Innovation in Library and Information Services in the Digital Era
A Systematic Review

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Abstract

The digital era presents both an imperative and an opportunity for library and information services to evolve beyond traditional standards. While the adoption of technologies like artificial intelligence (AI), open-access platforms (OA), and makerspaces is frequently discussed, the evidence remains fragmented across case studies, obscuring a comprehensive understanding of the full impact and consistent challenges. This study fills this knowledge gap by synthesizing empirical data on digital innovation in libraries using a thorough literature review anchored by the Technology-Organisation-Environment (TOE) framework. Following the PRISMA guidelines, we analyzed 85 peer-reviewed studies published between 2014 and 2024. Our findings identify four predominant thematic areas of innovation, such as intelligent discovery systems, scholarly communication infrastructures, digital literacy platforms, and the expansion into lending non-traditional items (Library of Things). The review confirms that these innovations significantly enhance operational efficiency, accessibility, user personalization, and community relevance. The TOE framework analysis reveals that digital innovation is consistently hindered not by technological limitations but by organisational barriers (financial constraints, skills gaps) and environmental pressures (funding models, competition). The study concludes that the sustainable integration of digital innovation is a strategic issue, requiring committed investment from parent institutions and a paradigm shift in library education. This review provides a consolidated evidence base for policymakers, library administrators, and LIS educators to make informed decisions for future-proofing library services.

Keywords: Digital Innovation, Library Services, TOE Framework, Open Access, Technology Adoption.

1. Introduction

Libraries have long served as the cornerstone of knowledge preservation and access within academic and public communities. However, the rapid acceleration of digital technology in the 21st century has fundamentally disrupted traditional information ecosystems. Libraries must

transform from passive repositories into dynamic, interactive, and user-centric knowledge centres in response to the changing expectations of users brought about by the emergence of artificial intelligence (AI), the Internet of Things (IoT), and pervasive digital communication (Bennett & Overseen, 2021). This transformation, often termed "digital innovation," involves the application of digital technology to create new or modify existing services, processes, and organisational structures to improve the quality and reach of library offerings.

While a substantial body of literature explores specific technological applications, such as the efficacy of chatbots in reference services (Xie & Tao, 2023) or the impact of discovery layers (Chen & Wang, 2022), the evidence remains uneven across isolated case studies and specific technologies. This presents a significant knowledge gap, that is, a lack of a macro-level, systematic synthesis that consolidates this scattered evidence to identify overarching patterns and explain the underlying factors that drive or hinder innovation in library and information service delivery. Consequently, it remains difficult to predict the pathways to successful digital transformation across diverse library contexts. This study uses a theoretical framework to guide its systematic literature review (SLR), which attempts to close this gap. Using the Technology-Organisation-Environment (TOE) framework, this assessment goes beyond just listing innovations and examines the factors that influence their successful or unsuccessful adoption. The main research questions guiding this study are:

1. Which digital innovations are most frequently used in library and information services?
2. What effects do digital advances have on the provision of library and information services?
3. In what ways do innovations in library and information services act as both facilitators and obstacles to adoption?

2. Technology-Organisation-Environment (TOE) Framework

This review uses Tornatzky and Fleischer's (1990) Technology-Organisation-Environment (TOE) framework to offer a systematic explanation for the adoption and effects of digital innovations. According to this perspective, three factors affect an organisation's choice to accept and use new technology: i) technological context: the organisation's relevant internal and external technologies, including their perceived benefits, compatibility, and complexity; ii) organisational context: the organisation's internal characteristics, such as its size, formal and informal structures, the caliber

of its human resources (skills), and any slack resources (like funding); iii) environmental context: the environment in which the organisation operates, including industry characteristics, competition, resource accessibility, and regulatory pressures.

In light of the TOE, for instance, Yang (2023) applied the TOE framework to understand AI adoption in academic libraries, finding that technical compatibility (Technological), top management support (Organisational), and competitive pressure (Environmental) were the most significant factors. Wang et al (2021) used the TOE framework to analyze barriers to research data management (RDM) services, identifying that technological complexity, a lack of skilled personnel (Organisational), and the absence of mandatory data policies (Environmental) were key impediments. Using TOE, De Souza et al (2017) investigated the impact of the digital divide on organisations. Regression analysis revealed that factors associated with a more intense use of ICTs by organisations included access to technology and the Internet, as well as ICT skills and attitudes. The digital divide in the context of many libraries is increasingly defined by second-order exclusion (unable to use the technology) rather than first-order exclusion, which is simply a lack of access to information and communication technologies (ICTs). This more complex obstacle shows itself as an adoption gap, when businesses have the technology but lack the organisational capabilities, digital skills, or strategic vision to use it successfully for growth and competitive advantage (De Souza et al., 2017). By using this framework, this review will provide an explanatory model for the patterns observed in the literature. The TOE framework is exceptionally suited for this study as it provides a complete structure to categorize and analyze the fragmented findings from empirical studies.

