Eight Critical Issues in Information Policy for Data-Driven Innovation

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Abstract

The data-driven model of research innovation promotes new information service demands, thereby necessitating developmental guidance through science and technology information policies. This paper systematically reviews eight key issues in science and technology information policy: copyright law and contracts, copyright and trade agreements, copyright exceptions and limitations, orphan works, technological protection measures, reproduction rights organizations, Creative Commons, and open access. The conclusion is that these eight issues have already extended into numerous new implementation details of science and technology information policy; due to continuously evolving user demands, related decision support research should be dynamically adjusted.

Full Text

Eight Key Issues of Information Policy for Data-Driven Innovation

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Abstract The data-driven model of scientific research innovation stimulates new demands for information services, necessitating the developmental guidance of science and technology information policies. This article systematically reviews eight key issues in science and technology information policy: copyright law and contracts, copyright and trade agreements, copyright exceptions and limitations, orphan works, technological protection measures, reproduction rights organizations, knowledge sharing, and open access. The conclusion is that

these eight issues have already extended into more detailed implementation aspects of new science and technology information policies. As user needs continue to evolve, relevant decision-support research should be adjusted dynamically.

[**Keywords**] data-driven research innovation; science and technology information; information policy
[**Classification Number**] G209

In the new generation of scientific and technological innovation models driven by data, the importance of scientific and technological information cannot be ignored, as it plays a pivotal role. To better adapt to this new environment, we must address the new challenges brought by corresponding information policies. These challenges primarily involve ensuring that information policies facilitate measures related to information services, information content, and information access in the new environment.

In response to these challenges, this article identifies and discusses eight key points of science and technology information policy, delves into the contradictions between traditional information policies and the current information environment, and proposes possible future development directions.

1 A New Horizon for Scientific Research and New Requirements for Information Services

In the era of data-driven scientific research, we have ushered in a new horizon for scientific research and entirely new requirements for information services. Research on science and technology information policy now actively proceeds from the actual needs of researchers, striving to meet their various demands in the new environment.

This new research approach not only focuses on the needs of researchers but also fully considers the provision of actual scientific research information services. We deeply understand that quality information services constitute important support for research work; only by fully satisfying researchers' information needs can we better promote scientific progress and innovation.

Of course, we also clearly recognize that policy work plays a crucial role in this process. To better handle conflicting relationships among various parties, policy work is striving to find pragmatic and effective solutions. Our goal is to ensure that researchers can conduct their work smoothly in a favorable policy environment and continuously advance scientific and technological progress.

1.1 The Data-Driven Research Innovation Model

Over the past two centuries of scientific research history, humanity has established solid foundational theories and paradigms, achievements that need no elaboration. However, we also clearly recognize that passively waiting will not

lead to new scientific discoveries; instead, it may cause us to fall behind the times.

Scientific methodology initially began with observing phenomena, from which scientists induced principles and gradually deduced theories. As technological capabilities improved, scientific research entered the experimental stage, where hypotheses were verified and falsified, yielding relatively stable theorems under certain constrained conditions through iterative processes. Later, the leap in technological capabilities and the explosive growth of scientific literature propelled the launch of large-scale scientific research projects. These projects required enormous human and material resources; consequently, third-stage scientific research began emphasizing computing power.

The enhancement and protection of computing power have risen to the level of national development strategy. Unlike the past emphasis on population and resources, "computing power" has today become an important component of national strategic resources. However, since the beginning of this century, the science and technology system has experienced "structural disruption." We have discovered that merely assembling like-minded individuals is insufficient to fully meet the needs of innovation projects; we also need innovation services to support research and corresponding policies. Against this backdrop, the data-driven research model has emerged as a new paradigm. Unlike previous scientific research paradigms of "identifying problems → solving problems → establishing models," the new paradigm encompasses cycles of "imagining problems → creating phenomena → analyzing and explaining," causing structural disruption to foundational theoretical systems and even the division of labor in major applied technologies.

