



Optimizing electronic archive management through information and communication technology for educational SDGs advancement

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ABSTRACT

The digital transformation in information and communication technology (ICT) has significantly influenced archive management in educational institutions. This study aims to explore how electronic archive systems are optimized to improve administrative efficiency and educational governance. Using a qualitative literature-based approach, the paper analyzes the concepts, systems, and legal aspects of electronic archive implementation. The findings reveal that institutions are shifting from manual to digital systems, leading to improved accessibility, transparency, and sustainability. This shift is crucial because effective electronic archive management enhances institutional responsiveness and aligns with the demands of modern education. The impact extends to strengthening digital literacy, ensuring long-term access to academic records, and supporting Sustainable Development Goals (SDGs), particularly Goal 4 (Quality Education) and Goal 16 (Peace, Justice, and Strong Institutions). Therefore, educational organizations must adapt strategically to ICT to maintain relevance and institutional resilience.

Keywords: archive, digitalization, education, ICT, sustainability

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INTRODUCTION

The optimization of electronic archive management has become an integral component of institutional governance in the digital era. In essence, archives are repositories of institutional memory, serving as references for administrative, legal, academic, and strategic decisions. With the advancement of information and communication technology (ICT), traditional manual archiving systems have progressively transitioned to electronic formats, enabling faster access, remote retrieval, and greater efficiency. This transformation is not merely technical; it reflects a paradigm shift in how organizations, particularly in the education sector, manage documentation in a sustainable and integrated manner. That is why many reports regarding ICT have been well-reported (Abdulmuhsin et al., 2025; Arciosa, 2022; Bolaji & Ajia, 2023; Dwiana et al., 2022; Gbadeyanka et al., 2024; Ibarrientos, 2024; Ibrahim et al., 2025; Wanjara & Ogembo, 2024).

Electronic archives offer improved traceability, security, and data lifecycle management that align with modern demands for transparency and responsiveness. The integration of ICT into archive systems has led to the emergence of digital platforms that accommodate various forms of media and support real-time access, ensuring institutional adaptability and continuity in an information-rich environment (Hakim, 2015).

Previous studies have explored the technical, legal, and organizational dimensions of electronic archive implementation. For instance, Sutirman (2015) emphasized the urgency of shifting from manual to digital systems due to the inefficiency and vulnerability of physical archives. Similarly, a study by Berisha (2015) discussed long-term storage challenges in digital environments, while another addressed the legal implications surrounding the authenticity and

admissibility of electronic records (Effendhie, 1993). International bodies such as the National Archives and Records Administration (NARA) and the Australian Archives have also defined electronic archives as machine-readable records created, communicated, and preserved through digital technologies. These archives not only document institutional functions but also act as legal evidence of transactions and decisions. Despite these developments, organizations still face significant challenges such as limited digital infrastructure, lack of skilled personnel, and resistance to change, especially in educational institutions where administrative culture is often slow to evolve (Syafitri, 2018).

This study aims to analyze how ICT-based electronic archive management can be optimized to enhance institutional performance, particularly in the field of education. By reviewing the theoretical and practical foundations of digital archiving, the paper identifies strategies to strengthen digital transformation through structured archive systems. The novelty of this research lies in its focus on integrating electronic archive practices within educational environments to support digital literacy, institutional efficiency, and the achievement of Sustainable Development Goals (SDGs), especially Goal 4 on Quality Education and Goal 16 on Peace, Justice, and Strong Institutions. Through this analysis, the study offers insights into how archive optimization contributes to sustainable educational governance and information equity in the digital age.

The concept of electronic archives has evolved in response to the rapid expansion of digital technology and the growing need for efficient documentation systems. Although definitions vary across literature, a common understanding emphasizes that electronic archives refer to records created, processed, and stored using computer-based technologies. These records may originate in digital format (born digital) or be converted from physical formats through digitization. According to the Digital Recordkeeping Guidelines in 2004, electronic archives are designated repositories intended for long-term preservation of digital records. Some researchers support this by noting that such archives may include scanned documents or those directly created using digital platforms.

In the international context, the National Archives and Records Administration (NARA) define electronic archives as records that can only be processed through computer systems, while ARMA in 1984 refers to them as machine-readable records that require translation by computers for human comprehension. The Australian Archives emphasizes that electronic records serve as legal evidence of institutional functions and transactions, created and maintained within digital systems. Furthermore, other papers distinguish digital archives as integrated services managing collections of digital resources, including cultural heritage archives and academic repositories.

In Indonesia, the understanding of electronic archives aligns with global definitions but also incorporates specific local interpretations. Digital archives consist of binary-coded information that can be saved, opened, and erased using digital devices. Similarly, a report highlights digital archives as systems designed for long-term access to digital information, ranging from complex repositories to personal storage devices (Berisha, 2015). Other papers reinforce the view that electronic archives are essential tools for documenting institutional memory, especially in government and educational sectors. Legal frameworks, such as ITE Law No. 11 of 2008, further legitimize the recognition of digital documents as legally binding evidence.

