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Mapping damage and preservation of historical newspapers at the National Library of Indonesia

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ABSTRACT

Background: Historical newspapers serve as crucial primary sources, preserving a Indonesian nation's collective memory. However, their fragile material composition presents persistent preservation challenges for memory institutions, creating a need to assess the gap between collection conditions and existing safeguards. **Purpose:** This study aimed to systematically map the extent of physical deterioration in historical newspaper collections and assess the effectiveness of preservation measures implemented by the National Library of Indonesia (Perpusnas RI). **Methods:** The research used a quantitative descriptive design combined with the Analytical Hierarchy Process (AHP). A proportional sample of 400 bundles was drawn from a total of 25,814 bundles, representing four major historical periods of Indonesia. **Results:** Findings indicated that a majority of the collections exhibited moderate to severe damage, including high acidity (95%), foxing (90%), and fungal stains (65%). Crucially, only 5.25% of bundles had undergone physical conservation and 36.25% had been digitized, identifying torn paper and missing sections as the most critical categories requiring immediate intervention. **Conclusion:** The study concludes that systematic digitization serves as a sustainable preservation surrogate. There is an urgent need to address the significant preservation gap to ensure the long-term survival of Indonesia's documentary heritage. **Implications:** The findings imply a necessity for strengthening institutional policies, technical protocols, and human resource capacity. Theoretically, it establishes an evidence-based framework for newspaper preservation, while practically, it advocates for prioritizing AHP-based decision-making in conservation resource allocation.

Keywords: Newspaper collections; Newspaper preservation; Digitization; Analytical Hierarchy Process (AHP); Preservation gap

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INTRODUCTION

The preservation of documentary information is a fundamental aspect of libraries' role in safeguarding a nation's collective memory. Libraries are not merely administrative managers of collections; they are also entrusted with epistemic and social responsibilities of preserving intellectual heritage across historical periods. Among these various types of materials, newspapers demand particular attention due to their classification as serial publications with significant historical value. As defined by Winoto et al. (2019) and confirmed by Stead (2019), serials are materials published periodically—such as daily, weekly, monthly, or annually—and include newspapers, magazines, and tabloids. Newspapers are unique because they not only document current events but also serve as vital records of a country's political, economic, social, and cultural developments in a structured and chronological manner.

This archival function becomes even more crucial in the context of developing countries such as Indonesia, where documentary heritage is not only fragmented but also often neglected due to institutional, technological, and infrastructural limitations. A growing body of research underscores that the fragility of paper-based heritage, particularly newspapers, is exacerbated by tropical climates, budget constraints, and inconsistent national policies on records management (Agus et al., 2021; Klinken, 2019; Wahyuni, 2017). These constraints create a scenario in which valuable historical documentation becomes increasingly difficult to retrieve, access, or even preserve beyond its physical lifespan. This concern is further compounded by the fact that newspapers—unlike other archival documents—tend to be printed on low-grade paper that deteriorates more rapidly due to its acidic nature, rendering it vulnerable to environmental fluctuations and physical handling.

This study was initiated in response to empirical findings indicating substantial physical deterioration in newspaper collections at the National Library of Indonesia (Perpustakaan Nasional Republik Indonesia, abbreviated as Perpusnas RI). A recent empirical study conducted by the Faculty of Communication Sciences, Universitas Padjadjaran, in collaboration with the National Library of Indonesia (Perpusnas RI), systematically examined the physical condition of historical newspaper archives through the *Newspaper Archives Damage Level Study* (Khadijah et al., 2023). A survey of 400 representative newspaper bundles found that over 60 percent of the materials had experienced moderate to severe physical deterioration. The most common types of damage included high paper acidity (68.2%), brown stains (32.3%), fungal contamination (27.5%), torn pages (42.5%), perforations (22.3%), and missing sections (19.7%). These findings represent one of the most comprehensive quantitative datasets available to assess the physical integrity and preservation status of Indonesia's historical newspaper collection.