The fourth generation of scientific research relies more heavily on data, just as humanities scholars value "authentic historical materials" and social sciences emphasize "first-hand data." Scientific data has also become the key core of technological development. Without scientific data, we would find it difficult to conduct critical scientific and technological research, seriously affecting the progress of fourth-generation scientific research.

In response to this challenge, we have begun to pay attention to and study scientific data, generating a series of discussions. However, the current main focus lies in the computational processing and exchange patterns of scientific data. Issues such as the sources of scientific data, acquisition methods, and scope of use are equally worthy of in-depth exploration. On this matter, staff engaged in scientific research information services undoubtedly have deeper insights.

1.2 Information Needs of New-Form Research Services

In the era of data-driven scientific research, the role of scientific and technological information has become increasingly prominent while facing unprecedented challenges. However, every new challenge will bring new opportunities, prompting human progress.

History has repeatedly proven that the emergence of new technologies will not replace or eliminate traditional needs; instead, it will drive a leapfrog enhancement of original technological capabilities. The rise of experimental research did not eliminate the value of observational studies in scientific research but rather sublimated it. Similarly, in library and information services, the traditional scientific era required libraries to perform basic services such as literature collection, catalog establishment, and index provision, complemented by consultation and education to enhance users' information utilization capabilities and rights.

In the new scientific era, these foundational tasks remain important, but users' information needs and behavior patterns have undergone significant transformation. They no longer satisfy themselves with simple literature retrieval but have higher expectations for new services such as integrated data, computational data, and diversified resources. This transformation poses cutting-edge challenges for our library and information profession, requiring us to both deepen every aspect of library work and conduct extensive cooperation with non-library fields.

Focus of Information Service Work

Digitalization	Datafication
Collect literature → Establish catalog → Provide index Services, consultation, education	Integrate data → Operate data → Provide resources Integration, correlation, and recommendation of literature, data, institutions, facilities, conferences, publications, news, tools, personnel, projects, exchanges, etc.

In this context, the guiding role of science and technology information policy becomes increasingly important. To fully leverage new scientific and technological information service capabilities and enhance research productivity and competitiveness, we must have adequate management of science and technology information rights and interests. Only in this way can we ensure that researchers receive full support in their scientific activities in the new era and promote the vigorous development of scientific and technological undertakings.

Science and technology information policy for data-driven research indeed faces many challenges, but these are precisely the driving force and direction for our progress.

2 Current Ten Key Issues in Science and Technology Information Policy and Their Conflicts

Science and technology information policy is an important strategy closely related to scientific and technological development. In the new era oriented toward data-driven research, it is undergoing a series of transformations and challenges. Previously, policy decision-support services and policy decision-making were two relatively independent components. However, in a data-driven research environment, the boundaries between them gradually blur, generating new interactions and synergies. The role of science and technology information policy researchers is also changing in this process. They are no longer merely providing information but need to participate more in the decision-making process to ensure the sufficiency, correctness, accuracy, effectiveness, and rapid transmission of information. This is not merely a simple task transformation but an entirely new challenge to researchers' capabilities and vision.

2.1 Copyright and Trade Agreements

Trade agreements, as contractual agreements between two or more countries, provide preferential markets for goods and services. When signing these agreements, countries often need to adjust their domestic laws to comply with agreement terms, which affects how libraries handle copyrighted content and may trigger competition for financial priorities. Such challenges are evident in the serious concerns expressed by the International Federation of Library Associations and Institutions (IFLA) on April 11, 2012, regarding ACTA (Anti-Counterfeiting Trade Agreement).

Despite such challenges, we must remain optimistic. The existence of challenges means the coexistence of opportunities. In the process of copyright transforming into national law, libraries and their services will have new obligations, enforcement effectiveness, and assessments operationally. This simultaneously breaks the traditional balance between rights and exceptions, bringing new possibilities for transformation to the library community.

