Technology-driven Transformation of Literature Information Services: Review and Prospects Post-print

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Abstract

Since modern times, the development of libraries has, in a certain sense, been a result of technology-driven processes. The rapid advancement of information technology, exemplified by artificial intelligence, has presented both challenges and opportunities for libraries and librarians. Library and information services should objectively assess the impact of information technology, confront its challenges squarely, fully leverage the advantages and roles of technology, transform service concepts and models, enhance the professional competencies of library and information professionals, strengthen interdisciplinary and inter-institutional cooperation and exchange, balance the harmonious development between technological progress and information security, better meet user needs, and more effectively deliver high-quality services to users.

Full Text

A Review and Outlook on the Transformation of Technology-Driven Document and Information Services

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Abstract: The development of modern libraries has, in a sense, been driven by technology. The rapid advancement of information technology, represented by artificial intelligence, presents both challenges and opportunities for libraries and librarians. Document and information work should objectively assess the

impact of information technology, confront its challenges, and fully leverage its advantages to transform service concepts and models, enhance the capabilities of information professionals, strengthen interdisciplinary and inter-institutional cooperation and exchange, and balance the harmonious development between technological progress and information security, thereby better meeting user needs and delivering high-quality services more effectively.

Keywords: information technology; technology-driven; artificial intelligence; library; document and information services

Classification Number: G250

Over the past several decades, information technology has advanced by leaps and bounds, exerting broad and profound impacts across all industries. In particular, the emergence of artificial intelligence technologies such as ChatGPT is reshaping the models and capabilities of document and information services, bringing new transformations to libraries. In a sense, the development of modern libraries has been the result of continuous technological drivers. Therefore, we must consider: what impact has information technology had on document and information services? How should libraries view information technology? How should document and information work respond to information technology? In-depth exploration of these questions not only concerns how the library community understands and addresses information technology but also has direct and significant implications for the innovative development of document and information services.

1. Progress in the Application of Information Technology in Document and Information Work

In his article "Three Major Challenges for the High-Quality Development of China' s Library Cause," Wu Jianzhong specifically pointed out that "libraries should develop in step with technology" [1]. Over the years, numerous research findings have been published exploring the application of information technology in document and information work. A comprehensive review of this progress reveals several distinct phases.

1.1. Initial Computer Application Phase

(1) Computerized Retrieval. The earliest introduction of information technology into document and information work began in the 1950s. In 1954, the U.S. Navy Weapons Center Library developed the first information retrieval system using an IBM-701 computer, improving retrieval efficiency and marking the beginning of the computerized information retrieval era [2]. Computerized information retrieval remains a research topic in multiple disciplines, evolving from metadata retrieval to the association, mining, and analysis of digital content (data), thereby advancing research in knowledge discovery.

(2) Machine-Readable Cataloging. In 1966, the Library of Congress initiated its Machine-Readable Cataloging (MARC) pilot program, launching the application of computers in library cataloging. Mr. Liu Guojun specifically introduced this in 1975 and advocated for the introduction of electronic computers in libraries [3]. He subsequently published "Several Issues in Using Electronic Computers to Compile Library Catalogs" [4], which exerted important influence on future computer-based cataloging and library automation, earning him recognition as a "pioneer of library automation in China" [5] and marking the true beginning of libraries introducing and applying information technology. To date, this field has evolved from card catalogs to MARC, then to OPAC online cataloging, and further to OCLC' s WorldCat, which enables searching library collections worldwide, advancing the co-construction, sharing, and mutual awareness of global library information resources.

(3) Microform Technology. The emergence of microforms represented a new transformation in library collection organization. Microform technology enabled the microfilming preservation of documents, significantly saving library storage space while "restoring" the original appearance of literature. Although reading microforms still requires specialized equipment, this approach ensures the long-term preservation of document resources. Many foreign libraries continue to regard microforms and their reading equipment as important components of their collections and services. China' s National Library has established the "National Library Microform Reproduction Center" (i.e., the National Library Microform Department) [6], demonstrating the library community' s high regard for microform work and indicating that digitization has not replaced microfilming, or that microfilming itself represents a form of digitization.