The results of this study revealed urgent preservation challenges that necessitate the development of systematic and data-driven preservation strategies. Unlike conventional or ad hoc conservation efforts, a data-informed approach allows preservation managers to set clear priorities based on measurable indicators, including the extent of damage, informational value,

and cultural significance. Such a framework is crucial for optimizing limited institutional resources while ensuring the sustainability, accessibility, and authenticity of the nation's documentary heritage. Therefore, this study emphasizes the importance of adopting an evidence-based preservation approach that integrates empirical analysis, decision-support tools, and institutional policy alignment as a foundation for long-term preservation planning and management. Without such interventions, there is a tangible risk that the information embedded within these newspapers, many of which constitute irreplaceable primary sources, could be permanently lost.

The newspapers examined in this study are part of a larger collection comprising 2,680,213 items held by Perpusnas RI, categorized into four historical periods: the pre-independence era (before 1945), the independence and revolution period (1945–1966), the New Order period (1966–1997), and the Reform era (1998–2013). To date, only 21 bundles have undergone physical conservation, and 145 have been digitized, indicating that a significant portion of the collection remains unpreserved. This disparity between the volume of material and the scope of preservation efforts reflects structural constraints and requires prioritization mechanisms based on empirical assessments of condition severity.

Due to the use of low-quality paper, newspapers are highly vulnerable to physical degradation. Their material characteristics, such as high acidity, easily fading ink, and brittle fibers, make them particularly susceptible to damage, especially when stored in conditions that do not meet proper conservation standards. This study employed visual observation techniques to assess physical deterioration by evaluating factors such as thickness, tensile strength, weight, and surface condition. Damage levels were categorized into three levels: low (<30%), moderate (30–50%), and high (>50%). Specific forms of damage identified included torn, water-damaged, burnt, moldy, and perforated paper. Such assessments are essential for determining conservation and digitization priorities. These categorization efforts not only enable institutions to allocate resources effectively but also serve as an essential step in long-term preservation planning (Hidayatun et al., 2023; Pasqui, 2024).

The deterioration of newspaper collections is influenced not only by the age and quality of the materials but also by environmental conditions, the absence of standardized conservation procedures, and the limited application of preservation technologies. In this context, digital media conversion has emerged as an effective preservation method. Fatmawati (2018) outlines three key preservation strategies: conservation (physical maintenance), restoration (recovery), and digital migration (format conversion). Among the three, digital migration is particularly significant, as it allows continued access to information even if the physical documents are damaged. It also provides scalability and flexibility, enabling access by a broader audience beyond the geographical and temporal limitations of physical archives.

Sulendra (2014), who supports this perspective, emphasizes that preservation efforts should address both the physical integrity and informational content of the materials. Therefore, newspaper preservation should extend beyond

physical restoration to ensure that the information remains accessible to future generations. The philosophical underpinning of dual preservation—physical and informational—thus reflects a more holistic view of archival science, where the content integrity is prioritized equally with the storage medium.

Government Regulation No. 88 of 1999 reinforces this approach by authorizing the conversion of physical documents to alternative formats such as CD-ROM or WORM, while ensuring information security and authenticity. Buršić and Stančić (2019) also define media conversion as the process of transforming data into a digital format accessible by computer systems without compromising the integrity of the original information. In this regard, digital-based preservation strategies are increasingly relevant to protect the National Library of Indonesia's growing and threatened newspaper collection. As more institutions transition to digital infrastructure, compliance with these regulations also provides a framework for establishing technical and procedural standards across repositories (Mahanti, 2021; Primaranti et al., 2023).

Regarding the theoretical and contextual background, recent literature offers several insights that inform this study. Bawono et al. (2022) emphasize the role of awareness in Indonesian archival practices, arguing that cultural and emotional dimensions influence institutional approaches to recordkeeping. Harisanty and Anugrah (2022) further emphasize the importance of a legal framework in supporting the integrity of electronic archive management, highlighting regulatory compliance as a critical factor in sustainable preservation.

