

Reimagining Scholarly Communication in the Era of Open Science



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Abstract

Significant changes have been observed in the conventional scholarly communication system, driven by the rapid evolution of digital technologies and the expansion of global research collaborations. In recent years, the concept of open science has been identified as a revolutionary approach transforming the conventional scholarly communication system. This study aims to examine the impact of open science on the conventional scholarly communication system through emerging conceptual frameworks, digital research infrastructures, and interlinked research systems. This study is conducted using a conceptual review approach, synthesizing scholarly publications, policy documents, and recent discussions on emerging open science practices. The findings of the study revealed the increased significance of digital research infrastructures such as institutional repositories, research data repositories, preprints, and global scholarly databases in promoting the open dissemination of knowledge. Despite the significant developments in the conventional scholarly communication system, several challenges were identified regarding the sustainability of open science infrastructures and the availability of open science resources. This study concluded that the future of the conventional scholarly communication system depends on establishing an integrated system comprising policy frameworks, research infrastructures, and interlinked research systems.

Keywords: Open Science, Scholarly Communication, Open Access, Research Infrastructure, Research Ecosystem, Academic Libraries, Research Data Sharing.

1. Introduction

Scientific communication and the process of producing and evaluating scientific knowledge have witnessed revolutionary changes in recent decades (Phogat et al., 2025). For centuries, the traditional model of scholarly communication was dominated by the conventional publishing system, in which scientific knowledge was disseminated primarily through subscription-based journals. Recent research showed that four major publishers made a profit of more than 30% through their paid access system (De Oliveira & Ballesterio, 2026). In this model, the primary access to scientific knowledge was restricted to institutions capable of affording the expensive journals. Additionally, although the conventional publishing model employed certain quality-control measures in scholarly communication, such as peer review, it remained a major hindrance to the transparent and open nature of scientific communication. During the last few decades, the issue of the credibility and reliability of scientific findings, along with rapid developments in information technology, has forced scholars and institutions to critically examine the limitations of the conventional model of scholarly communication (Puschmann, 2014). The major turning point in this direction was the recognition of the replication crisis in science. In recent years, various replication studies in psychology and the social sciences have shown that a substantial portion of prior findings cannot be replicated under the same conditions. This realization of the replication crisis in science and other disciplines has spurred the emergence of the

open science movement, aimed at strengthening the integrity of science through transparent, open practices (Hagger, 2022). Majorly open science has derived from democratic, measurement, public, infrastructure and pragmatic school of thoughts. (Bartling & Friesike, 2014a)

"The open science movement is to make scientific research, data, code, educational resources, and publications freely available to everyone without barriers. It promotes transparency, collaboration, and reproducibility in research and encourages the use of open source, open data, and open access publishing" (Chiware, 2025). Open science projects, such as Frontier, NLM PubMed Central, Allen Institute open science project for biomedical publication, National Science Foundation's Public Access Initiative, etc., have supported researchers. Researchers gain access to new means of communication that enable them to easily communicate and collaborate with other scientists globally. Open science practice allows researchers to collaborate more effectively and efficiently in the production of new scientific knowledge (Soliman et al., 2025). Apart from the role played by new technologies, the open science movement has had significant impacts on the wider scientific environment by involving various stakeholders including universities, research funding agencies, and academic libraries. The role played by research libraries in the development of open science cannot be ignored. According to Maria Cassella, "libraries should develop new and innovative strategies that move beyond traditional publishing agreements and support open science, open science

infrastructures, and open science evaluation models" (Cassella, 2024). Several policies have supported the development of the open science movement. In this case, international and national government bodies are realizing the importance of open science in the modern scientific environment. One of the most significant frameworks that supports the implementation of open science policies includes the UNESCO recommendation on open science. This framework, adopted by UNESCO member states in 2021, emphasizes the importance of open science in facilitating universal access to scientific knowledge, open research infrastructures, and cooperation among scientific communities and societies. This is an important policy framework that highlights the international commitment to the development of open science policies to enhance the transparency and societal impact of scientific research as argued by Cudennec Christophe et al., (Cudennec et al., 2022). It is important to develop open science mindset that emphasises the making data open from the project proposal to completion of the project and related publications (Hagger, 2022).

Despite these developments, the development of open science is a complex process in which a number of factors should be considered. Thus, various issues require consideration during the development of an open science strategy. In this regard, the purpose of this study is to evaluate the impact of open science in transforming the conventional scientific communication system. Through the integration of the most recent developments regarding open science policy, digital infrastructure, and institutional practices, this research intends to explore the dynamic nature of scientific communication within the open science framework.