Thus, the concept of electronic archives encompasses not only technological and functional definitions but also legal, administrative, and strategic dimensions. This multifaceted understanding provides a strong theoretical foundation for the analysis of digital archiving systems within institutions.

The management of electronic archives introduces various benefits and challenges that distinguish it from conventional paper-based systems. At the forefront, electronic records offer improved accessibility, minimal physical storage needs, and streamlined distribution. To better understand this, we refer to Figure 1, which outlines the life cycle of electronic archives from creation to depreciation. The life cycle emphasizes the systematic management of digital records, starting from creation, moving through storage, manipulation, and distribution, and ending in

eventual disposal. This cycle reflects the need for integrated approaches that manage electronic records across all stages to ensure consistency, legality, and accountability.



Figure 1. Electronic Archive Life Cycle

To compare these processes with conventional archiving, Table 1 presents the distinctions between the life cycles of electronic and manual archives.

Table 1. The comparison of electronic archive life cycle and conventional archive

Stage	Electronic Archive	Conventional Archive
1. Creation	Creating (digital format)	Creating (physical documents)
2. Storage & Rediscovery	Digital storage and metadata-based retrieval	Manual storage and physical search
3. Manipulation	Editable with software tools	Physical annotation or copying
4. Distribution	Instant sharing via network or email	Manual duplication or hand delivery
5. Depreciation	Digital deletion or migration	Physical disposal or destruction

From the comparison, it is evident that electronic archives streamline multiple processes by merging certain stages (such as creation and storage or distribution and use) into unified digital workflows. However, this digital efficiency also introduces complexities. For instance, the lack of physical evidence often leads to disputes regarding the authenticity and legal status of digital records. Some institutions still prioritize physical signatures and official stamps over digital verification, highlighting the need for stronger legal adaptation (Effendhie, 1993).

Moreover, the management of electronic archives requires institutional courage and capacity, especially when transitioning from legacy paper systems. Policy formulation, infrastructure readiness, and digital literacy among staff have become essential prerequisites for successful transformation. The use of internet-based platforms and offline systems further necessitates robust security measures due to the susceptibility of electronic formats to virus attacks, data corruption, and rapid obsolescence (Syafitri, 2018).

In practice, one of the most significant challenges lies in how organizations treat digital transformation solely as a technical concern. This perception often results in fragmented implementation and underestimation of the managerial, human, and ethical dimensions of archive management. To prevent this, a comprehensive understanding of the electronic record life cycle must be embedded in institutional culture and supported by capacity-building efforts (Rifauddin, 2016).

Information technology plays a central role in shaping modern archive management systems. As a cornerstone of knowledge management, ICT enables institutions to create, store, and disseminate records more effectively. ICT has revolutionized five key dimensions of organizational behavior: work processes, communication modes, efficiency perceptions, information creation and use, and the role of archivists. These changes signify that the integration

of ICT is not merely a tool for automation but a transformative force that reshapes institutional memory and operations.

In defining ICT, it is a convergence of computing and communication technologies used systematically in industrial and administrative settings. The classification of ICT tools (ranging from supercomputers to microcomputers) reflects variations in storage capacity, speed, and user load (Berisha, 2015). This diversity enables flexible deployment of archive systems based on institutional scale and needs.

One significant impact of ICT in archiving is the rise of non-textual and multimedia records, often referred to as "special format archives" or "new media archives". These digital records challenge traditional practices in conservation and call for advanced management strategies. The automation of archiving processes, from document scanning to cloud-based repositories, increases institutional efficiency but also requires strong regulatory frameworks to ensure integrity and accessibility.

Given these dynamics, it becomes clear that electronic archive management cannot be separated from broader technological ecosystems. Understanding both the opportunities and challenges of ICT integration is essential for ensuring that archive systems contribute meaningfully to institutional goals, including those in education and public service.

METHOD

This study employed a qualitative approach through a literature-based analysis to explore the optimization of electronic archive management in the context of ICT. The methodological approach followed the procedures outlined by Susilawati et al. (2025). Rather than collecting primary data, the study analyzed and synthesized existing theoretical frameworks, regulatory instruments, and research findings related to the management of digital archives. This method was selected because it allows for a comprehensive understanding of complex, interdisciplinary themes such as digital transformation, legal frameworks, institutional readiness, and educational governance.

