



Evolution of digital archives as branch of archival science and document management: Comparison of practices in the USA and Latin America

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Abstract. The aim of this article was to provide a comparative evaluation of the adaptive strategies employed in the functioning of digital archives in the United States of America and leading countries in Latin America (Brazil, Mexico, Argentina). The study was based on a qualitative comparative analysis using theoretical analysis methods, case studies, and synthesis to compare the official strategies of the National Archives and Records Administration (NARA) and the Library of Congress with the strategies of the National Archives of Brazil, Mexico, and Argentina. Within the framework of this research, a systemic dichotomy in the maturity of the models in the USA and Latin America was identified. It was determined that the NARA functions as a mature Trusted Digital Repository that employs active preservation and ensures authenticity through complex, resource-intensive metadata Preservation Metadata: Implementation Strategies, and continuous preventive format migration. In contrast, it was found that archival institutions in Latin America employ a fragmented model of the Open Archival Information System, where investments are directed towards digitising historical heritage, rather than ingesting natively digital documents. Therefore, the study identified gaps in Latin America, such as infrastructure deficits (lack of ingestion systems in Brazil), personnel shortages (the dominance of an IT approach over archival science in Mexico), and financial instability, which undermine efforts to implement trusted digital repositories. As a result, authenticity in Latin America often relies on legal provisions rather than on the technical storage chain. The results of the study allowed for the formulation of a holistic approach as a recommendation for improving the long-term authenticity of electronic archives, which combines archival education reform and the creation of joint regional repositories as adaptive strategies. The practical value of the research lies in providing specific recommendations for the strategic adaptation of international standards for countries with limited resources

Keywords: resource limitations; long-term data preservation; digital transformation; ingestion; format migration; metadata

Introduction

The relevance of the research topic is determined by the transformation of the information environment, where digital documents are becoming dominant and requiring new approaches to their long-term preservation, access organisation, and authenticity assurance. In the context

of the global digital revolution, it is crucial to investigate and compare the strategies of two major cultural-geographical regions: the technologically developed United States of America (USA) and the countries of Latin America. Such a comparative analysis will not only uncover

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practices in the development and implementation of open archival systems (e.g., DSpace (n.d.), Fedora (n.d.)) and the formation of national digital heritage policies but also identify both universal and regionally specific issues related to data migration, metadata, legal aspects, and professional training.

The evolution of digital archives as a field of archival and document management research reflects significant progress in technology and methodology, influencing how records are created, stored, and accessed. This transformation is characterised by the integration of digital processes into traditional archival practices, emphasising the need for innovative approaches to managing the unique challenges posed by digital records. The research by E. Wibowo & T.A. Salim (2022) demonstrated a significant increase in the number of publications on digital archives (from 1988 to 2015), with modern trends forecasting further growth – digital archives and metadata standards highlighting the evolutionary nature of archival studies. Related findings were presented in the work of M.P. Damanik *et al.* (2024). The researchers noted the growth of digital archive management from 2001 to 2023, with increasing scholarly interest, particularly in records management, e-government, and blockchain, highlighting the sector's evolution toward using technology to optimise archival practices and enhance security. According to L. Jaillant (2022), digital archives have evolved, transforming the humanities by enhancing accessibility. Thanks to the development of open-source software and commercial software, archives that emerged in the digital world are now better preserved and managed.

The study by M.-A. Chabin (2021) outlined the dual digital transformation of archives, highlighting the availability of digitised analogue documents online and the surge in various native digital productions, significantly affecting archival processes and positioning archival research within information sciences. According to the researcher, while digitalisation changes archival practices, certain challenges arise for digital technologies. These include the fragility of media (issues with long-term preservation of digital data), decentralisation of storage, and the impact of big data and algorithms on methods of processing and utilising archival data.

An important issue in this area is the storage of electronic archival documents, their transfer to state storage, as well as the practical experience of archival institutions in the area of digital records. According to M.C. Miguel & R. da P.F. Costa (2021), technological innovations arising in the context of archives are directly related to their ability to evolve and adapt. Identifying and studying which of these new technologies can be best applied in archives could be a decisive factor in the evolution of archives. Researchers noted that the future of archives is still uncertain, but it points to certain directions, with a digital focus, universal access, though not free, inclusive, and developing faster and more dynamically than in the 20th century. Research by A.Ç. Akgün & N. Çiçek (2022)

showed that the evolution of digital archives requires rethinking traditional archival principles, such as provenance and original order, as electronic documents require new approaches to organisation and description due to their unique characteristics and vulnerabilities in information security.

The evolution of digital archives in archival and document management research reveals significant differences between practices in the USA and Latin America. Although both regions recognise the importance of digital documentation, their approaches to legislation, infrastructure, and access differ significantly. This review will examine key aspects of this practice, highlighting the legal framework, technological progress, and challenges faced in both contexts. The conclusion of the research by Y. Delgado López (2022) showed that digital documents are an integral part of a nation's documentary heritage. This emphasises their importance in the overall preservation of historical and administrative records. The legal protection position in both Mexico and Cuba, according to the research, does not provide for the physical or digital medium of support for digital documents and archives. It focuses on the content and authenticity, rather than on the specific format or method of storage. M. Afanador-Llach (2024) pointed to the uneven development of digital archives in Latin America compared to the Global North, highlighting the impact of historical colonialism on access and infrastructure, as well as the need to address power asymmetries in digitisation and cultural heritage management. The researcher noted that Latin American institutions face significant barriers in managing historical archives and developing digital infrastructures for access to cultural data, exacerbated by historical inequality, the digital divide, and geopolitics of knowledge, leading to delays in the development of digital humanities in the region compared to the Global North. The study by I. França (2023) noted that the evolution of archival science in Latin America highlights the integration of information and communication technologies and the shift to archives as instruments of government accountability and citizens' guarantees, contrasting with the American practice of digital archiving.