In the past, people often used "China's national conditions" as a starting point for explaining issues. However, today we increasingly need to face international scrutiny of China's national conditions. This is not only a challenge but also an opportunity to examine our own systems more comprehensively and meticulously, further reforming and improving them. Meanwhile, we must also recognize that joining international organizations will not only affect domestic systems but also bring more opportunities for international cooperation and exchange. Although regional free trade agreements may bring impacts from economic fluctuations, they also provide possibilities for seeking stable development in economically unstable environments.

Therefore, libraries should actively strive to become consulting parties in any trade negotiations, providing better services for the country and the people from our professional perspective. In short, while science and technology information

policy for data-driven research brings many challenges, the library community has the confidence to transform these challenges into new opportunities for development and contribute to social progress.

2.2 Copyright Law and Contracts

Copyright law safeguards the rights of copyright owners and users' copyright assets, providing a legal basis for libraries' preservation activities and fair use of assets. Meanwhile, contract law, as a legally binding private agreement, provides a platform for libraries to negotiate terms and conditions with various parties. In library operations, licenses are often contract-based and become important means for managing electronic products.

From an enterprise perspective, contract disputes primarily focus on the types and costs of disputes, seeking cost-effective solutions. Research further indicates that contract structure influences the dispute resolution process and outcomes, making the choice of structure a strategic decision. Particularly noteworthy is that contract effectiveness legally usually takes precedence over copyright law provisions.

However, a recent challenge lies in the perception that the online public domain is too broad and may damage intellectual property rights. The library community believes the focus should not overemphasize legal norms and technical restrictions on the fair use of cultural products but should address practical public needs such as the diversity and content quality of the public domain. Nevertheless, understanding the highly technical and complex English contracts drafted by international corporations remains necessary, as these contract clauses may transcend the legal jurisdiction of the library's home country and affect various library businesses. Therefore, libraries need dedicated personnel to review, modify, and negotiate contracts.

Facing complex issues between copyright law and contract law, between public rights and private rights, and regarding adaptation rights and reproduction rights, a feasible suggestion is to promote the integrated development of user activism, digital access, and preservation methods. Of course, this will also trigger new topics and challenges.

Overall, despite numerous challenges, we should maintain an optimistic attitude. Through continuous learning and innovation, the library community can safeguard rights and interests while meeting the needs of users and promoting the healthy development of science and technology information policy for data-driven research. This requires not only legal and technical support but also our wisdom and determination.

2.3 Orphan Works

In the new era of data-driven scientific research, developing user activism and digital access and preservation methods has increasingly become the core of

open access policy. Although the challenges are more complex when copyright owners cannot be identified, we should still maintain a positive and optimistic attitude.

Orphan works (OW), as copyrighted works whose current copyright owners cannot be located, are increasing in number, especially among online resources. This issue directly affects the mission of digital libraries to preserve cultural heritage through their collections. The expensive cost and time consumption of searching for orphan works may render efforts to find rights holders ultimately futile.

Currently, the prevalence of legal consultation in libraries is generally insufficient, which is an issue requiring attention. Libraries have the responsibility to copy and preserve, but in the future, they will likely need to obtain remote access permissions. Limited access time and energy may cause libraries' enormous digitization projects to ultimately produce so-called "dark archives."

How to handle orphan works involves major issues of long-term preservation and cultural development. This is a question still under contentious development but also a challenge full of opportunities. We need to seek consensus on this issue and explore solutions that can both respect and protect intellectual property rights and give full play to the functions of digital libraries to promote cultural development.

2.4 Technological Protection Measures

Technological Protection Measures (TPM) are technical means that control access to and copying of digital content through hardware, software, or a combination of both. Although there are subtle definitional differences from Digital Rights Management (DRM), the two terms are often used interchangeably. The existence of TPM/DRM is to prevent commercial copying, ensure copyright revenue, and also restrict consumer use, including normal uses such as format conversion and archive migration. This is because digital content is easily copied and manipulated, making it difficult to distinguish piracy from content alone. Therefore, to protect content ownership and security, many encryption methods combined with multi-signature authentication means have emerged, aiming to restrict users' use of content and ensure commercial copyright and profit.