Methodology

The present study employed a qualitative integrative review and conceptual analysis approach to explore how open science is revolutionizing scholarly communication. Sources related to the topic were found using journal databases, publishers' sites, and open-access journal databases. The keywords for searching included open science, research data sharing, FAIR principles, and open science infrastructure. Foundational studies were included to provide background on the history and concept of open science, while recent works were used to identify the existing policies and practices. The literature was reviewed thematically and organized into four themes: the historical development of open science, open science infrastructure, frameworks supporting open science, and the research ecosystem in the context of open science. The literature was analyzed narratively due to the diversity in the purposes, approaches, and disciplines of the selected sources.

Historical Background of Open Science

Open science is not a relatively recent phenomenon as the idea behind this concept has deep historical roots, tracing its way back into the early history of modern science (Bowman & Keene, 2018). At that time, the development of science was based on the very principle of knowledge exchange among the wider scientific community. In particular, one of the first scientific organizations called the Royal Society of London was found in 1660. It fostered knowledge sharing among its members through letter writing as well as through the first issue of scientific journal 'Philosophical Transactions' (Fecher & Friesike, 2014a). Thus, it can be seen that scholarly communication was an effective means of fostering transparency and the development of knowledge in the scientific community. However, there is evidence of the gradual commercialization of scholarly communication in the twentieth century. The scientific journals have become the primary vehicle for disseminating scientific results to the wider scientific community. Nevertheless, access to scientific journals was greatly limited because of the subscription-based business model adopted by most scientific publishers. Moreover, the prices charged for scientific journals rose sharply in the second part of the twentieth century. The lack of access to scientific literature in universities led to what came to be known as the 'serials crisis' (Suber, 2012).

The emergence of internet technology in the 1990s opened up many new opportunities for invention or discoveries and how science was communicated (Bartling & Friesike, 2014b; Hauben et al., 2007). This was made possible through the advent of digital technologies, which allowed for the dissemination of information to a wider audience and in a faster manner compared to conventional publishing. One of the major milestones in the shift towards open science was marked by the Budapest Open Access Initiative in 2002. This initiative was aimed at promoting open access to literature and information. This initiative was based on the principle that publicly funded information should be made available to readers across the globe for free (BOAI, n.d.). This was followed by other initiatives that further promoted the open access movement. This was marked by "the Bethesda Statement on Open Access Publishing in 2003 and the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities in 2003" (Abdin et al., 2021). These marked the foundation of the open science movement through the promotion of open access to knowledge. This was made possible through the promotion of open access publishing by scholars and other relevant stakeholders (Suber, 2012).

Over the years, the concept of open science was expanded to include openness in other aspects of the research process. This was marked by the shift towards open science, which involves open data, open methods, open peer review, and open collaboration in science. This concept was aimed at

promoting openness in science to improve the quality of science (Fecher & Friesike, 2014a). One of the major turning points in the development of open science was in the early twenty-first century with the emergence of concerns regarding the trustworthiness and replicability of scientific research. The replication crisis in psychology and biomedical science showed that a great deal of the results of scientific research could not be replicated (Soliman et al., 2025). This further strengthened the case for open science and transparent research practices, such as preregistration of studies and open sharing of data and methods (Hagger, 2022). At the same time, technological developments have made it possible to establish open science infrastructure. Today, digital repositories and research databases enable scientists to share materials and publications in an efficient manner. This change in the technological field has played a central role in the transformation of the structure of scholarly communication systems (Redkina & Ryabova, 2025).

Open Science Infrastructure

Effective deployment of open science strategies relies significantly on the development of efficient digital infrastructures to facilitate the dissemination, preservation, and availability of research products. Open science infrastructure refers to the systems, tools, and services that enable the promotion of open access publication, data exchange, and transparency in research. This involves the development of “shared scientific equipment or instruments, data repositories, open-access journals, preprint repositories, unique persistent identifiers, scientometric systems for assessment, and open-source code and software” (McKenna, 2024). The infrastructure plays an important role in open science strategies since it provides the means for the spread of knowledge within the scientific community. One of the most fundamental components of open science infrastructure is the institutional repository. Institutional repositories are the digital infrastructure that research universities and research centers use to collect, preserve, and provide open access to the scholarly outputs of research conducted by the members of the research community (Stojanovski, 2022). By providing open access to research publications, institutional repositories promote the visibility of research and the democratization of knowledge. Another critical component of open science infrastructure is the research data repository. Research data repositories are the infrastructure that research communities use to share research data related to the research they conducted. By providing open research data, research communities promote the credibility and transparency of research practices (Redkina, 2024). In fact, research data sharing has become an increasingly important component of credible research practices. Preprint servers and open access

publishing platforms are some of the critical components of open science infrastructure. Preprint servers are the infrastructure that research communities use to disseminate research findings before the formal publication of research results. Prepublishing research findings promote the dissemination of knowledge among research communities. In fact, preprint servers such as arXiv, bioRxiv, and SSRN have become critical infrastructure that promote the dissemination of knowledge among research communities.