From a service and access standpoint, Supratman (2020) identifies key challenges in preserving pre-independence newspapers, offering valuable perspectives on collection handling and condition assessment. In terms of technical methods, Ratmono (2021) advocates for the use of Malaysian binding techniques as an effective and locally adapted strategy for newspaper preservation. On the global front, Oberbichler et al. (2022) advocate for an interdisciplinary digitization workflow that integrates the Humanities and Computing, while Ali et al. (2024) propose utilizing artificial intelligence and machine learning to enrich metadata and enhance archival accessibility.

Despite a growing body of literature, few studies in the Indonesian context empirically integrate damage assessment with structured preservation prioritization methods, such as the Analytical Hierarchy Process (AHP) (Mosa et al., 2022; Sandhyavitri et al., 2020; Siswanto et al., 2019). Most existing studies focus on technical descriptions, cultural influences, or legal frameworks in isolation. Therefore, a comprehensive model that simultaneously maps damage, prioritizes treatment based on severity and impact, and evaluates the effectiveness of preservation is urgently needed. The absence of such a framework not only hampers decision-making but also delays timely and targeted preservation interventions.

Moreover, studies by Kopin & Narlock (2024) and Putra et al. (2023) highlight how the lack of trained human resources and inconsistent budgeting for digital preservation projects have hindered the implementation of national preservation initiatives. Their studies

suggest that while digitization has been formally acknowledged as a solution, the absence of long-term sustainability planning, infrastructure maintenance, and monitoring systems has weakened its impact. Institutional inertia, a lack of cross-sector partnerships, and limited digital literacy among staff further exacerbate these challenges.

As the urgency for mass digitization increases—especially folowing the COVID-19 pandemic—libraries worldwide are accelerating their digital transformation projects. Gross and Marsh (2022) show that digital access to archival materials increased exponentially during the pandemic, raising new expectations for digital preservation infrastructure in public institutions. This momentum should be leveraged to establish adaptive, inclusive, and technologically resilient preservation practices. At the same time, equitable access must be ensured, particularly for researchers and communities in rural or underserved areas who rely on state institutions, such as the Perpusnas RI for access to heritage materials.

This study aimed to map the extent of physical and informational damage to newspapers held by the National Library, categorized by their historical period. It also aimed to identify the most common types of damage and their causes. Additionally, #the study assessed the effectiveness of the implemented conservation and digitization practices.

Using a data-driven approach, the study formulates recommendations tailored to the collection's specific needs and responsive to the technical and operational challenges faced by library staff. By applying the Analytical Hierarchy Process, this study also introduced a replicable model for prioritizing preservation that can be adapted by other institutions in Indonesia and beyond.

From an academic perspective, this research contributes to the development of library and information science, particularly in the management of rare and vulnerable collections. It bridges the research gap by introducing a structured, quantitative preservation model using AHP in the Indonesian archival context. Practically, the findings can serve as a reference in developing strategic newspaper preservation policies at the Perpusnas RI and similar archival institutions.

Within the broader context of libraries' digital transformation, this study also supports the creation of a sustainable, evidence-based preservation system in line with national information management policies. Thus, it aspires to contribute not only to the stabilization of institutional memory but also to the democratization of historical knowledge for future generations.

RESEARCH METHODS

This study employed a quantitative descriptive approach to assess the physical deterioration and information quality of newspaper archives stored at the National Library of Indonesia, and to evaluate the effectiveness of preservation practices, including physical conservation and digital conversion. The research design was selected for its ability to provide a structured and measurable framework for analyzing archival conditions, thereby supporting the formulation of data-driven preservation strategies (Santos & Flores, 2020; Sugiyono, 2017).

The descriptive method facilitated the classification of archival damage based on observable characteristics and historical categorization. The research focused on identifying the dominant forms of degradation, analyzing their distribution across temporal periods, and assessing the extent of preservation interventions that have been applied.