1.2. Automation and Networking Application Phase

With the further development of computer and network communication technologies, integrated library systems (ILS) began to be widely applied in document and information work, achieving automatic control of various operations. Library automation systems originated in the late 1970s. In 1978, the U.S. National Library of Medicine (NLM) first officially used the term "integrated library system" (ILS) for its successfully developed library automation system [7]. In 1976, the National Science Library of the Chinese Academy of Sciences (formerly the Library of the Chinese Academy of Sciences), in collaboration with the Institute of Computing Technology and Institute of Physics of the Chinese Academy of Sciences, developed laser document retrieval software and explored computer-based literature retrieval experiments, pioneering the application of computers for library automation system construction in China [8]. In 1984, the Bibliographic Literature Publishing House translated and published the book *Library Automation Systems* [9], providing a relatively systematic introduction to the development of foreign library automation systems. Since the 1980s, numerous libraries and technology enterprises have independently or collaboratively developed multiple library automation systems, significantly enhancing

libraries' technological application capabilities. With the development and application of cloud computing, many companies have shifted from software sales models to software service models, providing users with various forms of cloud services. Characteristics such as reliable data storage, powerful computing capabilities, convenient application services, and significant economic benefits make cloud computing' s application prospects in library automation development extremely broad.

The development of integrated library systems represents a process from partial to comprehensive automation and from localization to cloud-based deployment. This process involves the advancement and application of various technologies, including computer hardware, software, and network technologies. Simultaneously, it involves changes and developments in various requirements. The emergence of library automation systems has largely transformed librarians' manual business models, automating processes from acquisition, classification, and cataloging to circulation and business statistical analysis. This has significantly freed librarians from transactional and procedural operations, greatly improving work efficiency and enabling libraries to focus more intensively on resource development and service quality improvement to meet user needs more effectively. Currently, domestic and international libraries and technology enterprises are developing next-generation automation systems with new functionalities oriented toward internet users and intelligent services.

1.3. Digitalization and Intelligent Development Phase

With the deep integration of information technology and document and information work, concepts such as digital libraries and smart libraries have emerged successively, transforming library document and information work from traditional paper-based models to digital, networked, and intelligent models. People can access needed document information anytime and anywhere, substantially improving the efficiency and service quality of library document and information work.

(1) Digital Library Construction. The emergence of the Internet in the 1980s and its widespread impact promoted the construction and development of digital libraries. In the early-to-mid 1990s, the American library community began exploring digital libraries, attracting high attention and active research and application from the international library community, including China. Related developments included electronic libraries, virtual libraries, digital libraries, and mobile libraries. In China, the concept of digital libraries was formally proposed and subsequently developed on a large scale at the 62nd International Federation of Library Associations and Institutions (IFLA) Conference held in Beijing in 1996. In July 1997, the "China Experimental Digital Library Project" was approved by the Ministry of Culture and the State Planning Commission as a national key science and technology project, with participation from six public libraries including the National Library of China and Shanghai Library. This project' s implementation marked the beginning of digital library construction

in China. The core of digital library construction is resource digitization and service networking, breaking the limitations of physical library services and providing users with anytime, anywhere library services, initiating a truly revolutionary chapter in library development history. Related research shows that over 4,000 articles have been published on digital library research in China [10].

(2) Smart Library Construction. Entering the 21st century, with the emergence of concepts and technologies such as search engines, big data, blockchain, cloud computing, the Internet of Things, and the metaverse, libraries have begun researching and exploring smart libraries, intelligent libraries, and metaverse libraries, marking a new research and application phase in digital library development. These concepts have become important components of libraries' "14th Five-Year Plan" and hot topics in related papers and conference discussions. In September 2023, the *Library and Information Service* magazine held the "Metaverse Library Opportunities and Challenges" and the 3rd Smart Library and Smart Services Academic Seminar in Chongqing [11], demonstrating the library community' s high regard for these frontier topics. At the end of 2022, with the emergence of ChatGPT, research on the significance and impact of artificial intelligence technology in the library community rapidly became the latest hot topic. The *Library and Information Service* magazine and other academic journals have also published "Policy Statements on AI-Generated Paper Content" [12].