Global research discovery platforms have also helped to build open science infrastructures. These are platforms that offer discovery and analysis of scholarly information. OpenAlex, Dimensions, and The Lens are examples of global research discovery platforms. According to Redkina and Ryabova (2025), these platforms are becoming increasingly important in supporting research analytics and monitoring scientific trends (Redkina & Ryabova, 2025). Despite these developments, open science infrastructures face a major challenge of sustainability. Building and sustaining open science infrastructures, such as digital infrastructures, research data infrastructures, and global discovery infrastructures, is a costly venture. In addition, ensuring interoperability between infrastructures and sustaining high-quality metadata standards is another challenge.

Frameworks Supporting Open Science

The development of open science has been guided by a variety of conceptual frameworks, principles, and policies. These frameworks, principles, and policies are instrumental in providing direction in the implementation of open science. These frameworks are important in ensuring that open science is transparent, accessible, and sustainable. One of the major frameworks supporting open science is the FAIR data principles. These are a set of principles that focus on the importance of making research data Findable, Accessible, Interoperable, and Reusable. These principles were developed by Wilkinson et al. (2016). These principles are important in ensuring that research data is shared and used effectively. In this regard, they are important in maximizing the value of scientific outputs (Wilkinson et al., 2016). The onion framework is also an important component in open science, which highlights the importance of pre-registered reports, shared data, shared analysis, shared materials, and requests to authors (Bowman & Keene, 2018). Publishing and different organizations have come together to support the research ecosystem. The Center for Expanded Data Annotation and Retrieval has built a template to support innovators to encrypt descriptive metadata standards as templates that describe the attributes of different kinds of experiments and connect those attributes to ontologies (Musen et al., 2026).

International policy initiatives have played an important role in the development of open science frameworks. The OECD, European Commission, and UNESCO have promoted policies aimed at ensuring greater access to scientific information and fostering open science collaboration. Among the international policies, the UNESCO Recommendation on Open Science (2021) represents one of the pioneering policy instruments that have significantly helped promote open science frameworks worldwide. According to the UNESCO Recommendation on Open Science, open science represents a system comprising open access to publications, open data, open infrastructure, and inclusive participation in science processes. The UNESCO Recommendation on Open Science also emphasizes the importance of equal participation in research activities, which allows scientists from various parts of the world to benefit from open science initiatives (Cudennec et al., 2022). Similarly, projects like the Simons Sleep Project and the Nationally Determined Contributions' framework support the open science movement to deliver enhanced credibility and legitimacy (Beltramo et al., 2026; Hacoheh et al., 2026). Strategies related to open science have also played a key role in promoting open science frameworks globally. Many countries have adopted open science strategies that require researchers to make their research accessible to all through open-access publications and open-access data repositories.

Research Ecosystem in the Context of Open Science

The traditional research ecosystem was mainly composed of the research community, institutions, and commercial publishers. However, the development of the concept of open science, government and corporate investments, and integration among all stakeholders has transformed the research ecosystem into a more dynamic and collaborative environment (FICCI, 2024). The research ecosystem involves collaborative efforts by inventors using shared infrastructure, with appropriate policies and practices, working collectively to support the development and dissemination of scientific information at all stages of the research process to the public freely (Savona et al., 2025). Generally, research ecosystems are shaped by global research culture, research communities, society, and time (Pandey & Pattnaik, 2015). Worldwide research databases have provided a platform for researchers to collaborate and enhance the visibility of their achievements (Redkina & Ryabova, 2025). Academic libraries have become an important part of the research ecosystem through the development of repositories. They have significantly contributed to the development of a research ecosystem that encourages information sharing and research transparency. Maria Cassella emphasizes that the academic library has increasingly adopted a

strategic role in supporting the development of the open science movement, in which the use of open-access journals, institutional repositories, and open-science databases has become a crucial component of the research ecosystem for the development of the research community (Cassella, 2024).