Sources reviewed included academic journal articles, government regulations, digital archive standards, and institutional reports from both national and international bodies. The data collection technique was drawn from the previous studies (Al Husaeni & Nandiyanto, 2022; Al Husaeni & Al Husaeni, 2022; Rochman et al., 2024). Key references such as Law No. 11 of 2008 concerning Electronic Information and Transactions, Law No. 43 of 2009 concerning Archiving, and various guidelines from archival authorities like NARA and ARMA were used to frame the legal and technical foundations of electronic archive systems. The study also considered empirical observations from prior studies on the effectiveness and limitations of electronic archive systems in various institutional settings, especially within education and public administration (Muhidin, 2016; Rifauddin, 2016; Sutirman, 2015).

The analysis was structured thematically, focusing on three core dimensions: (i) conceptual foundations of electronic archives, (ii) managerial and institutional practices in digital archiving, and (iii) the role of ICT in enhancing archive system efficiency and compliance. Through this structure, the study aimed to draw conclusions about best practices and propose strategies for effective implementation in educational institutions. By grounding discussion in documented experiences and regulatory insights, this method provides a robust basis for understanding how ICT can be leveraged to optimize archival functions in support of SDGs, particularly in advancing quality education and institutional integrity.

FINDINGS AND DISCUSSION

Findings

Shifting paradigms in archive management

The transformation of archive management from manual to electronic formats represents a major shift in how organizations preserve, access, and utilize information. This shift has been driven primarily by advancements in ICT, which offer efficiency, accessibility, and security that traditional archiving methods lack. Institutions, particularly in the education sector, rely heavily

on accurate documentation for decision-making, legal compliance, and knowledge continuity. Manual archive systems, characterized by physical storage, require significant space and are vulnerable to degradation, disasters, and mismanagement. As a result, electronic archives have emerged as a strategic response to overcome the limitations of manual systems and align with digital transformation initiatives across sectors (Sutirman, 2015; Syafitri, 2018).

In contrast to traditional archives, electronic records are dynamic and non-material. They require digital infrastructure and specific technical knowledge for their creation, management, and preservation. The change is not merely about format but reflects a broader paradigm shift in institutional governance and administrative culture. The adoption of digital archiving systems requires not only investment in technology but also a rethinking of roles, workflows, and compliance mechanisms. Institutions that fail to modernize their archive management risk inefficiency, information loss, and reputational harm, especially in an era where transparency and data-driven governance are increasingly expected (Muhidin, 2016).

To understand how digital archives operate over time, we refer to Figure 1 shown previously, which presents the life cycle of electronic archives. The figure illustrates five core stages: creation, storage and rediscovery, manipulation, distribution, and depreciation. These stages emphasize the need for systematic processes in managing digital records, from their inception to eventual disposal. Unlike manual records, which may remain physically intact regardless of use, electronic archives require active maintenance and periodic migration to preserve accessibility and format integrity.

The shift to digital archiving has also influenced how institutions perceive efficiency and accountability. Information that once required days or weeks to retrieve from physical storage can now be accessed within seconds through keyword searches or automated indexing. This efficiency translates into quicker decision-making, streamlined communication, and improved service delivery, particularly relevant for educational institutions that manage diverse records such as student transcripts, academic calendars, curriculum documents, and research outputs.

Benefits and challenges of electronic archive systems

The adoption of electronic archive systems offers numerous benefits across operational, legal, and strategic domains. Institutions benefit from reduced storage needs, lower risks of physical degradation, and enhanced ability to share documents across departments or campuses. These systems enable automated backup, version control, and real-time synchronization, making them far superior to static, manual archives in dynamic organizational environments (Berisha, 2015; Rifauddin, 2016).

At the same time, the implementation of electronic archives introduces new challenges. One of the main concerns is the legal recognition of digital documents. Despite advances in digital signature technologies and regulatory frameworks such as Law No. 11 of 2008 on Electronic Information and Transactions, some institutions still prioritize physical signatures and wet stamps as authentic proof of documentation. This resistance reflects both cultural and procedural inertia that must be addressed through capacity-building and institutional policy reform (Effendhie, 1993).

In addition, electronic records are inherently fragile in ways that differ from paper-based archives. They are susceptible to file corruption, virus attacks, hardware failure, and format obsolescence. For example, a document saved in a proprietary software format may become unreadable if that software is discontinued or updated without backward compatibility. Therefore, digital preservation requires a proactive strategy, including format migration, system updates, and redundant storage solutions (Hakim, 2015).

To better understand these differences, Table 1 as shown previously compares the life cycles of electronic and conventional archives. The table highlights structural differences in how records are handled across both systems. In manual archiving, creation and storage are distinct processes, often involving multiple staff and physical handovers. Distribution typically requires physical transfer or duplication, increasing time and risk. In contrast, electronic archiving systems often merge these stages through software platforms where creation automatically links to storage and indexing. Distribution becomes instantaneous, facilitated by email, intranet, or cloud services.

