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Digital Preservation for Sustainable Library Information

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ABSTRACT

This article examines digital preservation as a strategic approach to maintaining the uniqueness of information and the collective memory of libraries in the digital transformation era. The shift toward digital collections introduces challenges, including technological obsolescence, data vulnerability, and limited policy and human resource support. This study aims to analyze sustainable preservation strategies by focusing on institutional policies, governance, and librarian competencies. Using a literature review method, the study synthesizes recent scholarly works to identify key determinants of effective digital preservation. The findings reveal that sustainability depends on the integration of clear policies, lifecycle-based management, and the enhancement of both technical and strategic competencies of librarians. Policies provide a framework for consistency, governance ensures adaptive and risk-aware implementation, and librarian competencies bridge policy and practice. The study highlights digital preservation as a critical agenda for ensuring long-term information access and supporting future knowledge needs.

ABSTRAK

Artikel ini mengkaji pelestarian digital sebagai pendekatan strategis untuk mempertahankan keunikan informasi dan memori kolektif perpustakaan di era transformasi digital. Pergeseran menuju koleksi digital menghadirkan tantangan, termasuk keusangan teknologi, kerentanan data, dan dukungan kebijakan serta sumber daya manusia yang terbatas. Studi ini bertujuan untuk menganalisis strategi pelestarian berkelanjutan dengan berfokus pada kebijakan institusional, tata kelola, dan kompetensi pustakawan. Dengan menggunakan metode tinjauan pustaka, studi ini mensintesis karya ilmiah terkini untuk mengidentifikasi faktor penentu utama pelestarian digital yang efektif. Temuan menunjukkan bahwa keberlanjutan bergantung pada integrasi kebijakan yang jelas, manajemen berbasis siklus hidup, dan peningkatan kompetensi teknis dan strategis pustakawan. Kebijakan menyediakan kerangka kerja untuk konsistensi, tata kelola memastikan implementasi yang adaptif dan sadar risiko, dan kompetensi pustakawan menjembatani kebijakan dan praktik. Studi ini menyoroti pelestarian digital sebagai agenda penting untuk memastikan akses informasi jangka panjang dan mendukung kebutuhan pengetahuan di masa depan.

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1. INTRODUCTION

Libraries as information management institutions play a central role in collecting, storing, managing, and disseminating knowledge to society. Along with the rapid advancement of information technology, many libraries have increasingly developed and provided digital collections to meet users' demands for fast, easy, and unrestricted access to information regardless of time and place. This transformation has fundamentally reshaped library collection management systems and introduced new challenges, particularly in

ensuring the long-term accessibility and sustainability of digital resources amid continuous technological change (Cahyaningtyas, 2026).

In this context, digital preservation has emerged as a strategic approach in modern library management. Marleni et al. (2022) define digital preservation as a series of processes aimed at managing digital information assets, including both born-digital materials and digitized content produced through media conversion using scanning technologies, digital cameras, or other imaging devices. Digital preservation encompasses selection, storage, preservation, and conservation activities designed to ensure sustainable access and extend the lifespan of digital content so that it remains usable for future generations.

Despite the recognition of digital preservation and conservation as essential strategies for sustaining library information, existing literature indicates that their implementation continues to face complex challenges. These challenges are not limited to technical issues such as inadequate technological infrastructure and the risk of digital format obsolescence, but also extend to managerial and policy-related concerns. Many libraries have yet to establish integrated digital preservation policy frameworks, resulting in preservation efforts that are often partial, fragmented, and reactive. Such conditions pose a serious threat to the long-term sustainability of access to digital information, particularly when legacy technologies become incompatible with newer systems.

The rapid growth of digital collections further intensifies sustainability challenges, particularly in guaranteeing long-term access to digital resources. Although digital preservation and conservation are widely acknowledged as critical components of modern collection management, various studies reveal persistent difficulties in their practical application, both technically and managerially. These include technological obsolescence risks, limited infrastructure and storage systems, and the suboptimal implementation of preservation strategies such as data migration and system emulation. These issues suggest that digital preservation practices in libraries have not yet been managed in a systematic and sustainable manner.