Overall, the development process of information technology in library document and information work represents a journey from initial application to deep integration. Information technology has transformed the models of document and information work, improved its efficiency and service quality, and promoted the high-quality sustainable development of library document and information work.

2.1. Positive Impacts of Information Technology on Document and Information Work

Today' s library development results from the combined drivers of user demand and information technology. Technology-driven development is the outcome of user-driven development, which in turn requires the leverage of technology. Library development follows a logical system of "demand-resources-services," while also requiring support from elements such as technology, management, capability, innovation, and effectiveness. Our fundamental understanding is: demand-oriented, resource-based, technology-empowered, service-focused, management-centered, capability-prioritized, innovation-essential, and effectiveness-paramount. Among these, "technology" relates to all other elements and runs through them consistently; none can function without technological application. The degree of technological application will largely determine and influence the degree of library development. With other elements held constant, better technological application leads to better library development. From a technological perspective, library development is exhibiting four

trends: resource electronicization, business automation, service networking, and method intellectualization. Whether digital libraries that began construction over 20 years ago or smart libraries being built today, all are committed to continuously expanding and deepening these areas to provide users with more convenient, efficient, and precise services.

The development of information technology has profoundly impacted the transformation, reform, and innovation of document and information institutions. By transforming service models, providing personalized customized services, promoting digital transformation, and innovating knowledge management and services, it has greatly enhanced the breadth, depth, and efficiency of document and information services, strengthened the status, influence, and social contributions of document and information work, empowered and redefined document and information work in the new era, and brought new development opportunities and value.

2.2. Objective Examination of Information Technology by Libraries

From the process of libraries introducing information technology, librarians have always paid close attention to technology and remained highly sensitive to technological developments. Technology has driven library development, and technological capability has significantly impacted libraries.

However, we do not advocate or support "technology supremacy." Library development is not driven by technology alone but results from the combined effects of social demand, government support, and librarians. Technological development is not unlimited and is constrained by various factors such as policies, funding, conditions, and personnel capabilities. We must not confuse the function of technology as a means and tool with its role as an end and outcome. Technology provides support for library development, while the ultimate test of effectiveness remains libraries' professional capabilities, service levels, and service outcomes.

We need to fully utilize artificial intelligence technology. Large language models such as ChatGPT will substantially improve work efficiency, providing an "intelligent" means of problem-solving. With ChatGPT' s assistance, users' information searching, data collection, literature review, text translation, code writing, and program checking can be facilitated, helping users learn relevant knowledge and broaden their academic horizons. However, ChatGPT' s limitations are also evident, with extensive discussions on platforms such as Zhihu. In summary, these mainly include: the reliability of models, algorithms, and data remains to be verified; AI-based causal inference is essentially statistical relationship inference, not necessarily true causal relationships; artificial intelligence (machine learning) may incorporate fundamentally flawed language and knowledge into our technology like a virus, thereby degrading our scientific standards and moral norms; AI represented by ChatGPT currently still lacks human

consciousness or understanding capability.

Artificial intelligence is important, but it must also follow corresponding technological ethics rather than developing unrestrainedly. Some propose accelerating the development of robust AI governance systems, such as detection of AI-generated papers. The state is strengthening strategic deployment in the AI field, with the Ministry of Science and Technology launching the "AI for Science" special deployment initiative [13], publicly soliciting opinions on the "Trial Measures for Science and Technology Ethics Review" [14], and relevant departments issuing the "Standardization Guide for AI Ethics Governance (2023 Edition)" [15]. It is foreseeable that as people's understanding of artificial intelligence and other information technologies becomes more comprehensive and profound, the role of library information technology will also be recognized more objectively. Libraries should not blindly introduce and develop technology but should seek a balance between technology and humanities, pursuing more scientific and reasonable paths to problem-solving.