However, this ease of use also contributes to information overload and raises concerns about record authenticity and redundancy (Muhidin, 2016).

The integration of electronic archive management into educational institutions has shown particular promise. Schools and universities, with their complex administrative needs, stand to benefit greatly from streamlined documentation processes. Digital systems support accreditation, data reporting, academic performance tracking, and student services—all of which rely on timely, accurate, and accessible documentation. However, successful implementation requires proper training, leadership commitment, and alignment with broader institutional digital transformation strategies (Syafitri, 2018).

Institutional capacity and legal frameworks

Beyond technical considerations, the successful implementation of electronic archives is heavily dependent on institutional readiness and regulatory alignment. Archive systems function within legal frameworks that define the authenticity, validity, and security of records. In Indonesia, the foundation for electronic records management is established through Law No. 43 of 2009 on Archiving and Government Regulation No. 28 of 2012. These regulations emphasize that archives must be managed professionally, systematically, and following technological developments.

Despite these mandates, many institutions struggle with limited human resources and infrastructure. The transition from paper to digital archives demands expertise in digital literacy, information systems, and records governance. Archival managers must understand both archival theory and ICT practice to ensure that records remain accurate, accessible, and legally admissible. Moreover, compliance requires institutions to continuously monitor changes in legal standards, technological innovations, and user expectations.

Efforts to professionalize archive management must include targeted training, technical support, and institutional incentives. Regulatory agencies such as the National Archives of the Republic of Indonesia (ANRI) play a crucial role in providing guidance, standardization, and certification for digital archiving practices. Such institutional collaboration is necessary to ensure that electronic archives serve not just internal operational needs but also public accountability, knowledge preservation, and educational sustainability (Muhidin, 2016).

Digital literacy and human resource readiness

One of the key factors influencing the success of electronic archive implementation is the digital literacy of institutional personnel. Archive management is no longer limited to filing and storing documents; it now requires understanding metadata structures, digital security protocols, and software navigation. Many educational institutions face challenges due to the digital skill gap among administrative staff, who are often unfamiliar with archive life cycles, content indexing, and document retrieval systems. As a result, even with adequate technological infrastructure, electronic archive systems remain underutilized or inconsistently applied (Muhidin, 2016; Rifauddin, 2016).

Human resource readiness goes beyond basic ICT skills. Effective electronic archive management involves knowledge of records appraisal, classification systems, retention scheduling, and legal compliance. Institutions must therefore invest in continuous professional development through workshops, certifications, and collaboration with archival authorities such as ANRI. This ensures that archive managers do not merely act as system operators but as information custodians who understand the ethical and legal implications of their work.

In educational contexts, this readiness is particularly urgent. Academic institutions manage a wide range of records—student databases, staff employment files, accreditation documents, learning materials, and research outputs. Mismanagement or data loss can disrupt academic operations, affect institutional credibility, and even result in legal consequences. Therefore, enhancing digital literacy among archive personnel directly contributes to institutional resilience and academic service quality.

Automation and system integration

The next evolutionary step in archive management involves not just digitization but automation and integration. Digitizing archives refers to converting paper records into digital formats, while automation focuses on streamlining workflows such as classification, metadata generation, version tracking, and document disposal scheduling. Integration ensures that electronic archive systems are linked with other institutional systems, such as human resource information systems (HRIS), academic information systems (AIS), and financial management tools. This interconnectivity enhances efficiency, reduces redundancy, and supports informed decision-making (Berisha, 2015).

In the context of education, integration can improve administrative turnaround times. For instance, when student academic records are linked with the university's accreditation reporting system, data retrieval becomes instantaneous, facilitating compliance with external audits. Automation also minimizes the margin for human error, especially in assigning document codes, applying retention rules, and generating reports. However, these advantages can only be realized if institutions invest in robust ICT platforms and ensure interoperability among systems.

Moreover, integrated electronic archive systems allow for centralized control and decentralized access. This means documents can be accessed by authorized personnel across campuses or departments, supporting collaboration without compromising data security. Access control, encryption, and audit trails are essential components that must be built into the system to protect institutional data and ensure regulatory compliance (Hakim, 2015).

Automation and system integration also play a role in environmental sustainability. By reducing the use of paper, physical storage, and manual transportation of records, institutions contribute to more sustainable operational models. This aligns with broader educational goals that promote environmental responsibility and digital transformation in support of SDG 13 (Climate Action) and SDG 12 (Responsible Consumption and Production).

Educational impact and institutional sustainability

Electronic archive management contributes directly to educational service quality. Accurate and accessible records enable schools and universities to serve students, faculty, and external stakeholders more effectively. Academic transcripts, course documentation, and faculty credentials can be retrieved in real-time, facilitating academic mobility, credential verification, and inter-institutional cooperation. These improvements enhance institutional credibility and align with the goals of modern education systems that value transparency, agility, and accountability (Muhidin, 2016; Syafitri, 2018).