The target population encompassed the entire newspaper archive at Perpusnas RI, totaling 25,814 bundles. Given the scope of the population, a complete enumeration was not feasible. Consequently, the sample size was determined using Slovin's formula, with a 95% confidence level and a 5% margin of error. The sample was rounded to 400 newspaper bundles, providing a representative subset of the total collection. The following calculations were applied:

$$n = \frac{N}{1 + N(e)^2}$$

Substituting values:

$$n = \frac{25.814}{1 + 25.814(0{,}5)^2}$$

$$n = \frac{25.814}{65.538} = 393.896$$

To ensure balanced representation, proportional stratified sampling was employed, dividing the sample across four historical eras: Pre-Independence (<1945), Independence and Revolution (1945–1966), New Order (1966–1997), and Reform Era (1998–2013). This allowed for meaningful comparisons across archival ages and storage conditions.

To ensure the reliability and comprehensiveness of the findings, this study employed a combination of four distinct data collection methods. Each technique was specifically designed to capture different dimensions of the problem, including the physical archival condition and institutional preservation practices:

Visual observation: A standardized checklists was used to document the physical condition of each newspaper bundle. Observations included cover type, binding status, and visible damage indicators such as tears, missing sections, holes, mold, stains, and paper acidity levels. The checklist also recorded whether any conservation or digitization efforts had been undertaken.

Structured interviews: Interviews were conducted with staff from Perpusnas RI specializing in archives and preservation. These interviews aimed to understand operational procedures, institutional challenges, and the limitations of current preservation infrastructure.

Analytical Hierarchy Process (AHP): To establish preservation priorities based on the severity and potential impact of physical damage, this study applied the Analytical Hierarchy Process (AHP) as a structured decision-support framework. The AHP analysis was conducted after completing the quantitative assessment of 400 newspaper bundles, with aggregate field data representing the frequency and intensity of various types of deterioration used as an empirical foundation for evaluation and prioritization by experts.

Two subject-matter experts participated in the evaluation process: Prof. Dr. Ninis Agustini Damayanti, M.Lib., from the Faculty of Communication Sciences, Universitas Padjadjaran, and a senior archivist from the National Library of

Indonesia (Perpusnas RI). Both experts were invited to the Preservation Centre of Perpusnas RI for a consultation session. During the session, the research team presented summarized survey results, examples of documentation of damage types, and analytical charts derived from field data. Using these materials, each expert independently completed a pairwise comparison matrix to assess the relative severity of various damage categories, including paper tears, fungal stains, acidity, and missing sections, based on professional judgment.

Expert assessments were processed using Saaty's AHP computational procedure to produce weighted priority scores for each damage category (see Table 1). The resulting hierarchical model identified tears and missing sections as the most critical types of deterioration requiring immediate conservation intervention. This expert-driven, data-based prioritization provides a robust analytical foundation for evidence-based preservation policies and resource allocation. By integrating empirical field observations with professional expertise, the AHP framework enhances objectivity, precision, and strategic focus in decision-making in archival preservation management.

Table 1
Sample AHP matrix for damage criteria

Damage type	Tear	Stain	Hole	Missing	Mold
Tear	1	3	4	2	5
Stain	1/3	1	2	1/2	3
Hole	1/4	1/2	1	1/3	2
Missing section	1/2	2	3	1	4
Mold	1/5	1/3	1/2	1/4	1

Source: Research instrument results from expert judgment using the Analytical Hierarchy Process (AHP) method, processed by the research team, 2023.
Note: A value of 1 indicates equal importance; higher values denote greater priority for the row items over the column items.

The judgments provided by the experts were normalized to generate a set of relative weights for each damage type. This quantitative ranking created an objective basis for developing final, prioritized recommendations for preservation.

To collect comprehensive data, this study employed four complementary techniques. Each was designed to capture a distinct aspect of the archival condition and institutional preservation efforts.

Document analysis: To maintain methodological rigor and empirical validity, this study used document analysis as a complementary method to field observations. This analysis systematically reviewed institutional reports and academic literature related to archival damage assessment and preservation practices at the National Library of Indonesia (Perpusnas RI).