The literature review revealed a gap in comparative studies, which lies in the absence of a systematic comparison of the high-tech, resource-rich digital archiving practices of the USA with the regionally specific experience of Latin America. Thus, the aim of this research was to conduct a comparative analysis of the current practices of digital archives in the USA and leading countries in Latin America (using Brazil, Argentina, and Mexico as examples). The implementation of this goal involved a number of tasks: to analyse the legal and institutional models of digital archives in the USA (NARA) and Latin America; compare technological strategies for long-term preservation and ensuring the authenticity of digital archives; assess the challenges of access and inclusion to digital archival heritage in both regions.

Materials and Methods

The empirical research was based on an in-depth analysis and comparison of institutional and technological strategies for long-term digital preservation. A key factor in selecting the countries for comparative research was that they represent two systematically distinct models of digital archival science – the model of global leadership and high maturity (the United States) versus the model of resource limitations and adaptive implementation (Brazil, Mexico, Argentina). The data collection for this research was based on the analysis of legal regulations and international standards for auditing and certifying digital repositories. These included Law No. 15930 (1961), ISO 15836 (2017), ISO 16363 (2025), ISO 14721 (2025). The research was based on official strategic documents on archival data preservation and national archives, including the Digital Preservation Strategy 2022–2026 (2022), Library of Congress (LoC) (n.d.), Universidad Nacional Autónoma de México (UNAM, n.d.), International Research on Permanent Authentic Records in Electronic Systems (InterPARES, n.d.), AN digital: Digital preservation policy (Version 2) (2016), AGN International (n.d.). These materials were selected for the study as they represent the official foundation (legislative and institutional documents) of various digital archiving models. To analyse the socio-economic and cultural challenges faced by digital archival science in Latin America in the context of access to archival data, data on the digital divide (United Nations Development Programme, 2024), as well as the works of M. Arellano & J. Santillán-Aldana (2025), G.M. Gangurde (2025) were used.

During the writing of the research, qualitative methods were applied to structure the analysis. The theoretical analysis method was applied to study conceptual models, in particular, the Open Archival Information System (OAIS) (based on ISO 14721 (2025)) and Trusted Digital Repositories (TDR) (based on ISO 16363 (2025)), as well as key metadata standards such as Dublin Core (2025), Metadata Encoding & Transmission Standard (METS, n.d.), Preservation Metadata: Implementation Strategies (PREMIS, n.d.). The conceptual analysis method (comparing practical issues with the theoretical OAIS model) was used to study socio-economic and cultural challenges related to digital preservation in Latin America and compare them with the USA, to highlight the uniqueness of the challenges in Latin America (LAC – Latin America and the Caribbean). The case study method was used to analyse operational practices and their implementation in each country (USA, Brazil, Mexico, Argentina), covering the macro level (government policy). The comparative analysis method was applied to conduct an individual analysis of each case for comparison based on defined comparison criteria, covering the entire lifecycle of a digital record: the dominant preservation model (evaluation of the OAIS and TDR implementation level), preservation priority (focus on born-digital (natively digital) records versus digital surrogates (digitisation));

authenticity assurance (metadata); technological strategy; critical challenge (defining the greatest threat), education and human capital. The synthesis method was used to combine the requirements of the analysed standards into a unified set of criteria for assessing the maturity of digital archives. During this process, key aspects were considered: functional requirements (defining necessary processes, such as ingestion and preservation planning), TDR requirements, technical requirements (including the need for the preservation of the chain of custody and significant properties as mandatory conditions for long-term authenticity).

The interpretation of the results was based on a pragmatic and socio-economic approach. This approach allowed for the exploration of the problem of long-term digital preservation not only from a technical (what to preserve and how) but also from an institutional and resource perspective (why preserve, for whom, and at what cost). It also allowed for a comparison of international standards' requirements with the real possibilities and priorities of national archives (cases) to clearly adapt international digital preservation standards in different institutional and geographical contexts.

Results and Discussion

The evolution of archival science in the digital era marks a fundamental shift from the management of physical media and paper records to the long-term preservation of born-digital records and digital surrogates. This transition not only requires complex implementation of new technologies but also a radical reconsideration of traditional archival principles, particularly those relating to authenticity, integrity, and context. The digital transformation creates a new dynamic in document management, where the success of long-term access largely depends on the reliability and comprehensiveness of recorded metadata (dos Santos & Flores, 2020). International archival science (especially in the USA and the European Union) relies on two key conceptual models. The first is the OAIS (Open Archival Information System) model (ISO 14721, 2025), which defines functional requirements for any system designed for the long-term preservation of digital information. The OAIS case is not a specific archive but a conceptual framework that describes the necessary functions, information packages (SIP – Submission Information Package (n.d.); AIP – Archival Information Package (n.d.); DIP – Formats and Dissemination Information Package (n.d.), and external entities (producer, consumer, management), which must be present to ensure the long-term preservation of digital information. This model is considered a de facto international standard, enabling objective comparisons of architectures and processes, regardless of regional technological or financial differences (The Consultative Committee for Space Data Systems, 2024). The OAIS model introduces the concept of preservation planning, meaning that the archive does not simply store files but

also continuously monitors technologies and develops strategies (e.g., format migration or emulation) to ensure data remains readable, even if the original software and hardware no longer exist.

OAIS provides a common language for archivists, developers, and information producers worldwide. It clearly divides processes into six functional blocks (ingest, store, manage data, administer, preservation planning, access), allowing different systems to be compatible and share data. The model requires the archive to clearly define its designated community and adapt access packages (DIP) so users can understand the preserved information, rather than simply receiving a set of bits (ISO 14721, 2025). Therefore, OAIS is essential for transforming simple digital repositories into reliable, long-lasting digital archives that can serve as lifelong sources of historical, scientific, and administrative information.