Educational institutions are also expected to model good governance and information ethics. Implementing reliable archive systems reflects a commitment to these values. Furthermore, digital archives support pedagogical innovation by preserving instructional materials, research data, and intellectual property in ways that are searchable, shareable, and reusable. This contributes to continuous learning and knowledge dissemination, strengthening the institution's academic culture (Rifauddin, 2016).

From a governance perspective, archive optimization enables leaders to make evidence-based decisions. Strategic planning, budgeting, and policy formulation all require accurate documentation. When archives are fragmented, outdated, or inaccessible, decision-making becomes reactive and speculative. Conversely, a well-maintained electronic archive acts as a decision-support system, enhancing the institution's ability to navigate uncertainty and drive sustainable growth (Berisha, 2015).

The long-term sustainability of educational institutions is also influenced by their capacity to preserve their intellectual assets. Archives serve as repositories of institutional memory, capturing achievements, lessons, and milestones. In the context of higher education, where institutional histories can span decades or centuries, digital archiving ensures that this legacy is not lost due to material degradation or administrative turnover (Hakim, 2015).

Discussion

Institutional transformation through archival innovation

The transition to electronic archive systems often acts as a catalyst for broader institutional reform. When properly implemented, digital archiving does more than improve data handling; it transforms organizational culture, encourages policy development, and embeds digital competence as a core capacity. Educational institutions, in particular, experience institutional learning as they navigate the technical, legal, and behavioral dimensions of digital archive adoption.

Digital archive systems prompt institutions to reconsider how they define access, confidentiality, and record value. In manual systems, accessibility may be limited by location, staff availability, or physical deterioration. With electronic systems, institutions can adopt role-based access controls and standardized metadata to ensure both openness and protection. This transparency reinforces accountability, while protection protocols uphold privacy and legal compliance (Rifauddin, 2016).

Furthermore, institutions are encouraged to define record management policies that span the entire document lifecycle, from creation to disposal. These policies must include digital preservation strategies, data recovery plans, and audit mechanisms. The presence of such policies reflects organizational maturity and supports institutional accreditation and compliance with national education standards (Muhidin, 2016; Law Number 43 of 2009 on Archiving, 2009).

The process of establishing digital archive systems also promotes inter-departmental collaboration. Archiving no longer falls solely under administrative offices but requires joint effort from IT units, academic staff, legal counsel, and institutional leaders. This cross-functional collaboration fosters an integrative approach to governance and capacity building. Moreover, universities and schools that digitize their archives often position themselves as forward-looking institutions committed to quality assurance, digital transformation, and service excellence.

Information ethics and regulatory compliance

Ethical considerations are essential in the management of electronic archives, especially in educational environments that handle sensitive and personal data. Issues such as consent, data ownership, document manipulation, and retention periods must be addressed with clarity and consistency. For instance, student records often contain confidential information that should only be accessed by authorized personnel. A failure to protect this data can result in privacy violations, legal sanctions, and reputational damage (Hakim, 2015; Effendhie, 1993).

Compliance with legal standards is equally critical. In Indonesia, the legal framework for electronic information management is set by Law No. 11 of 2008 concerning Electronic Information and Transactions, and Law No. 43 of 2009 concerning Archiving. These laws mandate that digital documents must be treated with the same level of integrity and responsibility as their physical counterparts. Institutions are required to maintain accurate logs of document access and revisions, employ encryption and digital signatures, and ensure backup procedures are consistently followed.

An additional layer of regulation concerns document retention. Not all records need to be preserved indefinitely, archiving systems must incorporate retention schedules aligned with institutional and national policies. Some documents, such as financial reports or curriculum approvals, may be retained for a specified period, after which they must be archived offline or deleted to reduce digital clutter and comply with privacy regulations (Syafitri, 2018).

Information ethics also includes the right to information. Educational institutions are public service entities with an obligation to provide access to certain types of records for students, staff, and stakeholders. Balancing openness with protection requires well-designed access controls and clear communication protocols, ensuring that electronic archives contribute to both transparency and institutional integrity (Berisha, 2015).

The role of national archival institutions

The optimization of electronic archive management cannot be undertaken in isolation by individual institutions. It requires the guidance, standardization, and oversight of national archival

authorities. In Indonesia, the ANRI plays this crucial role by setting archival standards, providing technical assistance, and developing training programs for archivists. Through such coordination, ANRI ensures that institutions across sectors (including education) adopt consistent, lawful, and effective archiving practices (Muhidin, 2016).