The primary institutional document examined was the *Laporan Akhir Kajian Tingkat Kerusakan Arsip Surat Kabar Perpustakaan Nasional Republik Indonesia* (Universitas Padjadjaran & Perpusnas RI,

2023), which provided detailed quantitative and descriptive data on the condition of newspaper archives, the extent of physical damage, and current preservation approaches. In addition, studies conducted by Fatmawati (2018), Khaddafi and Akbar (2024), and Sulendra (2014) were reviewed to build the conceptual foundation of dual-dimension preservation, which focuses on protecting the physical form and informational content of archival materials.

Insights from this document analysis guided the development of operational parameters for the next research stages. Key indicators of deterioration, such as paper acidity, brittleness, tears, and biological contamination, were identified and aligned with established preservation standards. This analytical process strengthened the study's interpretative framework and ensured effective triangulation between thereby enhancing the validity and consistency of the overall research methodology.

To ensure a systematic interpretation of the collected data and the validity of the research outcomes, a multi-step analysis process was undertaken. This process incorporated quantitative and decision-support techniques, as outlined below:

Categorization of damage levels: To systematically quantify the extent of deterioration, the observed damage severity was classified into three distinct levels based on established criteria. These categories were defined as low damage (<30%), moderate damage (30–50%), and severe damage (>50%).

Descriptive statistics: The collected data were first tabulated and calculated as percentages to quantify the findings. These results were then visualized using bar charts, a method chosen to clearly and effectively convey the distribution and frequency of each type of damage.

AHP calculation and prioritization: Expert evaluations were processed using the AHP calculation technique, producing weighted rankings for each damage type. Consistency ratios were computed to validate the coherence of the judgment matrix.

Data triangulation**:** To ensure methodological rigor and strengthen internal validity, this study employed a data triangulation approach, combining three complementary data sources: direct field observations, expert assessments, and in-depth interviews. This design aimed to cross-verify empirical findings, minimize interpretive bias, and enhance the objectivity of the analysis.

The interview component involved three staff members from the Preservation and Media Conversion Division of the National Library of Indonesia, each with over five years of experience in conservation, digitization, and archival management. Semi-structured interviews were conducted on-site at the Preservation Centre to gather qualitative insights into operational practices, technical constraints, and resource challenges in implementing preservation. Interviews were structured around three thematic areas: (1) preservation procedures and implementation, focusing on conservation workflows, prioritization of damaged materials, and monitoring systems; (2) institutional and technical challenges, addressing limitations in human resources, equipment, and budget; and (3) strategic and policy orientation, examining long-term planning, policy execution, and interdepartmental coordination.

The qualitative insights obtained from these interviews were then compared with quantitative findings from field observations and Analytical Hierarchy Process (AHP) analysis. This triangulation approach ensured consistency and reliability across data sources while reinforcing the empirical foundation of the study's analytical framework. As a result, the policy recommendations derived from this research are data-driven and contextually grounded, aligning with best practices in archival preservation management and research.

The research was conducted at the Periodicals Division of Perpusnas RI, located in Central Jakarta. As the primary repository of Indonesia's national newspaper archives, this division plays a central role in safeguarding printed cultural heritage and was deemed an appropriate field site for this study.

Recent literature supports the integration of quantitative analysis and expert-based decision-making frameworks in archival preservation research. Studies by Arisanti et al. (2023) and Mahendra (2018) confirm that combining visual observation with AHP modeling enhances the accuracy and applicability of preservation strategies. This approach is particularly relevant when institutions face resource constraints and must make strategic decisions regarding collection priorities.

In sum, the methodological framework adopted in this study combined the rigor of quantitative precision with the nuanced understanding of expert insights. This integrated approach offered a comprehensive perspective for evaluating archival damage and developing preservation pathways tailored to the institutional capacities and specific conditions of historical newspaper collections.