The second concept is TDR, is an institutional and technical framework that requires regular audits (e.g., ISO 16363, 2025) and certifies that the repository is not only technically functional but also organisationally and financially sustainable. The TDR concept was developed to go beyond the purely technical requirements for long-term preservation (like OAIS) and ensure that the archival institution is capable of fulfilling its long-term obligations. TDR confirms that a digital repository is trustworthy. This means it not only has the correct systems and processes (complying with OAIS) but also possesses the necessary resilience, policies, and resources to operate in the future. Unlike OAIS, which is a model of "how the archive should work", TDR is a model of "how the archive should be organised and certified". The main mechanism for confirming TDR compliance is regular auditing according to international standards, notably: ISO 16363 (2025), which defines detailed metrics and requirements for audits. It evaluates three main areas: infrastructure and governance (Organisational Infrastructure) – evaluating the mission, policies, legal obligations, and financial sustainability of the repository; digital object management (Digital Object Management) – evaluating policies for acceptance, metadata creation, ensuring integrity and authenticity (technical compliance with AIP (Archival Information Package) OAIS requirements); technological infrastructure and security – evaluating security, backup, migration, and data integrity maintenance. Long-term sustainability within the context of TDR requires both financial and organisational stability. However, there is a universal challenge related to poorly defined costs for technical and organisational infrastructure. For highly developed countries like the USA, this issue concerns optimising existing systems, but for Latin American countries, these undefined but high costs can become an insurmountable barrier, calling into question the very possibility of meeting TDR standards, as this requires continuous "acid investments" (Formenton & Gracioso, 2025). Thus, TDR is an operational requirement subject to audit in

the USA, while for many institutions in Latin America, it remains an ambitious strategic goal.

The results of the current study confirmed the evolution of digital archives as a field of archival and document management research. This transformation has been driven by the need to integrate digital archives into the global information landscape. A related position was outlined in the work of P.F.C. da Silva & W.J. de Araújo (2024). According to the researchers, archiving represents a necessary evolution in managing digital records, integrating technologies such as artificial intelligence and machine learning, expanding accessibility and data processing efficiency, and highlighting the interdisciplinary nature of the field. The evolution of digital archiving, according to D.P. Udochukwu & C. Oraekwe (2021), emphasises the integration of digital collections for identifying, processing, and preserving valuable materials. The researchers pointed out the importance of preservation, accessibility issues, and practical solutions for strengthening the role of collecting and archiving institutions. A related position regarding the results of the current study was outlined in the work of J.B. Montoya-Mogollón & S. Troitiño (2020) the evolution of digital archives in archival science indicates the need for interdisciplinary approaches to solving problems of authenticity, reliability, and the preservation of digital records, integrating concepts from archival diplomacy and digital forensics for effective knowledge organisation.

A critical element of digital preservation is metadata, which provides identification, searchability, and, most importantly, confirmation of the authenticity of the digital object. In modern digital archives, these standards function as a hierarchical system. Dublin Core (2025) serves as the basic level for descriptive metadata, which is a universal standard for a minimal set of elements (usually 15), according to ISO 15836 (2017), for describing any resource. Its primary function is ensuring searchability and identification. Dublin Core is so simple and flexible that it has become the de facto base for quick cataloguing and inter-system data exchange, but it is insufficient for long-term preservation needs. Metadata Encoding & Transmission Standard (METS, n.d.) is an XML format used as a container or "wrapper" for encoding various types of metadata (descriptive, administrative, and structural) for complex digital objects. METS is supported by the Library of Congress (n.d.). Its necessity arises when working with complex objects (e.g., a digitised book consisting of hundreds of images or a website), where there is a need to aggregate various types of metadata (e.g., referencing Dublin Core for description, PREMIS for preservation); describe the structure of the object (page order, connections between sections); and ensure bulk transfer of objects between archives and repositories. PREMIS (n.d.) was developed by an international working group (with support from OCLC (Online Computer Library Center), RLG (Research Libraries Group)) and defines the essential preservation metadata

that must be independent of the specific technical implementation of the repository (e.g., in compliance with OAIS requirements). PREMIS metadata are indispensable for ensuring the viability, reproducibility, understandability, and, most importantly, the authenticity and identity of the digital object over time. They detail actions – the history of all actions performed on the object (migration, integrity check, format change); rights – information about intellectual property rights and access conditions; agents – who or what performed the actions (person, programme). PREMIS serves as a “digital journal” of the object, recording the chain of custody. Full repository systems require hundreds of PREMIS metadata elements for each stored item, making this process extremely labor-intensive and costly, but essential for confirming the authenticity of the archive.

The National Archives and Records Administration (n.d.) operates as a high-tech, centralised repository guided by a clearly defined strategy. The Digital Preservation Strategy 2022-2026 (2022) establishes the goal of identifying, preserving, and ensuring access to born-digital records and digital surrogates of the US government to protect citizens’ rights, ensure accountability, and document the national experience. The NARA digital preservation infrastructure is comprehensive. It includes tools for analysing collections, identifying and managing risks, and developing preservation action plans. A key element is the presence of necessary storage, network capacity, and systems for ingesting, processing, rendering, active file management, and system-to-system exports. The infrastructure also involves using accessible, managed, replicated content storage infrastructure (both local and cloud). NARA uses an active and resource-intensive approach to long-term preservation, which ensures the authenticity of records by confirming their reliability as an accurate representation of the original. NARA achieves this by documenting all digital preservation actions according to ISO 16363 (2025). This involves detailed metadata recording of all processes and transformations that the digital object undergoes.

One of the greatest challenges is combating technological obsolescence. NARA uses a strategy of preventive migration or format transformation. NARA’s infrastructure includes tools for forensic identification of formats and characteristics, which are used to assess obsolescence risks. Transformation is defined as the process of converting all files of a certain format or its version to a chosen, stable format. During this process, NARA strives to preserve the significant properties of the original. This active archive maintenance requires substantial ongoing investments in tools to perform format transformations. This strategy demonstrates that long-term authenticity in the high-tech environment of the USA is not a function of passive storage, but of continuous, costly, active, and technologically complex processes of migration and transformation. The success of this model depends on ensuring the adequacy of financial

flows to support these operational costs. Original files, regardless of their format, are stored in low-access storage, ensuring that the primary object remains accessible, even if its working copy is transformed (Digital Preservation Strategy..., 2022). According to J.-Y. Le Meur & N. Tarocco (2019), the field of digital archiving is in its infancy, evolving from traditional practices established for centuries for printed content. Current efforts are focused on standardised, systematic preservation methods, solving issues like format obsolescence and ensuring reliable digital repositories, as seen in CERN initiatives. According to R. Torrão Valentim & N. Bolfarini Tognoli (2020), the theoretical-methodological development of digital diplomacy, emphasising its convergence with digital forensics, reflects the evolution of digital archives in archival research, focusing on authenticity, integrity, and preservation of digital records. A.K. Higashi *et al.* (2020) discussed the complexity of digital archival records, highlighting the interdependence of preservation and storage chains and the need for reliable systems to ensure authenticity and access, emphasising the evolution towards comprehensive documentary treatment in digital archives. The results of R.S. Matoli research (2025) showed that digital preservation includes various methods and tools aimed at ensuring long-term availability, integrity, and usability of digital materials. These include data migration, emulation, and format normalisation. The researcher emphasised the importance of metadata in supporting context and usability, as well as the need for reliable backup and redundancy systems.