These challenges are compounded by limitations in human resources with specialized competencies in digital preservation. The literature highlights that insufficient conceptual and technical understanding among librarians directly affects the effectiveness of digital preservation initiatives. Moreover, the lack of integration of digital preservation policies into institutional management structures leads to practices that remain fragmented and reactive. Consequently, the sustainability of library information becomes increasingly vulnerable to data loss, digital media degradation, and system incompatibility with evolving technologies.

Based on these conditions, this article aims to provide a comprehensive conceptual understanding of digital preservation as a strategic effort to ensure the sustainability of library information through a literature-based study approach. The novelty of this study lies in its conceptual synthesis that integrates technological, policy, and human resource dimensions within a sustainability framework—an area that remains relatively underexplored in library and information science literature. By doing so, this study is expected to enrich the theoretical foundation of digital preservation and serve as an academic

reference for the development of policies and best practices in sustaining digital library collections in the digital era.

From a broader perspective, digital preservation is closely linked to the responsibility of libraries in safeguarding collective memory and ensuring the continuity of knowledge across generations. The loss or degradation of digital collections should not be viewed merely as a technical failure, but rather as a serious threat to scientific, cultural, and historical heritage. In the absence of systematic and sustainable preservation strategies, valuable digital resources remain highly vulnerable to technological obsolescence, institutional neglect, and limited management capacity. This condition underscores the urgency of positioning digital preservation as a long-term strategic commitment within library institutions.

Despite the growing recognition of its importance, existing studies on digital preservation tend to approach the issue in a fragmented manner. Much of the literature emphasizes technical mechanisms, such as data migration and system emulation, or focuses on specific institutional case studies without situating these practices within a broader sustainability framework. As a consequence, digital preservation is often treated as an operational or technical concern rather than as an integrated system embedded within institutional governance. In addition, there is still limited critical analysis examining how technological, organizational, and human resource dimensions interact dynamically in shaping long-term information sustainability, indicating a significant gap in the current body of knowledge.

Addressing this gap, the present study proposes an integrative conceptualization of digital preservation grounded in a sustainability-oriented framework that incorporates technological adaptability, policy alignment, and human resource readiness. By moving beyond predominantly descriptive and technically oriented approaches, this study highlights the interdependence of these dimensions and repositions digital preservation as a proactive and systemic commitment. Through this synthesis, the study contributes to strengthening the theoretical foundation of digital preservation while providing clearer directions for future research and policy development in sustainable digital library management.

2. METHOD

This study uses a qualitative approach with a library research method. The qualitative approach was chosen because this study aims to understand, interpret, and analyze the concept of digital preservation as an effort to sustain library information in depth based on theoretical studies and previous research findings. According to Sugiyono (2017), qualitative research focuses on revealing the meaning and understanding of a phenomenon through descriptive and interpretive analysis without involving statistical measurements, thus enabling researchers to explore patterns of thought and the development of digital preservation concepts. This is in line with Creswell's (2014) view that states that a qualitative approach provides space for in-depth analysis of relevant information sources. The library research method was used because this study focuses on reviewing library materials in the form of scientific books, journal articles, proceedings, and official documents related to digital preservation and the sustainability of library information. Library research allows

researchers to identify concepts, theories, strategies, and previous research results as a basis for developing a research framework. According to Zed (2014), library research is not merely collecting literature, but requires the ability to critically analyze the contents of the library to produce a systematic and argumentative synthesis of knowledge. Therefore, the literature sources in this study were analyzed selectively and in-depth to obtain a comprehensive picture of digital preservation as a strategic effort to ensure the sustainability of library information.