3. Empirical studies

The pace of digital transformation in library and information services has accelerated dramatically, necessitating an updated review of empirical research. This analysis synthesizes findings from recent empirical studies (2018-2024) that utilize the Technology-Organization-Environment (TOE) framework to investigate the adoption, impact, and challenges of innovation in libraries.

3.1 Predominant Forms of Digital Innovation: The Shift to Engagement and Openness

Recent empirical studies reveal an evolution in the forms of digital innovation beyond foundational systems. While next-generation Discovery Services remain critical, research now focuses on their integration with broader scholarly ecosystems. For instance, Bennett & Simning (2020), using a mixed-methods study, found that libraries are innovating by embedding discovery layers directly into learning management systems (LMS) and virtual research environments, significantly increasing resource integration into user workflows.

The most significant growth area is in Research Data Services (RDS) and Open Science infrastructure. In response to funder mandates and the open scientific movement, libraries are progressively creating RDS, encompassing data management planning support, data curation, and repository administration (Cox, Pinfield, and Smith, 2019). Alongside this, the adoption of Digital Preservation and Asset Management Systems has improved. A case study by Thompson, Palazzolo & Lee (2022) on a consortial digital preservation initiative highlighted the move towards shared, cloud-based platforms to ensure long-term access to digital collections.

Finally, experimentation with Advanced Technologies like AI and IoT has moved from conceptual to early implementation phases. Wu & He (2021), through a survey of academic libraries, documented the pragmatic use of AI for automated metadata generation and text mining, while also identifying significant concerns regarding algorithmic bias and cost. Similarly, Breeding (2022) provided empirical data from annual surveys showing a steady increase in the piloting of IoT applications, such as smart building systems for space utilization analytics.

3.2. Impact on Service Delivery: Measurable Outcomes and New Roles

The impact of these innovations is now being quantified with more robust empirical data. Studies confirm that service integration, like embedding discovery and librarians in LMS, leads to measurable increases in information resource usage and student engagement (Bennett & Simning, 2020). The impact of RDS is profoundly reshaping library staff roles. Tenopir et al.

(2020)**'s** longitudinal survey data revealed a marked increase in the time librarians spend on data-related support tasks, indicating a strategic shift from traditional reference towards expertise in data curation and management. This innovation directly ties the library's value to institutional research outcomes.

Furthermore, the COVID-19 pandemic acted as a obligatory innovation catalyst, providing empirical evidence on the impact of digitized service delivery**.** A large-scale study by Lippincott, Goldenberg-Hart, & Hemmasi (2021) found that the rapid adoption of virtual reference, online workshops, and curbside pickup/scan-on-demand services not only maintained but, in some cases, expanded library reach, demonstrating resilience and permanently altering user expectations for remote access. The pace of digital transformation in library and information services has accelerated intensely, necessitating an updated review of empirical research to showcase the adoption, impact, and challenges of innovation in libraries.

3.3 Contemporary Explanations for Challenges and Success

Applying the TOE framework to the recent empirical literature provides a clear understanding of the modern dynamics influencing innovation adoption in libraries. Within the Technological context, the key driver has evolved from mere functionality to interoperability and integration capacity. The success of digital innovations is now measured by their ability to seamlessly connect with a broader scholarly ecosystem through Application Programming Interfaces (APIs), embedding discovery layers into learning management systems and integrating research data services with identifier platforms like Open Researcher and Contributor Identity - ORCID (Bennett & Simning, 2020). However, significant challenges persist, for instance, the technical complexity of systems, particularly for digital preservation, remains a hurdle. Furthermore, emerging concerns over data security and user privacy, especially with the adoption of IoT and analytics tools, and the growing burden of technical debt from maintaining legacy systems while investing in new cloud-native applications, are prominent technological barriers identified in recent surveys (Breeding, 2022; Wu & He, 2021).