The Library of Congress (n.d.) case focuses on gathering, preserving, and ensuring access to the national creative and historical memory, which today is largely digital (born-digital documents, digitised collections). This makes it a key player in implementing OAIS requirements in practice. The Library of Congress plays a critical role in standardising metadata for digital archives (notably METS (n.d.)). LoC is a leading body that supports and develops this standard. METS is important for LoC because it allows complex digital objects and various types of metadata (descriptive, administrative, structural) to be aggregated into a single XML container. Alternatively, MARC (Machine-Readable Cataloging), although a traditional library standard, continues to be integrated by LoC into digital systems, adapting it for describing digital resources. LoC actively conducts research in long-term preservation, including challenges related to the variety of digital formats (format obsolescence), and is a partner in international initiatives. Its experience with millions of digital objects directly influences the formation of global best practices and often serves as a model for other national libraries and archives. Therefore, the Library of Congress is not just a user of standards but an active architect of the digital archival environment.

Digital archiving practices in Latin America are developing in the context of significant resource and infrastructure limitations. While internet access in the region

has increased significantly (thanks to universal access policies in Brazil, Chile, and other countries), the digital revolution remains incomplete. As of 2022, only 67.3% of LAC households had access to the internet, compared to 91.1% in OECD (Organisation for Economic Co-operation and Development) countries. There are significant disparities: only 46.4% of poor households in LAC had a fixed internet connection, compared to 84.6% for affluent households. Furthermore, urban households in LAC have double the access to the internet compared to rural ones (74.8% vs 35.8%) (United Nations Development Programme, 2024). This social and geographic digital divide directly affects the Access element in the OAI model, limiting the democratic potential of digital archives. Digital preservation in Latin America faces significant socio-economic and cultural challenges that hinder effective management and accessibility of digital information. These include budget constraints (insufficient funding for digital preservation initiatives, affecting their ability to implement sustainable practices (Arellano & Santillán-Aldana, 2025)); infrastructure limitations that hinder the development of effective digital preservation strategies and lead to potential data loss (Gangurde, 2025); historical inequality (the legacy of colonialism created inequalities in access to cultural heritage, impacting the digitisation of archival materials (Arellano & Santillán-Aldana, 2025)).

Socio-economic and infrastructure limitations in LAC impact the democratic potential of digital archives, creating a systemic access challenge (Access in the OAI model) that is unknown to the USA (United Nations Development Programme, 2024). In the USA, access infrastructure is almost universally available. However, in Latin America, even with the full digitisation of historical collections (the priority of the AGN (Archivo General de la Nación) of Argentina), the digital divide (the difference in access between urban/rural and rich/poor) limits the designated community (Designated Community) (AGN International, n.d.). This means that ensuring public access to archival heritage, which is the key social mission of archives, becomes incomplete and non-inclusive. Therefore, in LAC, the problem of digital archiving goes beyond purely digital archiving and becomes a socio-cultural problem of inclusion and inequality, where access to national memory is determined by economic status and geographical location. This forces LAC archives (unlike NARA, which focuses on technical authenticity) to balance between the technical authenticity of the future (born-digital) and the social inclusion of the past (digitisation of historical collections) (United Nations Development Programme, 2024).

Brazil demonstrates efforts to adapt international standards despite significant infrastructure barriers. The National Archives of Brazil (National Archives, n.d.) declares an institutional commitment to long-term

preservation, fully in line with the core principles of OAI (ISO 14721 (2025)). The declaration AN digital: Digital reservation policy (Version 2) (2016) is an official commitment by the National Archives of Brazil to adopt and follow internationally recognised archival standards in the digital domain – the OAI model, ISO 14721). The declared goal is to ensure three critical qualities of digital objects in the long term: recovery, understandability, and authenticity. This declaration signifies that the Brazilian archival institution formally recognises the need not only to preserve files but also to manage their life cycle (according to OAI functions – ingest, store, plan, access) to ensure the authenticity of digital records in the future. This declaration is an important step as the policy (defined by OAI management) precedes technological implementation. However, as the text reveals, the actual implementation of this commitment faces significant infrastructure and financial barriers. A. Lins & L.C.M. de Faria (2024) confirmed that the digital transformation of technologies, accelerated by the regulations of the Brazilian Ministry of Education (MEC) (2017-2022) and the COVID-19 pandemic, has radically reconfigured the management processes of academic archives, transferring them to the digital environment. This transition opens up opportunities for increased access and collaboration but also creates significant, often disproportionate, challenges for long-term preservation of documentary heritage.

Despite successes in policy adaptation and the use of open-source software, there are critical gaps that pose risks for the future: the lack of infrastructure for ingestion (the key finding is the absence of infrastructure for ingesting native-digital electronic records in national and provincial archives. This gap means that the system lacks the physical capability to properly manage state fund flows, even with quality preservation policies); financial overload – although open-source software removes the burden of licensing, it only shifts the financial burden to critically important expense categories: system integration and customisation, human resources (staff training), continuous migration to new platforms to avoid technological obsolescence; access threat (the lack of constant attention and financial resources for acidic investments (capital investment) in infrastructure and personnel threatens future functionality). The predicted outcome is a situation where access to a significant number of important state records will be impossible due to their physical or technological obsolescence.