The data sources in this study were secondary data obtained through a search of scientific literature relevant to the topic of digital preservation and the sustainability of library information, including scientific books, national and international journal articles, proceedings, research reports, and policy documents. Data sources were selected selectively based on the credibility of the authors, the relevance of the topic, and the recency of the publications to obtain a strong theoretical and empirical foundation (Zed, 2014). The data collection technique used documentation methods by systematically reviewing and assessing the contents of the literature sources through literature identification, grouping themes, and recording the main ideas and findings of previous research. According to Sugiyono (2017), documentation techniques in qualitative research allow for the collection of conceptual and factual data through written materials that are analyzed in depth to produce a comprehensive synthesis and interpretation.

After data collection through documentation techniques in the literature study, the next stage is qualitative data analysis to interpret the collected literature. Data analysis in qualitative research does not rely on statistical calculations, but rather on the process of discovering meaning, patterns, and relationships between concepts in the literature being analyzed. According to Miles and Huberman, cited in a methodological study on qualitative data analysis, the stages of analysis include data reduction, data presentation, and conclusion drawing/verification, which are carried out interactively and iteratively to ensure the validity of the findings (Miles & Huberman in a methodological study, 2025).

To maintain the relevance and robustness of the analysis, this study uses literature spanning the last 10 years (2015–2025) as its primary sources, considering that the development of digital preservation is heavily influenced by the dynamic advancement of information technology. However, several classic works that have made fundamental contributions to the concept of digital preservation are still used as a theoretical foundation, even though they fall outside this timeframe. Thus, the combination of recent and classic literature allows for a comprehensive, contextual, and theoretically in-depth analysis.

3. RESULTS AND DISCUSSION

3.1. Digital Preservation as an Effort to Ensure Information Sustainability

Digital preservation is increasingly recognized as a fundamental element in ensuring the sustainability of library information. Recent research confirms that without a planned and sustainable digital preservation strategy, digital collections, including books, journals, manuscripts, and multimedia resources, are at high risk of loss of accessibility, media degradation, and even extinction due to rapid technological change. This situation

demonstrates that digital collection management cannot rely solely on short-term storage but requires a strategic approach oriented toward long-term sustainability of information access.

The findings of a recent literature review by Nurhidayah et al. (2025) reinforce this view by demonstrating that digital preservation strategies are directly linked to efforts to ensure long-term access to digital information. Their study confirms that digital preservation in the context of academic libraries cannot simply rely on storage technology but also requires robust metadata management, inter-institutional collaboration, and librarian competency development. Integration of these aspects is necessary to respond to various technological risks, maintain data security, and ensure sustainable access to information across platforms.

In line with these findings, descriptive research focusing on digital preservation strategies indicates that technical approaches such as format migration, software emulation, hardware refresh, and digital archaeology are effective concrete steps in strengthening the sustainability of access to digital collections. Fatwa (2020) emphasized that these strategies serve as anticipatory mechanisms against technological obsolescence, which has the potential to render digital content inaccessible if older technologies are no longer supported. Thus, digital preservation serves as an instrument for libraries to adapt to the dynamics of information technology developments.

In the context of historical and cultural collections, Denanty's (2023) findings indicate that digital preservation practices in Nusantara library collections have begun to be strategically implemented by national libraries. This study revealed that digital preservation is not only oriented toward data preservation but also toward protecting the historical and cultural values contained within these collections so that they remain accessible and usable by researchers in the future. These findings emphasize the role of digital preservation as part of efforts to maintain the nation's collective memory through sustainable information management.

Furthermore, research by Aulia et al. (2023) revealed that the role of librarians in digital preservation has undergone a significant shift. Librarians no longer merely act as collection managers, but also as guarantors of information access and drivers of digital preservation policy. A case study at the University of Indonesia Library shows that librarians play a crucial role in policy formulation and communication among stakeholders to maintain the sustainability of digital collections, despite still facing challenges related to hardware and software updates. This suggests that the success of digital preservation is highly dependent on the capacity of the library's human resources.