3.1. Transforming Concepts and Models of Document and Information Work

We must clearly recognize that technological development is independent of human will and will continue to accelerate. From American librarian F.W. Lancaster's 1978 "library extinction theory" proposing the so-called "three-no library" (no building, no collection, no librarians), to American librarian Brian T. Sullivan's 2011 "Autopsy of the Academic Library in 2050" presenting six justifications, these are all issues requiring vigilance in the library community. Technology is a double-edged sword; it is neither a "flood or beast" nor a "heavenly angel." AI is intelligent but not omnipotent. Information technology represented by ChatGPT directly challenges core functions and main businesses in the document and information field, including information organization and management, information retrieval, intelligence research and analysis, and scientific monitoring and evaluation [16]. This prompts our reflection: information technology is an important engine for the development of modern document and information work, and we should adopt a receptive and inclusive attitude, break through inherent human limitations and obstacles, actively utilize information technology, capitalize on its strengths, and avoid its weaknesses.

Against the backdrop of rapid information technology development, document and information work should proactively transform its work concepts and service models. Traditional document and information work primarily focused on document collection, organization, and provision. However, information technology development enables document and information work to better achieve knowledge management and knowledge services, emphasizing knowledge acquisition, integration, dissemination, and utilization. The application of computer technology, network technology, data mining technology, and artificial intelligence technology provides powerful support for the digital conversion and integration of document resources, in-depth mining and analysis of collection resources,

and improvement of information retrieval intelligence and precision. We are welcoming the era of smart library construction, and metaverse libraries are also emerging, all aiming to provide readers with more personalized, precise, high-quality, and efficient knowledge services. Therefore, the goal of document and information work should be established as knowledge management-based and knowledge service-oriented, fully integrating information technology into library services, empowering diverse application scenarios, expanding service scope, thereby enhancing overall service effectiveness and libraries' social education functions.

The warnings brought by artificial intelligence and other technologies require us to have a strong sense of urgency, fully recognizing the opportunities and challenges information technology brings to document and information work, reflecting on deficiencies in existing work models, exploring the irreplaceability of service capabilities, and accelerating our own transformation and reform. Those who do not reform will be reformed. Adapting to change through change, strengthening transformation and reform, and maintaining continuous innovation to adapt to external environmental changes constitute the only path forward for document and information work.

3.2. Enhancing the Core Capabilities and Competitiveness of Document and Information Professionals

Information technology is impacting work methods and models across all social industries. Artificial intelligence technology will cause some professions to disappear, and this possibility of replacement will increase and encompass more types of occupations. Librarians can hardly remain unaffected and immune. "Robot librarians" will become a new type of position in libraries, replacing some traditional librarian work. Information technology has placed new demands on the knowledge structure and professional capabilities of document and information professionals, causing some librarians to harbor deep concerns about their professional survival. Related research suggests that positions composed purely of manual repetitive tasks will disappear, and processes where human intervention or decision-making adds little value may be considered for automation development. Therefore, librarians should establish their sense of responsibility, mission, and urgency before technology, re-examining library business processes and work methods.

We maintain a cautiously optimistic view of librarians' future professional survival. If librarians' work remains primarily transactional and skill-based, simple and repetitive, procedural and operational, such librarians are likely to be replaced by robots. If librarians' work is primarily creative and innovative, emphasizes interpersonal communication and emotional intelligence, and is research-oriented and academic, such librarians will not be replaced by robots. Merely mastering basic information skills may be insufficient to support document and information position requirements. Regardless of technological development, librarians must play a principal and key role. Librarian capability is the library'

s competitiveness and its gene. If we say technology saves libraries from extinction, some argue humanities save libraries, but we believe service saves libraries, capability saves and strengthens libraries, and more importantly, innovation saves and strengthens libraries. Borrowing a famous saying from the business world: "Mediocre libraries manage resources, excellent libraries provide services, and exceptional libraries cultivate talent." Therefore, librarians' professional attributes should transform from a job to a profession and career. Libraries need expert librarians who can utilize technological means for creative labor and solve complex user problems. This requires full commitment and dedication, continuously improving professional and innovative capabilities, enhancing librarians' core service capabilities and professional competitiveness—this is the library' s core capability and core competitiveness.