The Mexican model of digital archival science emphasises the critical interrelationship between funding, infrastructure, and personnel qualification. The main challenge faced by archives and libraries is the dynamic, fast-paced change in hardware and software and the acute shortage of trained archival and library personnel. Professionals graduating from archival programmes

traditionally focus on digitisation and the preservation of physical media, rather than on managing the authenticity of born-digital records. This personnel shortage leads to digital record management often being conducted by IT specialists who have zero knowledge of how to professionally manage records to ensure their authenticity over the long term (Ilizaliturri *et al.*, 2023). Long-term authenticity requires PREMIS-like metadata, which record context, identity, and chain of custody (Library of Congress, n.d.). If management is carried out by IT specialists without archival knowledge, critical archival properties required for legal and historical validity may not be recorded or may be lost. This means that even if the physical file is preserved, its archival value as evidence may be irrevocably lost.

Collaboration between Universidad Nacional Autónoma de México (UNAM, n.d.) and International Research on Permanent Authentic Records in Electronic Systems (InterPARES, n.d.) is focused on developing models, policies, and strategies to ensure the long-term authenticity and preservation of electronic records created or received by individuals and non-archival organisations. The main outcome of this collaboration was the identification of a significant mismatch between the needs of digital archiving and the current educational curriculum at UNAM and other Latin American institutions. This work provided UNAM (as a leading educational institution in the region) with a methodological foundation and justification for the need to reform its curricula. The aim of the reform is to integrate subjects directly related to the nature of digital records and their unique vulnerabilities; the practical application of international standards, such as PREMIS (for capturing preservation metadata) and OAIS principles. Thus, the collaboration between UNAM and InterPARES 3 became a catalyst for the transition of Mexican archival education from a focus on physical digitisation to a focus on intellectual management of the authenticity of digital information. This is a direct response to the problem where IT professionals without archival knowledge manage critical records.

The Archivo General de la Nación (AGN International, n.d.) of Argentina is one of the major repositories in Latin America, preserving a documentary collection

that spans five centuries. AGN's mandate, defined by Law No. 15930 (1961), is traditional and focused on the collection, organisation, and preservation of documents (written, photographic, audiovisual), as well as their cataloguing and dissemination of knowledge. AGN preserves a vast collection covering a five-century period, implicitly prioritising historical heritage and physical preservation. The main conclusion of this case lies in the strategic choice of priorities in the digital transformation field: the priority (investment and effort are directed towards digitising and cataloguing existing analogue collections, i.e., creating digital surrogates). The aim is the rapid dissemination of knowledge about Argentina's history and ensuring access to historical collections, which is part of public obligations. This priority leads to a significant gap typical for the region: the lack of a complex TDR infrastructure (insufficient attention to the development of a complex TDR infrastructure necessary for long-term, reliable preservation); the issue of born-digital ingestion (AGN does not prioritise the ingestion (intake) and active long-term preservation of complex native-digital (born-digital) government records).

The AGN case clearly contrasts with the priorities of NARA (USA). Specifically, the focus is on active ingestion and long-term preservation of born-digital records using TDR principles as a priority. Additionally, retrospective digitisation and access are secondary, where TDR and born-digital management are secondary. The AGN case illustrates a regional trend in Latin America where economic and resource limitations force archives to choose between the accessibility of historical heritage (digitising analogues) and the long-term preservation of the authenticity of future born-digital records. AGN effectively fulfils its public mission regarding access to the past but faces a high risk of losing the authenticity of future records since it does not invest enough in complex TDR/OAIS-compliant infrastructure for born-digital records.

Based on qualitative analysis of the cases, it was revealed that resource limitations in Latin America are technological and personnel-related, which forces the region to adopt alternative strategies that affect the level of authenticity guarantees (Table 1).

Table 1. Comparative analysis of resource limitations between the USA and Latin America

Country/region	Most limited resources	Impact on archiving
USA (NARA/LoC)	Personnel costs for automation (OPEX) and managing massive data volumes. Limitations on the speed of migrating obsolete data.	High-tech implementation focused on proactive preservation and ensuring technical authenticity.
Latin America	Financial stability (unstable CAPEX), technological infrastructure, qualified staff to work with complex standards (e.g., full implementation of PREMIS).	Limited full technical implementation of PREMIS, reliance on open-source software and legal guarantees of authenticity.

Source: compiled by the author based on analysis from AN digital: Digital preservation policy (Version 2) (2016), Digital Preservation Strategy 2022-2026 (2022), ISO 23507:2025 (2025), Library of Congress (n.d.), UNAM (n.d.), InterPARES (n.d.), AGN International (n.d.)

Analysis of Table 1 demonstrated a dichotomy in digital archiving strategies between the resource-rich approach of the USA and the resource-limited approach in Latin America. A review of Library of Congress (n.d.), AGN International (n.d.) indicated that the lack of comprehensive technical implementation of the PREMIS standard in Latin America affects the preservation of authenticity, as PREMIS is a global standard for recording the chain of custody. The limited use of PREMIS as a dictionary, rather than as an integrated XML schema, means archives cannot automatically and fully document all changes, migrations, format transformations, and staff actions with native-digital documents. This leaves gaps in the technical proof that an object remains unchanged, thus jeopardising its authenticity as legal evidence or historical source. The analysed cases in LAC, with limited financial resources for technical guarantees (requiring ongoing OPEX funding), compensate for this with legal and institutional mechanisms (UNAM, n.d.; InterPARES, n.d.; AN digital: Digital preservation policy (Version 2), 2016). Legal authenticity (certification of authenticity according to national legislation, electronic signature by an authorised body) substitutes or supplements full technical authenticity (guaranteed by PREMIS). This approach is reactive but necessary for legitimising archival heritage.