ANRI also acts as a regulator that enforces compliance with national archival laws and evaluates the archival readiness of institutions. It provides templates for classification codes, retention schedules, and metadata standards that help institutions align with national policy. These efforts are essential in ensuring that archive systems are interoperable and that digital records from one institution can be understood, validated, and, if necessary, integrated by another.

Collaboration between ANRI and educational institutions extends to research and innovation. Through partnerships with universities, ANRI can co-develop software, conduct training for archival science students, and promote awareness of archive management as a professional field. Such synergy benefits both archival development and educational reform by embedding practical, real-world needs into academic curricula and institutional policy.

In addition, ANRI serves as a national memory repository. For educational institutions, this means that digital records such as historical enrollment data, accreditation results, and institutional reports may be preserved at a national level, ensuring long-term preservation beyond the lifespan of the institution itself. This supports public history, policy continuity, and intergenerational knowledge transfer.

Anticipating future developments in archival technology

The evolution of digital archives continues to be shaped by emerging technologies such as artificial intelligence (AI), cloud computing, and blockchain. These innovations offer potential for more intelligent document classification, automated metadata extraction, secure timestamping, and decentralized verification of document authenticity. While these tools are still in early stages of adoption in educational institutions, they hold significant promise (Yaman et al., 2022).

AI, for instance, can facilitate document recognition, categorize records based on content, and predict retention schedules using usage patterns. This reduces human error and increases processing speed. In educational contexts, this could support faster processing of student records, more responsive reporting to government bodies, and personalized information access for faculty and learners (Berisha, 2015; Rifauddin, 2016).

Cloud computing, already used in many universities, enables scalable storage and access from multiple devices and locations. This is especially useful for distance education models and satellite campuses that need centralized data access. However, cloud storage raises questions about data sovereignty, especially when servers are hosted outside national borders. Institutions must carefully consider legal implications and data protection policies before migrating entirely to cloud-based archive solutions.

Blockchain technology is increasingly explored for document authentication. With its decentralized ledger system, blockchain allows institutions to prove that a document has not been altered since its creation. This could be used for diploma verification, academic transcripts, or research publications, strengthening the credibility of educational records and reducing fraudulent claims (Yaman et al., 2022).

While promising, the adoption of these technologies should be approached strategically. Educational institutions must evaluate their technological readiness, human capacity, and regulatory alignment before integrating such tools. Additionally, collaboration with archival and IT professionals is necessary to translate these technologies into practical, sustainable applications.

Integration of archival systems in educational curriculum

Beyond its administrative and governance implications, electronic archive management offers pedagogical relevance that is often overlooked. Integrating archival literacy into the educational curriculum, particularly in fields such as information science, public administration, and educational management, prepares students to manage and evaluate institutional data

effectively. As institutions adopt increasingly sophisticated systems, future graduates must possess competencies in digital documentation, metadata architecture, and legal compliance related to electronic records.

Archival education promotes not only technical proficiency but also ethical responsibility. Students trained in this area are more likely to understand the importance of transparency, traceability, and privacy in managing information. These values are essential not just in academic settings, but also in future workplaces across the public and private sectors. Thus, digital archiving becomes both a functional tool and a means of cultivating professional integrity.

Educational institutions that actively engage students in the archive system design or policy review can promote project-based learning and institutional development simultaneously. For example, students can participate in digitizing legacy records, evaluating software platforms, or mapping document flows across departments. This practical engagement reinforces academic learning while contributing to institutional goals. Moreover, as universities increasingly prioritize community engagement, digital archiving initiatives may be extended to local governments or schools, creating opportunities for outreach and capacity sharing.

Embedding archive management within the curriculum also supports SDG 4 by expanding the scope of quality education to include digital and informational literacies. Such literacies are vital in the 21st century, where information is both an asset and a liability. Proper archival training ensures that graduates are equipped not only to consume information but also to protect, preserve, and ethically manage it (UNESCO, 2020).

Overcoming institutional barriers to implementation

Despite the growing awareness of the importance of electronic archives, many institutions continue to face structural and cultural barriers to full implementation. Resistance to change remains one of the most common obstacles. Staff accustomed to manual systems may be hesitant to adopt new technologies, fearing complexity, job displacement, or increased accountability. Addressing these concerns requires change management strategies, including stakeholder engagement, training, and gradual system integration (Muhidin, 2016; Syafitri, 2018).

Budget constraints also hinder implementation. High-quality electronic document management systems (EDMS), secure servers, and IT support staff require significant investment. Institutions must therefore prioritize archival transformation within broader digitalization agendas, ensuring adequate funding and policy support. This challenge is particularly acute in public institutions that rely on centralized budgeting and often face competing priorities.