3.3. Strengthening Interdisciplinary and Inter-institutional Cooperation and Exchange

Driven by information technology, cooperation and sharing have become important trends in document and information work. Through cooperation and sharing, we can better achieve optimal allocation and efficient utilization of resources and technology.

First, the document and information field should actively leverage its advantages in rich data resources and expertise in knowledge organization and management to cooperate with other institutions or platforms in jointly constructing large-scale data repositories or knowledge bases. This promotes integrated capacity building in data resources, infrastructure, and intelligent technology, achieving integrated fusion of software, hardware, technology, methods, and corpora, enhancing data mining and knowledge acquisition capabilities, providing more comprehensive and accurate data support for artificial intelligence technology applications, and offering corresponding knowledge solutions for knowledge application needs across various fields. Second, we should conduct in-depth cooperation with other disciplinary fields, promoting interdisciplinary crossing and fusion, advancing interdisciplinary academic research innovation and development, strengthening technical exchange and learning, understanding advanced domestic and international document and information work experiences and technical methods, jointly promoting the application and development of artificial intelligence and other information technologies in the document and information field, and innovating document and information intelligence analysis models and knowledge service models. Finally, many issues currently facing social development are complex systems that cannot be solved by single knowledge or skills. Future analysis models and knowledge services require more comprehensive and detailed data interpretation, scientific prediction and verification, the most effective and practical problem solutions, innovative systematic thinking and capabilities, and the ability to address more complex uncertain demands. This fully demonstrates that interdisciplinary and inter-institutional cooperation and exchange will truly bring stronger adaptability and innovation

capabilities to document and information work, assist in library talent cultivation, expand more resources and cooperation opportunities, and enhance the depth and breadth of service innovation and intelligent development.

3.4. Balancing Harmonious Development Between Technological Progress and Information Security

Technological application and progress bring new knowledge, value, capabilities, services, methods, and business formats while also raising concerns and reflections on technological ethics and information security issues.

The current data-driven research paradigm and the newly proposed fifth paradigm—AI for Science—both treat multi-dimensional data as fundamental resources. This fundamentally requires that all social activities and behaviors generate data and be recorded and preserved. Data collection and use are becoming increasingly convenient and concealed, and users' information security faces unavoidable challenges.

Document and information work needs to attach great importance to technological ethics and information security issues, especially in providing personalized customized services that require integrating, analyzing, extracting, summarizing, and presenting multi-level data including user information, demand information, and resource information. Issues of data leakage, intellectual property ownership, and privacy protection follow accordingly. Facing the risks of data transparency requires legal, normative, and ethical constraints, demanding that management institutions of document and information work dynamically formulate ethics and privacy protection standards that keep pace with the times, and timely update and regularly supervise the formulation and implementation of ethics and privacy policies. Simultaneously, in conducting services, we should clearly inform users about data collection, use, storage, and purpose descriptions to solicit user control and consent, conduct service work according to data minimization principles, and employ encryption, firewalls, and other technologies for security control and supervision to ensure user information security. Emphasis on information security is a responsibility requirement for document and information work institutions, a key to gaining and maintaining user trust, and legally significant for privacy protection. Only by using legal, technical, and organizational means in top-level design and specific service implementation to balance the risks between technological progress and information security, and by governing and controlling artificial intelligence and other technologies, can we truly provide users with safe, reliable, and precise service experiences.

Information technology continues to evolve rapidly, and user needs are constantly changing. Only by continuously enhancing their capabilities, including technical abilities, can librarians better respond to technological development and library transformation. In an era of increasingly complex user needs, libraries need to introduce and apply more advanced technologies. However, technology introduction is not for window dressing or application for applica-

tion' s sake, but to truly solve problems—problems that cannot be solved by librarians manually, problems that cannot be addressed by traditional library methods—to better adapt to user needs and provide high-quality services more effectively. This is a challenge but also a capability, and both libraries and librarians must be fully prepared.

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