However, these protection measures have also brought a series of problems. To protect copyright, TPM and DRM lead consumers to face different pricing models. Due to lack of interoperability (for example, locking consumers into a specific platform), these measures may cause anti-competitive behavior, price discrimination, and market segmentation. For instance, Apple once provided free applications to sell e-books below market price but was accused of conspiring with five publishers to monopolize the digital publishing market.

In this context, library consortia and their industry consensus become particularly important. The library industry should in principle adopt an opposing

attitude, or at least not encourage excessive reliance on technological protection measures. Instead, we should emphasize readers' rights to use information and information literacy education. By cultivating readers' information literacy, we can ensure the wide dissemination and effective use of information while protecting intellectual property rights.

As an important link in information dissemination, libraries have the responsibility to advocate for reasonable copyright protection measures to ensure the free flow of scientific research information and public access. Faced with challenges, we should maintain an optimistic attitude, actively seek solutions, and promote the healthy development of science and technology information.

2.5 Reproduction Rights Organizations

In the new era of data-driven scientific research, authors' rights to communicate with the public, including the right to "broadcast" their works, have become particularly important. Although this right is currently mainly used for commercial activities of broadcasting organizations, there is indeed some ambiguity in the legal boundaries between authors and broadcasting organizations regarding broadcasting rights. To address this issue, Collective Rights Management organizations have emerged, assisting owners (such as universities, corporate institutions, publishers, or aggregators) in authorizing users to use the works of authors, performing artists, photographers, and others in accordance with domestic and international copyright laws.

In this complex ecosystem, collective rights managers may also play the role of Reproduction Rights Organizations (RRO). For libraries, those they frequently interact with are typically publishers or aggregators representing RROs.

These reproduction rights organizations are usually responsible for authorizing the photocopying of books, journals, and other printed publications, and even issuing digital copying licenses. The existence of RROs undoubtedly presents libraries with a mixed situation of advantages and disadvantages. The benefit lies in that they enable users to copy legally, thereby reducing the burden on libraries to conduct cumbersome negotiations with copyright owners of works. However, the challenges are equally obvious: libraries are often in a weak position in negotiations, facing a binary choice of "accept the contract or terminate content services," and many treaties may contain copyright statutory exceptions detrimental to libraries. This further affects various aspects such as long-term preservation, open access, institutional information assurance, and knowledge management.

But even when facing these challenges, we should maintain an optimistic attitude. After all, these are precisely the challenges inevitably encountered in the continuous advancement and improvement of science and technology information policy for data-driven research. A balance of rights and interests needs to be found among authors, broadcasting organizations, libraries, and users. This is not only a legal issue but also a problem requiring collective wisdom,

collaboration, and innovation.

2.6 Creative Commons

In the Internet age, the traditional copyright model faces a series of challenges. However, Creative Commons licenses provide many positive solutions, allowing non-commercial copying and dissemination behaviors and bringing new possibilities for copyright management.

Although conflicts occasionally arise between the legal environment stipulated by copyright law for online works and social norms and expectations, we have reason to remain optimistic. These conflicts are precisely the driving force for us to find better solutions. By adapting to new copyright management models in the Internet age, we can provide clearer and more flexible rules for rights protection and use for both creators and users.

Creative Commons provides a simple method for writers, artists, musicians, and other creators to choose how and under what conditions to make their works available to users. Although the irrevocability of Creative Commons licenses (CCL) may be seen as a disadvantage in some cases, it also ensures that once a work enters the circulation domain, it can continue to be shared and used by the public.

Of course, to better implement Creative Commons licenses, we need to conduct more research in science and technology information policy. This includes starting with an overview of intellectual property, further describing alternatives to rights management (such as collective management and self-management), and analyzing how users manage their own intellectual property rights (such as partial transfer or obtaining economic benefits). This is a three-stage process from theory to policy to practice.