Open platforms (e.g., DSpace (n.d.), Fedora (n.d.)) allow for meeting the basic requirements of long-term preservation and authenticity despite resource limitations: Primarily, the use of open-source software allows archives to avoid high initial costs of acquiring commercial high-tech solutions, which are a priority in the USA. Additionally, open-source software is flexible and can be customised to regional needs and standards (e.g., adaptation to Spanish/Portuguese language and national requirements for electronic signatures), even in the face of personnel shortages. While full PREMIS is unattainable, these platforms can meet basic functional requirements of the OAIS model, such as ingestion, storage, metadata management (at the Dublin Core level), and access, which are the necessary minimum for a Trusted Digital Repository. The financial burden shifts from licensing costs to staff labour (customisation and integration). This makes investments more manageable under unstable funding, giving priority to human resources over expensive commercial tools.

The USA model is based on the principle of active preservation. NARA actively manages obsolescence risks through ongoing investments in tools for preventive migration/transformation of formats. This is an active

archive maintenance strategy where authenticity is guaranteed through detailed documentation of every migration step according to ISO 16363 (ISO 23507:2025, 2025). In contrast, the LAC model, due to a lack of funding and infrastructure, often resorts to passive/reactive preservation. The lack of ingestion infrastructure (as in Brazil) and the inability to fund ongoing active migration create a systematic threat to long-term access and authenticity. As a result, authenticity may be lost not due to malicious intent but due to technological negligence caused by financial and personnel limitations.

In the USA, the emphasis on automation of metadata and the need to manage complex cloud/local infrastructures (meeting TDR requirements) requires a high level of technical and archival expertise within the professional community (Digital Preservation Strategy..., 2022). In Latin America, particularly in Mexico, there is an acute shortage of specialists trained in managing long-term authenticity of born-digital records. The issue is that IT competencies often prevail over modern archival knowledge (Formenton & Gracioso, 2025). This leads to management being carried out by IT professionals who lack the archival knowledge necessary for ensuring authenticity in a professional manner. This personnel gap is a direct threat to authenticity, as only archivists trained in managing context and preservation metadata (PREMIS) can guarantee the preservation of significant properties of digital objects during technological transformations.

The financial stability of institutions demonstrates the most significant gap in the maturity of digital archives, reflecting fundamental differences in investment models. The National Archives and Records Administration (n.d.), with stable government funding, focuses on operational costs (e.g., data integrity programmes and regular technological transformations), which are necessary for proactive risk management. In contrast, Latin American archives face the constant need for capital investments aimed at building basic organisational and technological infrastructures for ingestion and long-term preservation (Formenton & Gracioso, 2025). As a result, unstable or temporary funding in LAC complicates long-term planning, which is critical for implementing continuous processes inherent in the TDR model. Based on qualitative analysis and conceptual differences in financial stability and investment priorities (proactive vs reactive preservation, operational vs capital expenses), Table 2 provides a comparative analysis of funding, illustrating systemic differences in financial investment models and their consequences.

Table 2. Comparative analysis of digital archiving funding between the USA and Latin America

Comparison element	USA (NARA)	Latin America
1. Funding source and stability	Stable, sufficient government funding. Ensures financial sustainability needed for TDR.	Unstable, temporary funding. Complicates long-term planning, disrupting TDR requirements.
2. Main focus of investment	Operational costs (OPEX): continuous funding for active preservation (format migration, tool updates, managing large volumes of PREMIS metadata).	Capital investments (CAPEX): need to finance the building of basic infrastructure (ingestion, storage) and address staff shortages.

Continued Table 2.

Comparison element	USA (NARA)	Latin America
3. Risk management strategy	Proactive management: funding directed towards preventive migration of formats and documenting processes (ISO 16363) to ensure authenticity.	Reactive/passive preservation: lack of funds for active migration; risk of data and authenticity loss due to technological obsolescence and lack of ingestion.
4. Software costs	Costs for commercial, high-tech, and specialised tools integrated into complex infrastructures.	Minimising initial costs through Open Source Software (DSpace, Fedora). Financial burden shifted to customisation, integration, and human resources.
5. Authenticity impact	Guaranteed technical authenticity: funding supports full implementation of PREMIS, documenting the chain of custody.	Legal authenticity: legal guarantees replace or supplement technical authenticity; lack of funds for full, technically necessary implementation of PREMIS, jeopardising authenticity as evidence.

Source: compiled by the author based on analysis from AN digital: Digital preservation policy (Version 2) (2016), Digital Preservation Strategy 2022-2026 (2022), ISO 23507:2025 (2025), Library of Congress (n.d.), UNAM (n.d.), InterPARES (n.d.), AGN International (n.d.)

From Table 2, it is clear that the comparative analysis of funding reveals a systemic dichotomy between the USA (NARA) and Latin America, directly impacting the resilience of archival systems and the assurance of authenticity. The USA, with stable government funding, focuses its investments on operational costs (OPEX), allowing for proactive risk management (preventive format migration) and guaranteeing technical authenticity through the full implementation of PREMIS metadata and advanced commercial technologies. In contrast, Latin America faces funding instability, focusing on capital investments (CAPEX) to build basic infrastructure and using reactive/passive preservation. This leads to replacing technical authenticity with legal authenticity, creating a high risk of data loss and violating the requirements of Trusted Digital Repositories. The use of Open Source Software (DSpace, Fedora) in LAC, while minimising

initial costs, shifts the financial burden to customisation and human resources, emphasising the fundamental financial barrier in the region.

The systematic difference in the maturity of digital archives between the United States and Latin American countries stems from differences in strategic priorities: while federal archival institutions in the USA (NARA) operate as TDR, implementing proactive risk management and systematic format migration (managing a large “fleet”), most LAC archives remain at the stage of building basic ingestion infrastructure and addressing the critical shortage of qualified archival personnel, creating an institutional barrier to ensuring long-term authenticity of digital records (building a basic “secure boat”). To synthesise the identified differences and their consequences, Table 3 provides a comparative analysis of the key elements.