Another key issue is the lack of national or regional interoperability frameworks. Even when individual institutions adopt digital systems, inconsistency in classification, metadata standards, and file formats limits the ability to share or migrate records. This problem undermines efforts to build a national education archive ecosystem and creates operational silos. Therefore, collaboration among educational institutions, government ministries, and archival authorities is essential to harmonize standards and promote sustainable implementation (Berisha, 2015; Hakim, 2015).

Legal uncertainty can also create hesitation. While laws such as the ITE Law provide foundational recognition for electronic documents, ambiguities remain regarding their evidentiary weight, especially in disputes or accreditation audits. This has led some institutions to duplicate archiving efforts (maintaining both paper and digital records, which defeats the purpose of efficiency and adds to the institutional burden. Clear guidelines, legal precedents, and regulatory assurance are needed to build confidence in digital-first or digital-only archiving models (Law Number 11 of 2008 on Electronic Information and Transactions, 2008; Law Number 43 of 2009 on Archiving, 2009).

Toward a culture of documentation and sustainability

The successful optimization of electronic archive systems ultimately depends not only on technology or policy but on cultivating a culture of documentation. In many educational institutions, documentation is treated as a routine or bureaucratic task, rather than a strategic resource. Changing this mindset requires sustained advocacy, leadership support, and clear

demonstration of how archives contribute to institutional goals, such as accreditation success, administrative efficiency, and academic continuity.

When documentation is embedded into institutional routines and valued as intellectual capital, electronic archiving becomes more than a compliance mechanism. It becomes a dynamic platform for institutional learning, quality assurance, and strategic foresight. For example, longitudinal data on student performance, faculty development, or policy outcomes can inform future planning, research, and innovation. In this way, archives shift from being static storage units to becoming active knowledge infrastructure (Rifauddin, 2016).

Moreover, embedding sustainability principles into archive management ensures that institutions remain adaptable in the face of technological, environmental, and societal changes. This includes not only reducing paper usage but also designing archival systems with scalability, resilience, and ethical use in mind. Sustainable archive systems minimize digital waste, respect data rights, and serve multiple generations of users. This aligns closely with the holistic vision of sustainability under the SDGs and positions education institutions as leaders in digital stewardship (UNESCO, 2020).

Optimizing electronic archive management through ICT is a multi-dimensional endeavor. It touches upon governance, pedagogy, ethics, technology, and sustainability. When approached strategically, digital archives can serve as the foundation for educational innovation and institutional resilience, ensuring that the past is preserved, the present is managed, and the future is anticipated.

Supporting the Sustainable Development Goals (SDGs)

The optimization of electronic archive management through information and communication technology (ICT) directly supports several Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education) and SDG 16 (Peace, Justice, and Strong Institutions). In the context of SDG 4, reliable and well-organized archive systems ensure that educational processes, such as admissions, certification, curriculum documentation, and academic reporting, are handled efficiently and transparently. Institutions with structured digital records can better guarantee student rights, uphold academic integrity, and comply with educational standards (UNESCO, 2020; Muhidin, 2016).

To understand how ICT influences archival transformation within the SDG framework, we refer to Figure 2, which visualizes the progressive relationship between ICT platform development and institutional archive behavior. As technology advances, archival procedures shift from manual to digital handling, which in turn redefines how records are created, accessed, and preserved. The figure highlights the cascading impact of ICT on archival automation, access policy, data governance, and institutional adaptability. It reflects that effective digital archiving is not merely a technical upgrade but a structural shift that supports sustainable governance and equitable information access (Muhidin, 2016).