Funding bodies and policy institutions also have a vital role to play in the research ecosystem. Maria Cassella argues that collaboration among libraries, funders and publishers is the key to achieving success (Cassella, 2024). Currently, a majority of funding bodies, such as U.S. federal agencies, insist that inventors make the publications and data produced from funded research publicly accessible (Bullock, 2023). UNESCO has also emphasized the importance of global cooperation in building open research infrastructures and policy frameworks (Cudennec et al., 2022). The increased adoption of digital technologies has also helped to build global research collaborations. Currently, researchers from different countries have the ability to collaborate in research undertakings and communicate their research findings more effectively in open-access journals than in the past. Such research partnerships have contributed towards making a more developed global research ecosystem. Nevertheless, despite the above-mentioned progress towards a better research ecosystem, challenges remain for the open science research ecosystem. Majorly, collaboration itself is a greater challenge along with governance policies, copyright policies, privacy concerns (Savona et al., 2025; Wang et al., 2026). While Alexander Gerber indicated that scientific culture as the main challenge (Gerber, 2014). The varying levels of technological advancement and the availability of funding in various nations might result in inequalities in the use of open science (Eisfeld-Reschke et al., 2014; Fecher & Friesike, 2014b).

Discussion

The commercialisation of academic publishing and concerns about the credibility and reproducibility of research are some limitations of the traditional scholarly communication system (Suber, 2012; Puschmann, 2014; Hagger, 2022). Open science appeared as a response to these limitations by extending openness from the published article to research data, research methods, software, materials, evaluation, infrastructure, and collaboration. As a result, practices of preregistration, data sharing, open methods, open analysis procedures, and open research materials were encouraged (Hagger, 2022; Soliman et al., 2025). Thus, it can be seen that credible scholarly communication requires not only communication of research results but also transparency of the evidence and processes that support these results. It can also be found in the review that digital infrastructure plays an important role in implementing open science. Institutional repositories, research data repositories, open-access

journals, preprint servers, persistent identifiers, metadata system, open-source software, and discovery platforms represent the technological tools necessary for storing, preserving, discovering, linking, and reusing scholarly outputs (McKenna, 2024). Institutional repositories increase the visibility and accessibility of research conducted in universities and research institutions; research data repositories increase the transparency of the research through the possibility to share evidence behind the published work (Stojanovski, 2022; Redkina, 2024). Discovery platforms such as OpenAlex, Dimensions, and The Lens increase the efficiency of scholarly communication by linking scholarly outputs, researchers, institutions, citations, and other forms of scholarly communication (Redkina & Ryabova, 2025). Openly published data may remain practically useless when it is impossible to locate, understand, integrate with other datasets, and reuse it with certain conditions (Wilkinson et al., 2016). Therefore, FAIR principles facilitate scholarly communication by promoting standardisation of metadata, persistent identification, documentation, interoperability, and transparency of reuse conditions. The onion framework broadens the understanding of research openness by identifying different levels of availability which include preregistered reports, data sharing, shared analysis, shared materials, and author-requested access (Bowman & Keene, 2018). Thus, it shows that the concept of openness is not uniform and includes different levels of access, transparency, documentation, and reuse which should be evaluated in relation to the specific type of research and its ethical considerations. UNESCO Recommendation on Open Science further broadens this understanding by placing openness in a larger context of scientific knowledge, infrastructure, collaboration, and inclusive participation. It also pays attention to international collaboration and equitable participation thus connecting open scholarly communication with global inequalities of knowledge production (Cudennec et al., 2022). Open Science promotes collaboration, which in turn allows a higher number of open scholarly communications (FICCI, 2024; Savona et al., 2025). According to Soliman et al. (2025), open science opens up possibilities for global collaboration and efficient knowledge production for researchers. It means that openness facilitates scholarly communication through making it faster, more visible, more accountable, and socially relevant. Academic and research libraries occupy a prominent position in the new ecosystem. The traditional mission of acquisition and access to scholarly literature transforms into managing of repositories, research data support, metadata generation, copyright advising, digital preservation, and advocating of open access. Cassella (2024) states that the new mission of libraries involves not only the traditional agreements on publishing but also supporting open science infrastructure and

evaluation models. It shows a change in the nature of librarianship in general: libraries are not only access points for publications but also partners in the whole research lifecycle. Libraries can help researchers choose proper repositories, apply the licence, organise data, follow funders' requirements, increase the discoverability, and preserve scholarly outputs. This aspect of open science is especially important as many researchers may agree with the idea of openness but lack the skills to implement it in practice.

Conclusion

Open science signifies a paradigm shift in the process of creation, dissemination, assessment, and access to scientific knowledge. Open science addresses the inherent limitations of traditional scholarly communications by fostering a greater level of openness in publications, research data, methodology, software, and collaborations. Open science thereby opens up new possibilities for international exchanges, verification, and re-use of knowledge. The development of digital research infrastructure, policies, and international collaboration have played crucial roles in the development of open science and helped open science become more prominent within the current research environment. The future development of open science will depend on overcoming numerous challenges that are related to sustainability of infrastructure, access, privacy, intellectual property rights, research incentives, and disparities in digital skills and competencies. However, the implementation of open science itself will require coordinated efforts of researchers, academic libraries, publishers, funders, institutions, policy makers, and society at large.

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