These findings are reinforced by Pasqui (2024), who explains that digital preservation, from an international perspective, is understood as the concept of long-term digital preservation. This concept views digital preservation as a process that goes beyond simply storing digital media, but also encompasses holistic digital curation by integrating storage, accessibility, and long-term utilization of information. Recent research confirms that an effective digital preservation model must combine technological elements, such as the use of cloud computing and metadata standards, with institutional policies and cross-library collaboration to build a sustainable preservation ecosystem.

At a deeper analytical level, the reviewed studies collectively indicate a paradigm shift in digital preservation from a predominantly technocentric approach toward an integrated socio-technical system. Earlier works, such as Fatwa (2020) and Denanty (2023), primarily position digital preservation within an operational and technical domain, emphasizing strategies such as format migration, software emulation, and the digitization of culturally significant collections, thereby focusing on how digital objects are maintained over time. In contrast, more recent studies by Nurhidayah et al. (2025) and Aulia et al. (2023) extend this perspective by incorporating managerial and institutional dimensions, particularly highlighting the importance of robust metadata management, inter-institutional collaboration, and the evolving strategic role of librarians as policy actors. Furthermore, Pasqui (2024) synthesizes these dimensions within the framework of long-term digital preservation, conceptualizing preservation as part of a holistic digital curation lifecycle that encompasses the creation, management, access, and sustained use of digital information.

This comparative analysis reveals that the primary distinction among these studies lies not in their overarching objective of ensuring long term access to digital information, but rather in the levels of intervention they emphasize, namely technical aspects such as formats and media, organizational aspects including policies and governance, and human aspects related to librarian competencies. Building upon this synthesis, this study proposes an Integrated Digital Preservation Framework consisting of three interrelated layers. The first is the Technological Layer, which includes migration, emulation, cloud storage, and metadata standards. The second is the Organizational Layer, which encompasses institutional policies, governance structures, and cross institutional collaboration. The third is the Human Capacity Layer, which covers librarian competencies, digital literacy, and strategic decision making roles. These layers interact dynamically within a continuous cycle oriented toward long term accessibility. From this perspective, failures in digital preservation are not solely attributable to technological limitations, but rather to imbalances or weak integration among these layers. Therefore, the theoretical contribution of this analysis lies in affirming that effective digital preservation requires a multidimensional approach that systematically integrates technical, organizational, and human factors into a coherent and sustainable system.

3.2.Challenges in Implementing Digital Preservation

The implementation of digital preservation in libraries faces multifaceted challenges encompassing technical, policy, and human resource aspects. Recent research findings indicate that these issues are not merely conceptual but also occur in the practice of digital collection management in various library institutions, both in Indonesia and globally. This situation confirms that digital preservation is a complex strategic agenda and requires a multidimensional approach in its implementation.

From a technical perspective, the characteristics of digital content that are susceptible to technological obsolescence are a major challenge in digital preservation. A literature review by Haresariu (2020) identified that hardware and software obsolescence has the potential to lead to loss of access to a library's digital collections. Digital storage media have

a relatively short lifecycle compared to physical collections, while changes in data formats can hinder long-term access if not balanced with mitigation strategies such as format migration and regular data backups. These challenges demonstrate that the technical aspects of digital preservation require continuous system updates.

The results of Kinanti's (2026) literature review reinforce these findings by concluding that the challenges of digital preservation are multidimensional and interconnected. Threats such as technological obsolescence, storage media damage, and decreased file format compatibility demonstrate that digital preservation cannot be positioned as a purely technical activity. Instead, digital preservation must be understood as a planned and long-term risk management strategy. Limited librarian competency, minimal budget support, and suboptimal regulations and operational standards further increase the vulnerability of digital collections to loss of access and information degradation.