The Organisational context continues to be empirically identified as the most critical determinant of innovation success or failure. According to recent research, the two biggest indicators of which

libraries were able to successfully transition to digital-service-only models during the COVID-19 epidemic were strategic leadership and a risk-tolerant culture (Lippincott et al., 2021). Beyond leadership, the most pressing organisational challenge is the acute skills gap. As libraries move into areas like research data management and digital scholarship, there is a severe shortage of staff with expertise in data science, coding, and advanced metadata schemas, forcing institutions to choose between extensive upskilling, hiring new talent, or forging external partnerships (Cox et al., 2019). Ultimately, an organisational culture characterized by agility, user-centred design, and the presence of internal innovation champions is a recurring theme in case studies of successful implementation.

Finally, the Environmental context exerts powerful and often competing pressures on library innovation. Despite internal resource limitations, the rapid development of research data services is compelled by external funder and publisher mandates for open access, data management strategies, and open data (Tenopir et al., 2020). Similarly, the competitive information environment, characterized by user expectations set by commercial platforms like Google and Amazon, pressures libraries to provide equally seamless and user-friendly digital experiences. On the other hand, ongoing economic uncertainties and financial limitations provide a significant environmental problem, making the high price of sophisticated AI or digital preservation systems unaffordable (Breeding, 2022). In response to these environmental pressures, the strategy of forming consortial and collaborative partnerships has been empirically shown to be a highly effective model for sharing costs, expertise, and infrastructure, making large-scale innovation feasible for individual libraries that could not undertake it alone (Thompson et al., 2022).

4. Methodology

Using a systematic literature review (SLR) technique, this study made sure the procedure was transparent and replicable by following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria. Using a Boolean query built around the concepts of innovation, library services, and particular digital applications, a thorough search was carried out across four major databases, including Scopus, Web of Science, Library and Information Science Source, and LISTA, for peer-reviewed studies published between 2014 and 2024. Two stages of screening titles/abstracts and full texts against predetermined eligibility criteria were used in the study

selection process, which focused on empirical research reporting on the impact or implementation of digital advances in libraries. A total of 85 studies were selected for final inclusion. Data from these studies were extracted into a standardized matrix and subsequently analyzed using a thematic synthesis approach, where emerging patterns of innovations, impacts, and challenges were inductively coded and then interpreted through the analytical lens of the Technology-Organisation-Environment (TOE) framework.

5. Findings and Discussion

This systematic review sought to map the landscape of digital innovation in libraries and explain the factors influencing its adoption through the lens of the Technology-Organisation-Environment (TOE) framework. The analysis reveals a sector actively engaged in transformation, yet its progress is uneven and constrained by a predictable set of interrelated challenges. The following section presents and discusses these findings in direct response to the research questions.

5.1 Predominant Forms of Digital Innovation

The analysis identified four predominant, interconnected thematic areas of innovation, demonstrating that libraries are innovating across their entire service portfolio.

Intelligent Discovery and Resource Management

This is the most prevalent theme, focusing on technologies that enhance how users find and access resources and how libraries manage their collections. Innovations include the adoption of AI-driven discovery layers (e.g., Summon, Primo) that provide a unified, Google-like search experience across diverse databases and catalogues. These systems increasingly leverage natural language processing to understand user queries better, moving beyond simple keyword matching (Chen & Wang, 2022). Furthermore, the use of Radio-Frequency Identification (RFID) technology has evolved beyond automated checkout. Libraries now use it for advanced inventory management, generating useful maps of material usage to inform weeding and space reallocation, and for secure, automated sorting systems (Singh & Midha, 2021). Machine learning algorithms are also being piloted for predictive analytics in collection development, analyzing circulation data and academic trends to inform purchasing, and to offer personalized content recommendations to users (Wu & He, 2021).

Scholarly Communication and Digital Stewardship

At its core for libraries, scholarly communication includes the administration of Research Data Management (RDM) services and Institutional Repositories (IRs) in order to maintain and make institutional research outcomes publicly accessible. The innovation has expanded from simple document storage to curating complex digital objects, including datasets, code, and multimedia outputs. Libraries are leading advocacy for Open Access (OA) publishing models, often by establishing OA funds and advising on policy (Wang et al., 2021). They are also increasingly involved in large-scale digital preservation initiatives using systems like Preservica and Archivematica to ensure the long-term accessibility of both born-digital archives and digitized special collections, acting as crucial stewards of cultural and scholarly heritage (Thompson et al., 2022).