Table 3. Comparative analysis of key elements of digital archival science: USA vs Latin America (Brazil, Mexico, Argentina)

Comparison Element	USA (National Archives and Records Administration)	Latin America (Brazil, Mexico, Argentina)
1. Dominant preservation model	Comprehensive TDR/OAIS model. Priority given to reliable digital repositories (TDR), requiring both technical compliance with OAIS (ISO 14721) and passing the ISO 16363 audit for confirming financial and institutional sustainability.	Fragmented OAIS Model. OAIS is used as a declarative goal and basis for policy, but its full implementation is limited. Focus is shifted to the Access function (DIP).
2. Preservation priority	Born-Digital (Natively digital records). Focus is on active ingestion and long-term management of born-digital government records. Retrospective digitisation is secondary.	Digital Surrogates (digitisation). Priority is given to digitising vast historical heritage to ensure public access (as in the case of AGN). Born-digital ingestion is often ignored or delayed.
3. Authenticity assurance (metadata)	PREMIS as a mandatory standard. Authenticity is guaranteed through complex, continuous preservation metadata (PREMIS) that records the full chain of digital preservation (chain of custody).	Legal Authenticity. Authenticity is often guaranteed by national legislation (e.g., Brazil/Mexico), which legally equates digital documents to originals. Technical recording of PREMIS-like metadata is inconsistent or absent.
4. Technological strategy	Use of advanced, often commercial, solutions, cloud technologies, and regular migration strategies for actively preventing technological obsolescence.	Open Source Software. Widespread use of DSpace, Fedora, and other open platforms to minimise initial licensing costs. Financial burden shifted to customisation and human resources.
5. Critical challenge	Scale and cost of PREMIS. Challenge in maintaining billions of objects and vast amounts of complex metadata.	Personnel shortage and financial instability. Lack of qualified personnel (as in Mexico) who understand PREMIS/OAIS, and unstable funding (non-compliance with TDR), threatening long-term viability.

Comparison Element	USA (National Archives and Records Administration)	Latin America (Brazil, Mexico, Argentina)
6. Education and human capital	High integration of digital archival science in university curricula. Collaboration with IT professionals under the guidance of archivists.	Outdated curricula. Focus on traditional media. Critical need for reform (as shown by efforts at UNAM / InterPARES 3), as functions are often performed by IT staff without archival knowledge, leading to loss of archival properties.

Source: compiled by the author based on analysis from AN digital: Digital preservation policy (Version 2) (2016), Digital Preservation Strategy 2022-2026 (2022), ISO 23507:2025 (2025), Library of Congress (n.d.), UNAM (n.d.), InterPARES (n.d.), AGN International (n.d.)

The presented comparative Table 3 clearly illustrates the systemic dichotomy in digital archiving approaches between the USA and Latin America (Brazil, Mexico, Argentina), reflecting a fundamental difference between the resource-secure, technology-oriented model and the adaptive, resource-limited model. The United States (NARA) operates as a mature Trusted Digital Repository (ISO 16363, 2025), prioritising the active preservation of born-digital records and guaranteeing authenticity through the mandatory, complex use of PREMIS metadata and advanced commercial technologies. In contrast, Latin American countries use a fragmented OAIS model, where investments are directed towards digitising historical heritage (access) rather than ingesting future digital documents. This results in replacing technical authenticity guarantees with legal (legislative) authenticity, using open-source software as a financial compromise and, most critically, facing a significant personnel shortage and financial instability (non-compliance with TDR), creating a systemic risk to authenticity and long-term viability of their digital heritage.

Based on the results of the current study, there is a trend towards sustainable digital preservation, supported by the development of complex systems such as PREMIS (n.d.) and others, to ensure the integrity, availability, and durability of electronic records in regional regulatory contexts. According to J. Barriendos (2022) research, the ICAA (International Council of Archives) document project is an important digital initiative for Latin American art, demonstrating the intersection of museological practices, digital humanities, and the structured categorisation of cultural heritage using tools such as the Getty Foundation Thesaurus, thereby influencing global research in this field. According to N.J. Pulido Daza *et al.* (2024), sustainable digital preservation has become an essential component of long-term electronic record management, thanks to rapid technological advancements and growing dependence on digital formats. This paper presents a proposal for sustainable digital preservation (PPREDIS) – a comprehensive system developed to ensure the integrity, availability, and durability of electronic records in the Colombian regulatory context.

To overcome systemic barriers and ensure the long-term authenticity of electronic records in Latin America,

a holistic approach is needed that combines technological resilience with addressing issues of digital literacy and staff training, as the implementation of OAIS/TDR is not only a technical but also a complex socio-economic problem. The priority should be the development of human capital and education. The issue identified in the UNAM/InterPARES 3 collaboration in Mexico calls for a reform of educational curricula for archivists, focusing on the principles of authenticity, integrity, and the management of born-digital documents. This is necessary to overcome the dominance of the pure IT approach that ignores critically important archival properties of records (United Nations Development Programme, 2024).

Furthermore, considering the constant need for financial investment, it is not advisable for individual LAC countries to attempt to build their own fully functional TDR. Instead, regional infrastructure solutions should be explored, involving the creation of regional cloud or federated repository models. Such collaboration would allow costs to be distributed and ensure the necessary replicated storage. Regarding technical implementation, a strategic adaptation of standards is needed. Instead of attempting to implement full, resource-intensive schemes, LAC should focus on implementing a minimum viable core of PREMIS-like metadata. This core should include only those elements that are absolutely necessary to prove authenticity and integrity and could be integrated into existing open-source systems (e.g., DSpace) (Formenton & Gracioso, 2025).

International Aid and Partnerships (e.g., from the International Database (IDB) or World Bank), according to I. França (2023), require targeted international funding. The funds should be directed towards eliminating the most critical infrastructure gaps, particularly in creating electronic record ingestion systems (E-Records Ingest Systems), the absence of which in national archives (as found in Brazil) creates a systemic risk of irreversible loss of state funds. A similar position regarding the findings of this research was expressed by M.Á. Márdero Arellano & J. Santillán-Aldana (2025). The researchers emphasised the importance of digital preservation and sustainability in Latin America, and while examining the challenges and strategies characteristic of the region, they pointed to collaboration and future prospects for

improving digital communication in Latin American academic contexts. The same position was echoed in the work of K.D. Yadav (2025): issues of digital aging, data degradation, and long-term accessibility require strategies to ensure digital continuity. According to the researcher, an important aspect is a proactive, politically-oriented, and technologically updated approach to sustainable digital preservation. In this context, the findings of this research correlate with the work of N.B. Rabelo & C. Schmidt (2022): contemporary digital archiving projects, developing theoretical and methodological frameworks related to technological transformations, underscore the necessity of reflecting on new technologies in decentralised archival practices since their research trajectory in 1999.