Other findings from Alfanza and Rawanda (2024) indicate that the implementation of digital preservation is influenced by various factors, including developments in information technology, institutional policies, the methods used, and the characteristics of the digital materials being preserved. Each library institution faces different challenges, such as limited human resources, technological infrastructure, funding, and the readiness of policies and standards. Therefore, digital preservation strategies need to be tailored to the needs and capacities of each institution, while also being accompanied by ongoing system planning and updates to respond to technological dynamics.

From a policy perspective, literature studies reveal that many libraries lack a comprehensive digital preservation policy integrated into their institutional strategy. This situation often results in digital preservation being viewed as an additional activity, rather than a core component of long-term collection management. Haresariu (2020) emphasized that budget constraints and a lack of digital preservation expertise deprioritize preservation programs, leading to inconsistent and reactive implementation.

Research by Makmur et al. (2024) adds that policy challenges are also closely related to long-term budget planning and external support. In the context of digitizing ancient manuscript preservation, limited funding is a major obstacle affecting the sustainability of digital preservation programs. Without adequate financial support, libraries will struggle to maintain technology, develop human resource competencies, and regularly update systems.

In addition to technical and policy aspects, human resource challenges pose a significant obstacle to the implementation of digital preservation. Haresariu's (2020) study indicates that the limited availability of digital preservation expertise makes it difficult for libraries to make this activity a strategic priority. These competency limitations not only impact the management of technical systems, but also influence the formulation of internal policies and coordination between work units within the library organization.

This human resource challenge is reinforced by the findings of Makmur et al. (2024), who stated that librarians involved in digital preservation must have an understanding of the factors causing damage to digital collections, be open to new technological developments, and be able to continuously improve their technical skills. The need for ongoing training is

becoming increasingly important, given the continued development of technical competencies in digital preservation alongside the rapid changes in information technology.

A deeper comparative analysis of these studies reveals a converging perspective that digital preservation challenges are inherently systemic rather than isolated within individual domains. While Haresariu (2020) emphasizes technological obsolescence as the primary trigger of preservation risk, this view is expanded by Kinanti (2026), who reframes such technical vulnerabilities as part of a broader, interconnected risk ecosystem involving organizational readiness and resource allocation. In contrast, Alfanza and Rawanda (2024) adopt a more contextual approach, arguing that challenges vary significantly across institutions depending on technological infrastructure, policy maturity, and collection characteristics, thereby highlighting the situational nature of digital preservation practices.

Meanwhile, Makmur et al. (2024) extend the discussion by demonstrating that financial constraints and policy limitations are not merely supporting factors, but function as structural determinants that directly influence the sustainability of preservation initiatives. Collectively, these studies suggest a shift in the understanding of digital preservation from a predominantly technical concern to a holistic governance issue, in which the interplay between technology, policy frameworks, and human capital becomes determinative. This synthesis indicates that the success or failure of digital preservation initiatives depends less on technological solutions alone and more on the alignment among institutional strategy, long-term investment, and the continuous development of professional competencies.

3.3.Sustainable Digital Preservation Strategy and Synthesis

Sustainable digital preservation requires strong integration between policy, management, and librarian competency as the primary foundation for ensuring sustainable access to library information. In this context, digital preservation policies play a strategic role as a normative framework that regulates technical standards, workflows, data security, and institutional responsibilities in the long-term management of digital collections. Recent literature indicates that the absence of clear policies results in partial, reactive digital preservation practices, and vulnerabilities to the risk of loss of access due to technological obsolescence (Haresariu, 2020; Alfanzha & Lawanda, 2024). Therefore, digital preservation policies need to be positioned as an integral part of library collection development and knowledge management policies.

From a management perspective, digital preservation cannot be understood as a purely technical activity, but rather as a strategic governance process encompassing the planning, organization, implementation, and evaluation of the entire digital collection lifecycle. An effective digital preservation management strategy includes preservation metadata management, format migration, multi-layered backup, and ongoing technology risk assessment. This approach aligns with information lifecycle management theory, which positions preservation as a continuous strategic process from the planning stage to providing long-term access. Without strong policy integration and systematic management, technical strategies tend to be fragmented and less effective in addressing the dynamics of technological change.