Digital Literacy and User Engagement Platforms

Using cutting-edge tools to meet people in their digital settings, the move towards digital literacy and user engagement platforms represents a fundamental progression from passive to active training. The implementation of AI-powered chatbots and virtual assistants on library websites serves as an example of this. These tools use advanced natural language processing to respond instantly to commonly asked questions around-the-clock and manage multi-turn conversations, but their efficacy is still reliant on human supervision for intricate, specific queries (Xie & Tao, 2023). This automated service is complemented by the deeply contextual practice of embedded librarianship, which has been revolutionized through seamless integration with Learning Management Systems (LMS) like Canvas and Moodle; here, librarians embed customized research guides, instructional videos, and live chat widgets directly into course pages, delivering point-of-need, assignment-specific support that is integrated into the student's learning workflow (Bennett & Simning, 2020). The library's role in the social digital landscape is being redefined by its proactive use of social media and digital marketing on platforms such as Instagram, TikTok, and Twitter, which go beyond traditional educational platforms. These platforms are no longer just announcement boards; they are now dynamic spaces for interactive storytelling, showcasing unique digital and physical collections, and cultivating an active, relatable online community presence.

Expansion of Physical and Digital Spaces ("Library of Things")

The expansion of physical and digital spaces, notably through the "Library of Things" model, represents a significant redefinition of the library's role and collection philosophy, moving beyond traditional media to circulate practical technology and provide creative infrastructure. This innovation encompasses technology lending programs that directly address the digital divide by providing equitable access to expensive items like laptops, mobile hotspots, tablets, and cameras, a service whose critical importance for education and social equity was overwhelmingly demonstrated during the pandemic (Lippincott et al., 2021; Burke, 2018). Concurrently, the establishment of makerspaces equipped with 3D printers, laser cutters, and Virtual reality -VR/AR technology transforms libraries into active hubs for creation, innovation, and hands-on learning, thereby fostering Science, technology, engineering and mathematics-STEM education, community entrepreneurship, and new modalities of digital literacy, which collectively alter the public perception of the library's function from a passive repository to a vital community platform for creation and collaboration.

5.2 Impact on Service Delivery

The synthesis of findings reveals that the successful implementation of these innovations yields significant and multifaceted positive impacts on service delivery, fundamentally enhancing the library's value proposition.

Enhanced Operational Efficiency and Resource Allocation

Automation through technologies like Radio-frequency identification- RFID and next-generation Integrated Library Systems (ILS) has drastically reduced time spent on routine tasks. For instance, a study by Singh & Midha (2021) documented a 70% reduction in time spent on inventory management post-RFID implementation. By increasing efficiency, professional personnel may focus on more complicated, value-added services like data consulting, systematic review support, and in-depth research consultations, which elevates the importance of library expertise.

Democratized Access and Promoted Equity

The expansion of digital services and unique lending programs has been transformative for access. 24/7 access to digital collections and virtual reference services is crucial for distance

learners, working professionals, and users with mobility constraints. Empirical evidence shows that technology lending programs, particularly mobile hotspot loans, have a profound impact. A study by the American Library Association (2022) found that over 90% of patrons borrowing hotspots had no other means of reliable internet access, making the library a critical agent in bridging the digital divide and promoting social equity.

Hyper-Personalized User Experiences

AI and data analytics are enabling a shift from a one-size-fits-all model to services tailored to individual users. Modern discovery layers can provide customized resource alerts and reading recommendations based on past search history and borrowing patterns (Wu & He, 2021). Furthermore, LMS-integrated tools deliver learning content and support specific to a student's course of study. This move towards personalization increases resource utilization, improves the user experience, and demonstrates a sophisticated understanding of individual patron needs.

Strengthened Community Relevance and Identity

Initiatives like makerspaces and unique lending collections have successfully attracted new demographics. Burke (2018) documents how "Library of Things" programs draw in entrepreneurs, artists, and hobbyists who previously had no engagement with the library. This firmly re-positions the institution from a quiet repository of books to a community's central platform for creativity, digital literacy, collaboration, and lifelong learning. This strategic shift is essential for securing the library's ongoing relevance and justifying its funding in the digital age.

5.3 Adoption Challenges through the TOE Framework

The most significant contribution of this review is its use of the TOE framework to move beyond cataloging challenges to explaining their interrelationships and root causes. The analysis reveals that the most formidable barriers are not technological but organisational and environmental.

The Technological Context

The review found that the perceived relative advantage of innovations (e.g., increased efficiency from RFID, improved discoverability from AI-driven search) was a primary driver for adoption (Chen & Wang, 2022). However, significant technological barriers persist. Complexity, such as the technical difficulty of integrating RDM systems with existing university IT infrastructure or

managing intricate digital preservation workflows, often deterred adoption (Thompson et al., 2022). Furthermore, compatibility issues between new, often cloud-based, applications and legacy library systems created significant technical debt, security concerns, and implementation hurdles (Breeding, 2022). This context shows that while the technology itself is often available and promising, its integration into existing digital ecosystems is rarely seamless.