2.7 The Emergence of Scientific Creative Commons (SCC)

SCC is committed to eliminating unnecessary legal and technical barriers in scientific and technological innovation cooperation, providing researchers with a more open and smooth collaborative environment.

The long-term goal of SCC is to simplify the publishing, licensing, and access processes in research, enabling researchers to manage and share their research results more efficiently. The achievement of this goal will have a profound impact on knowledge management and institutional repositories, promoting academic exchange models toward a more open and efficient direction.

This emerging academic exchange model is called the sharing of research data among data-sharing researchers. It aims to promote the integration and public sharing of resources, breaking the barriers of traditional academic exchange models with the power of information technology. Although it still faces many difficulties in information technology, cooperation methods, and operational

mechanisms, this model has begun to have an important impact on scientific behavior.

2.8 Open Access

Open Access (OA) is an excellent policy that allows the public to freely access literature online and enables other users to easily read, download, copy, distribute, print, search, or link to full-text papers (Budapest Open Access Initiative, 2002). The driving force behind this policy is to maximize the impact of research funded by research foundations, making these research results available to the public.

For example, the Gutenberg-e digital publishing program supported by the Andrew W. Mellon Foundation bypassed traditional publishing enterprises, reducing the publication costs of high-quality works. This represents a completely new form of academic cooperation and community, expanding the readership of academic works.

The education sector has also begun to focus on Open Educational Resources (OERs) in bibliography evaluation, arts, history, development and projects, and their practice in institutional repositories and university education. Databases of Open Educational Resources (OER) facilitate knowledge access, create academic exchange opportunities, share teaching materials, and enhance teaching and learning experiences in higher education. These resources can be reused, translated, or modified, and even disseminated through social networks. These advantages have led countries to consider funding open access with public funds.

Although the operating expenses of current open access journals mainly rely on Article Processing Charges (APC), as Bjork and Solomon's research on 77 publishers shows, this model is being adopted by more and more publishers, while also considering other factors that may affect pricing, such as submission fees, paper length, and author nationality. Although further exploration is needed to achieve this model, we have already seen some positive signs.

The implementation methods of open access are also continuously expanding, for example, through open access journals and libraries based on institutional or disciplinary resources. OA journals are gradually becoming publishing platforms for high-quality research, as Xia, JF's h-index ranking study demonstrates.

Of course, we also realize that in promoting open access, we need to clarify the relationship between authors and institutions, including issues such as copyright ownership of works. This may require authors to negotiate when signing publishing contracts with traditional journals to ensure their papers can be freely accessed in institutional repositories. Although this process is still being explored, as long as all parties work together, we will surely effectively resolve these issues and promote the further development of open access to scientific research information.

3 New Challenges and New Opportunities

As the research field moves toward a data-driven era, science and technology information policy is facing a series of new challenges and opportunities. The eight issues discussed above have led to the emergence of a series of new policy topics, including government and funding agency open access policies, open deposit and sharing policies, the role of libraries in open access, and the rights management of scientific data. Each topic represents a new direction and challenge for the flow of research information, also indicating that we will see pro, con, and best practices for library and information services in subsequent discussions.

Viewed with cautious optimism, these challenges are actually opportunities for development. The continuous changes in user needs indeed pose challenges to science and technology information policy, but they also give us opportunities to dynamically adjust strategies and keep pace with the times.

We are no longer limited to traditional research models of establishing systems and delineating divisions of labor but can predict future trends and layout in advance along with the latest developments to gain more recognition and consensus.

Such challenges are actually a test of the depth of understanding of information resource management. This is an opportunity combining theory and practice, where we have the chance to truly implement policy-level theories into support for operational work. Only by stepping out of the office, communicating and coordinating with users and readers, and deeply understanding their actual needs can we provide better services.

Most importantly, we must never give up caring for and serving users. Library and information work has done many meaningful things in history serving the people; in the future, we must work even harder to keep up with our predecessors' footsteps, strive to understand the needs of practical work, and do a good job in science and technology information policy research and consulting services.

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Note: Figure translations are in progress. See original paper for figures.