Recent research confirms that the success of digital preservation is greatly influenced by the library's ability to integrate technology, policy, and collaboration between units and institutions to strengthen the resilience of the digital preservation system (Nurhidayah et al., 2025; Pasqui, 2024). Adaptive management enables libraries to respond to technological developments sustainably while ensuring continued access to information. Therefore, digital preservation governance must be understood as part of an institutional strategy, not simply an operational function of information technology.

In addition to policy and management, librarian competency is a key factor in building sustainable digital preservation. The role of librarians has shifted from traditional collection managers to strategic actors in policy formulation, digital system management, and monitoring the sustainability of information access. Required competencies include a technical understanding of digital preservation, metadata management, data security, and cross-disciplinary analytical and collaborative skills. Recent studies have shown that low librarian competency in digital preservation directly impacts weak policy implementation and the effectiveness of digital collection preservation strategies (Aulia & Salim, 2023; Makmur et al., 2024). Therefore, competency development through ongoing training is a strategic necessity for libraries.

A deeper examination of the reviewed literature reveals that the relationship between policy, management, and librarian competency in digital preservation is not merely complementary but structurally interdependent and mutually reinforcing. Studies such as Haresariu (2020) and Alfanzha and Lawanda (2024) position policy as a stabilizing mechanism, yet their findings also indicate that policy lacks operational effectiveness when it is not translated into adaptive and context responsive management practices. In contrast, Nurhidayah et al. (2025) and Pasqui (2024) advance this perspective by demonstrating that management functions as a dynamic interface that transforms policy into sustainable and scalable workflows, particularly in responding to continuous technological disruption. This comparison highlights a conceptual shift from a linear governance model in which policy dictates practice toward a more iterative and reflexive model where policy and management interact in an ongoing process of adjustment and alignment. When these findings are further examined alongside Aulia and Salim (2023) and Makmur et al. (2024), a significant structural limitation becomes apparent. Although governance frameworks may exist formally at the institutional level, their practical effectiveness is often constrained by disparities in librarian competency.

This indicates that competency should be understood not merely as a supporting element but as an enabling infrastructure that determines the extent to which policy and management can be effectively enacted. In this context, librarian competency can be conceptualized as a form of institutional capital that mediates the transformation of normative frameworks into measurable preservation outcomes. Taken together, these studies underscore the importance of an integrated governance approach in which policy establishes strategic direction, management ensures adaptability and continuity, and competency enables consistent and effective implementation. Without such integration, digital

preservation efforts are likely to remain fragmented, reactive to technological change, and limited in their capacity to ensure sustainable long-term access to digital information.

4. CONCLUSION

This study positions digital preservation as a strategic and systemic component of sustainable library information management in the digital era. The findings indicate that its effectiveness is not solely determined by technological capability, but by the alignment of three interdependent dimensions, namely institutional policy, governance-based management, and librarian competencies. Policies provide strategic direction and legitimacy, management operationalizes preservation through adaptive lifecycle processes, while competencies enable consistent and effective implementation. The absence of integration among these dimensions results in fragmented and unsustainable practices. Accordingly, this study proposes an integrated conceptual framework that redefines digital preservation as a governance driven and sustainability-oriented system rather than a purely technical function, thereby reinforcing the role of libraries as custodians of collective memory and ensuring long term access to digital information.

However, this study is limited by its reliance on a literature based qualitative approach, which constrains empirical generalization and contextual validation across diverse institutional settings. Therefore, future research should prioritize empirical validation of the proposed framework through case based or mixed method approaches, as well as examine the integration of emerging technologies and competency development models to enhance the scalability, adaptability, and effectiveness of digital preservation practices.

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