Thus, according to the results of the study, the National Archives and Records Administration model demonstrates highly effective methods of active preservation and format risk management. International cooperation should focus on adapting these high-tech methods to the resource realities of LAC. This could involve creating regional centres of excellence that would standardise format transformation processes and develop recommendations for choosing sustainable formats, thereby minimising the need for costly internal tool development in each individual country.

■ Conclusions

The results of the empirical research confirmed that international archival science is based on the systemic dichotomy of two key conceptual models: OAIS (ISO 14721), which defines the necessary functional blocks (ingest, preservation, access) and information packages (SIP, AIP, DIP), and TDR (ISO 16363), which verifies the organisational, financial, and technological sustainability of the repository. The application of theoretical analysis and synthesis of standards allowed for the creation of a unified set of criteria, according to which the authenticity of a digital object critically depends on preservation metadata (PREMIS) that records the chain of custody. It was determined that in the USA, NARA applies an active preservation strategy, which requires continuous investments in tools for preventive format migration, ensuring authenticity by documenting each step in detail according to ISO 16363. NARA's success also depends on the innovative efforts of the LoC and NARA in automating metadata creation to overcome the high labor intensity of the process. This confirmed that, for a high-tech model, long-term authenticity is a function of not passive storage but costly, active, continuous technological processes.

Based on the analysis of legislative documents and cases, a systemic difference in maturity levels between the USA and LAC was investigated, rooted in socio-economic factors. It was found that Latin American archival institutions use a fragmented OAIS model, where investments

are directed towards digitising historical heritage (access), rather than ingesting future digital documents. This has led to three critical gaps, which pose a systemic risk to authenticity: infrastructure deficit (the Brazil case), personnel deficit and authenticity loss (the Mexico case), and strategic compromise (the Argentina case). Despite the official AN digital: Digital preservation policy (which declares compliance with OAIS), the study found a critical lack of infrastructure for ingesting born-digital records in national archives. It was also found that the UNAM/InterPARES 3 collaboration revealed a sharp shortage of qualified archival personnel. As a result, the management of digital records is often delegated to IT professionals without archival knowledge, leading to the ignoring or loss of PREMIS-like metadata. This became a direct threat to authenticity, as the archival value of documents, regardless of their physical preservation, is lost without documenting context and the chain of custody. Furthermore, the analysis of the Archivo General de la Nación illustrated a strategic compromise, prioritising the digitisation of analogue collections (access function DIP), which resulted from postponing investments in the complex TDR infrastructure necessary for long-term preservation of born-digital records. Overall, it was determined that LAC demonstrates that the lack of financial stability and personnel potential are more significant barriers to implementing TDR/OAIS than the technology itself. Within this study, it was established that overcoming systemic barriers in LAC requires a holistic approach that combines technological resilience with addressing personnel training issues (curriculum reform, cost-sharing for preservation, ensuring replicated storage, enhancing international cooperation, etc.).

The limitation of the study was that it involved secondary sources (official strategies and scientific publications) rather than conducting primary field audits. This did not allow for the assessment of the actual state of compliance with international standards in real-time or quantitatively measure the effectiveness of these processes at NARA compared to LAC. Future research should be directed towards a quantitative risk assessment in LAC through the development of regionally adapted TDR metrics (based on ISO 16363) and empirical analysis of the effectiveness of the minimal core of PREMIS-like metadata, integrated into open-source software (DSpace, Fedora), to confirm their sufficiency for legal authenticity.

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Еволюція цифрових архівів як напрям архівознавства та документознавства: порівняння практик США та Латинської Америки

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Анотація. Метою цієї статті було здійснення порівняльної оцінки адаптивних стратегій, що застосовувалися у функціонуванні цифрових архівів у Сполучених Штатах Америки та провідних країнах Латинської Америки (Бразилія, Мексика, Аргентина). Дослідження ґрунтувалося на якісному порівняльному аналізі з використанням методів теоретичного аналізу, кейс-стаді та синтезу для зіставлення офіційних стратегій Національного управління архівів і документації США (NARA) та Бібліотеки Конгресу зі стратегіями національних архівів Бразилії, Мексики й Аргентини. У межах цього дослідження було виявлено системну дихотомію зрілості моделей у США та Латинській Америці. Було встановлено, що NARA функціонує як зріле надійне цифрове сховище (Trusted Digital Repository), яке застосовувало активне збереження та забезпечувало автентичність за допомогою складних, ресурсомістких метаданих типу Preservation Metadata: Implementation Strategies і безперервної превентивної міграції форматів. Натомість було виявлено, що архівні установи в Латинській Америці використовують фрагментовану модель відкритої архівної інформаційної системи, де інвестиції спрямовуються на оцифрування історичної спадщини, а не на введення цифрових документів у вихідному форматі. Тому в ході дослідження були виявлені прогалини в Латинській Америці, такі як дефіцит інфраструктури (відсутність систем введення даних у Бразилії), нестача персоналу (переважання ІТ-підходу над архівною наукою в Мексиці) та фінансова нестабільність, які підривають зусилля з впровадження надійних цифрових сховищ. У результаті автентичність у Латинській Америці часто ґрунтувалася на правових положеннях, а не на технічному ланцюгу зберігання. Результати дослідження дали змогу сформулювати цілісний підхід як рекомендацію для підвищення довгострокової автентичності електронних архівів, що поєднував реформу архівної освіти та створення спільних регіональних репозитаріїв як адаптивні стратегії. Практична цінність дослідження полягала у наданні конкретних рекомендацій щодо стратегічної адаптації міжнародних стандартів для країн з обмеженими ресурсами

Ключові слова: обмеженість ресурсів; довгострокове збереження даних; цифрова трансформація; введення; міграція форматів; метадані