The Organisational Context

This emerged as the most critical and challenging domain. A consistent finding was that a lack of slack resources, primarily financial constraints, was the single greatest barrier. The high initial capital investment for hardware/software, coupled with ongoing costs for licensing, maintenance, and upgrades, is prohibitive for many institutions, creating a tangible "innovation divide" between well-resourced and poorly-resourced libraries. This was compounded by the human resource quality factor, specifically a critical skills gap among existing staff. For instance, a library may acquire a sophisticated chatbot, but if the staff lack the data literacy skills to train its AI model with library-specific data and handle escalated complex queries, the innovation fails and leads to user frustration (Xie & Tao, 2023). Furthermore, the organisational structure and culture, manifesting as resistance to change from staff, a lack of visionary top management support, and siloed departmental structures that hinder collaboration, often stifled innovation initiatives. This demonstrates that the "soft" factors of culture, communication, and change management are as important as the "hard" factors of technology and funding.

The Environmental Context

Libraries operate within a broader ecosystem that exerts significant pressure. The competitive environment (e.g., from Google, Amazon, and commercial publishers) forces libraries to innovate to justify their value and distinctiveness. Partner relationships (e.g., with consortia for negotiating group licenses, with university IT departments for technical support) are crucial enablers without which many projects cannot proceed (Thompson et al., 2022). Most powerfully, the regulatory and funding environment is a major driver. Government and funder mandates for Open Access (e.g., Plan S) and data management plans are a powerful environmental pressure compelling libraries to develop new services like Institutional Repositories and open access publishing funds (Wang et al., 2021; Tenopir et al., 2020). Conversely, funding cuts from parent institutions (a key

environmental factor) are a direct cause of the organisational financial constraints previously mentioned, creating a vicious cycle that stifles innovation.

Synthesis and Discussion

The power of the TOE framework is in revealing how these contexts are not isolated but deeply intertwined. A library may seek to adopt a technology with clear benefits (Technological) but fail due to a lack of staff training (an Organisational factor) or insufficient funding from its parent institution (an Environmental factor). Conversely, an environmental OA mandate (Environmental) may force an organisational reallocation of funds (Organisational) and drive the technological acquisition of an IR platform (Technological). This systemic view explains the uneven adoption of similar technologies across different libraries and provides stakeholders with a clear, structured checklist of areas that must be addressed for innovation to succeed: not just the tool itself, but the people, the money, the culture, and the external pressures. The findings conclusively show that sustainable digital transformation is less a battle with technology and more a challenge of organisational capacity and environmental strategy.

6. Conclusion and Implications

6.1 Conclusion

This systematic review has methodically documented that digital innovation is fundamentally reshaping the core services and strategic identity of libraries, enabling transformative gains in operational efficiency, equitable access, and community relevance. The analysed innovations from AI-driven discovery layers and research data services to makerspaces and embedded librarianship collectively demonstrate a sector proactively adapting to the digital age. However, the transformative potential of these technologies is not being realized uniformly across the field. The TOE framework's application offers an effective explanatory view that unequivocally demonstrates that the biggest and most enduring obstacles to adoption are not technological in nature but rather have their roots in organisational limitations, such as ongoing funding shortages and critical skills gaps, and are influenced by strong external forces, such as the weight of regulatory requirements and competition from commercial platforms. Therefore, the sustainable integration of digital innovation is ultimately a strategic and managerial challenge that requires a holistic approach to addressing these multi-faceted, interconnected challenges.

6.2 Originality

A key original contribution of this research is the novel synthesis of recent empirical evidence through the structured lens of the TOE framework. This approach moves beyond labelling innovations to provide a diagnostic tool for understanding their adoption. By identifying and elucidating the specific interactions between technological, organisational, and environmental factors, such as how an environmental mandate drives organisational change which in turn necessitates a technological acquisition. Thus, this study provides a new, more clear understanding of the mechanics of library innovation that can guide future research and strategic planning.

6.3 Implications

The implications of these findings are significant for both theory and practice. For library managers, this review provides a validated checklist for strategic planning, emphasizing investment in staff development and organisational culture. For policymakers and parent institutions, it serves as evidence that sustained, strategic funding is required to treat libraries as critical knowledge infrastructure. For LIS educators, it underscores an urgent need to modernize curricula with digital competencies. Finally, for the research community, this study highlights the need for standardized metrics to measure the impact of innovation and suggests the TOE framework as a robust model for future inquiry into technology adoption in public service organizations.

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