in implementing OA mandates and educating stakeholders.
3. Gaps in infrastructure and funding limit OA adoption in resource-constrained regions.
4. Researcher engagement with OS practices is rising but remains inconsistent.

Conclusion of Present Research Study

Academic libraries are indispensable in advancing open access and open science. While they face infrastructural, financial, and cultural challenges, their expertise and advocacy make them central to the global transition toward open knowledge. Strengthening libraries' capacities, fostering collaboration, and developing sustainable policies are essential for realizing the full potential of OA and OS.

Suggestions and Recommendations of Present Research Study

1. Secure sustainable funding for OA and OS initiatives.
2. Train library staff in RDM, OA publishing, and digital scholarship.
3. Strengthen collaboration between libraries, IT units, and research offices.
4. Expand OA publishing funds and negotiate transformative agreements.
5. Advocate for national and institutional OA/OS policies.
6. Enhance researcher engagement through workshops and incentives.
7. Invest in long-term repository infrastructure and preservation strategies.

Future Scope of Present Research Study

1. Greater integration of AI and digital tools in research data management.
2. Expansion of global collaborations for OA infrastructures.
3. Stronger alignment with UN Sustainable Development Goals through open knowledge.
4. Growing role of libraries in open peer review and citizen science.
5. Transition from hybrid to fully open publishing ecosystems.

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