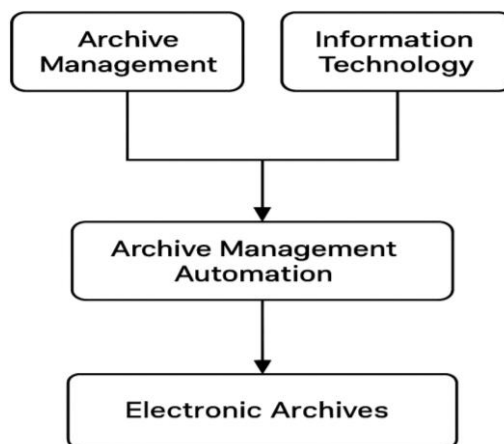


Figure 2. Influence of ICT Platform on Archive Management

Table 2. Previous studies on SDGs

No	Title	Reference
1	Low-carbon food consumption for solving climate change mitigation: Literature review with bibliometric and simple calculation application for cultivating sustainability consciousness in facing sustainable development goals (SDGs)	Nurramadhani et al. (2024)
2	Towards sustainable wind energy: A systematic review of airfoil and blade technologies over the past 25 years for supporting sustainable development goals (SDGs)	Krishnan et al. (2024)
3	Assessment of student awareness and application of eco-friendly curriculum and technologies in Indonesian higher education for supporting sustainable development goals (SDGs): A case study on environmental challenges	Djirong et al. (2024)
4	A study on sustainable eggshell-derived hydroxyapatite/CMC membranes: Enhancing flexibility and thermal stability for sustainable development goals (SDGs)	Waardhani et al. (2025)
5	Integrating multi-stakeholder governance, engineering approaches, and bibliometric literature review insights for sustainable regional road maintenance: Contribution to sustainable development goals (SDGs) 9, 11, and 16	Yustiarini et al. (2025)
6	Computational engineering of malonate and tetrazole derivatives targeting SARS-CoV-2 main protease: Pharmacokinetics, docking, and molecular dynamics insights to support the sustainable development goals (SDGs), with a bibliometric analysis	Merzouki et al. (2025)
7	Innovative nanofluid encapsulation in solar stills: Boosting water yield and efficiency under extreme climate supporting sustainable development goals (SDGs)	Namoussa et al. (2025)
8	Modernization of submersible pump designs for sustainable irrigation: A bibliometric and experimental contribution to sustainable development goals (SDGs)	Glovatskii et al. (2025)
9	Sustainable development goals (SDGs) in engineering education: Definitions, research trends, bibliometric insights, and strategic approaches	Ragadhita et al. (2026)
10	Sustainable packaging: Bioplastics as a low-carbon future step for sustainable development goals (SDGs)	Basnur et al. (2024)
11	Production of wet organic waste ecoenzymes as an alternative solution for environmental conservation supporting sustainable development goals (SDGs): A techno-economic and bibliometric analysis	Sesrita et al. (2025)
12	Hazard identification, risk assessment, and determining control (HIRADC) for workplace safety in manufacturing industry: A risk-control framework complete with bibliometric literature review analysis to support sustainable development goals (SDGs)	Henny et al. (2025)
13	Techno-economic analysis of production ecobrick from plastic waste to support sustainable development goals (SDGs)	Syahrudin et al. (2026)
14	Techno-economic analysis of sawdust-based trash cans and their contribution to Indonesia's green tourism policy and the sustainable development goals (SDGs)	Apriliani et al. (2026)
15	The influence of environmentally friendly packaging on consumer interest in implementing zero waste in the food industry to meet sustainable development goals (SDGs) needs	Haq et al. (2024)
16	Effect of substrate and water on cultivation of Sumba seaworm (nyale) and experimental practicum design for improving critical and creative thinking skills of prospective science teacher in biology and supporting sustainable development goals (SDGs)	Kerans et al. (2024)
17	Characteristics of jengkol peel (<i>Pithecellobium jiringa</i>) biochar produced at various pyrolysis temperatures for enhanced agricultural waste management and supporting sustainable development goals (SDGs)	Rahmat et al. (2024)
18	Contributing factors to greenhouse gas emissions in agriculture for supporting sustainable development goals (SDGs): Insights from a systematic literature review completed by computational bibliometric analysis	Soegoto et al. (2025)
19	The relationship of vocational education skills in agribusiness processing agricultural products in achieving sustainable development goals (SDGs)	Gemil et al. (2024)
20	Sustainable development goals (SDGs) in science education: Definition, literature review, and bibliometric analysis	Maryanti et al. (2022)

Furthermore, electronic archive systems support SDG 16 by fostering institutional transparency, accountability, and legal compliance. Archives that are well-managed and digitized reduce the risk of data manipulation, document loss, and unauthorized access. They also facilitate audits, accreditation, and public access to information, key indicators of good governance in education. This transparency promotes trust among stakeholders, strengthens institutional credibility, and aligns with national and international policy frameworks (Law Number 11 of 2008 on Electronic Information and Transactions, 2008; Law Number 43 of 2009 on Archiving, 2009).

Additionally, digitized archives help reduce regional disparities by enabling remote access to records. Educational institutions in underserved or geographically isolated areas benefit from centralized, cloud-based archives that eliminate dependence on physical storage or in-person document handling. This contributes to SDG 10 (Reduced Inequalities) by improving digital inclusion and equitable access to institutional services across different regions.

In this way, optimizing electronic archives is not only about operational efficiency. It is about realizing a broader vision of sustainable, inclusive, and resilient education systems. Finally, this study adds new information regarding SDGs, as reported in Table 2.

CONCLUSION

The optimization of electronic archive management through information and communication technology has become a crucial pillar in supporting institutional efficiency, transparency, and educational sustainability. This study has shown that digital archiving enhances data accessibility, legal compliance, and decision-making processes. Because electronic archives align with global standards and Sustainable Development Goals, particularly in education and governance, institutions must embrace digital transformation with strategic planning, professional capacity building, and ethical considerations. Ultimately, electronic archive systems are not just technical solutions but integral components of institutional resilience and long-term knowledge preservation.

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