RESULTS AND DISCUSSION

This study examined the extent of physical and informational deterioration in newspaper archives at the National Library of Indonesia by mapping the level of damage across historical periods and assessing the effectiveness of preservation measures. From a total of 25,814 newspaper bundles, a representative sample of 400 bundles was selected. These were distributed proportionally across four key historical periods: Pre-Independence (<1945), Independence and Revolution (1945–1966), the New Order (1966–1997), and the Reform Era (1998–2013). The breakdown of this sample is shown in Table 2.

Table 2
Distribution of newspaper archive samples by historical period

Historical period	Sample Size	Percentage
Pre-independence (<1945)	99 bundles	24.75%
Independence (1945–1966)	43 bundles	10.75%
New order (1966–1997)	163 bundles	40.75%
Reform era (1998–2013)	95 bundles	23.75%
Total	400	100%

Source: Research results, 2023

Data collection was conducted through direct observation using structured assessment sheets. These sheets captured key indicators of physical condition, such as the type of protective enclosures, binding status, and visible signs of deterioration, including stains, tears, holes, missing parts, and paper acidity. The severity of each damage type was classified into three categories: low (<30%), moderate (30–50%), and high (>50%).

The findings revealed that 94.75% of the bundles lacked protective boxes, while 76.25% were stored using basic folder enclosures. In terms of binding, 44% of the samples were unbound. The remaining 52.3% showed damage to the covers, and 47.7% had damage to the binding blocks. The highest rates of binding deterioration were observed in the Pre-Independence and New Order collections, both of which were classified as moderate in severity, as presented in Table 3.

Table 3
Binding damage by historical period

Period	Cover damage (%)	Binding damage (%)
Pre-independence	17	18
Independence & revolution	5	5
New order	9	12
Reform era	0	0
Total	31	34

Source: Research results, 2023

This condition strongly suggested a systemic inconsistency in the application of preservation protocols, even the most ones, such as providing proper enclosures and performing binding care, which was inconsistently applied throughout the archival period, a problem particularly evident in the oldest and most voluminous collections. Paper deterioration was categorized into five indicators: tape marks, tears, holes, missing segments, and scribbles. The most frequently observed type of damage was tears (60%, high category), followed by missing segments (42%) and holes (40%), both in the moderate category. Tape marks and scribbles were identified less frequently and classified as minor damage (Table 4).

Table 4
Paper damage types by period

Period	Tape	Tears	Holes	Missing segments	Scribbles
Pre-independence	10%	25%	21%	23%	4%
Independence	3%	10%	7%	8%	3%
New order	2%	21%	11%	10%	6%
Reform era	0%	5%	1%	2%	0%
Total	15%	60%	40%	42%	12%

Source: Research results, 2023

Photographic documentation confirms the physical condition of the paper, where tears, holes, and missing parts visibly compromised access to the archive's informational content. These damages are often irreversible and pose significant obstacles to digital conversion processes (Oberbichler et al., 2022).

Staining was the most widespread and severe form of damage. Identified stain types included blotchy discoloration (foxing) at 90%, browned edges (93%), blotchy patches (76%), and fungal stains (65%). These were observed consistently across all historical periods, with Pre-Independence and New Order archives exhibitinging the highest concentration of such damage (Table 5).

Table 5
Prevalence of stain damage by period

Period	Blotchy patches	Foxing	Edge browning	Mold
Pre-independence	21%	23%	25%	24%
Independence	10%	10%	11%	10%
New order	29%	35%	41%	22%
Reform era	17%	22%	17%	8%
Total	76%	90%	93%	65%

Source: Research results, 2023

These forms of discoloration were symptomatic of prolonged exposure to adverse environmental conditions, primarily high humidity and poor air circulation. This issue was often exacerbated by the use of non-archival storage materials, such as plastic, which could trap moisture and accelerate decay.

Additional forms of deterioration included paper acidity (95%, high severity), paper warping (41%), brittleness (40%), and insect damage (11%). Acidification was the most prominent form of degradation, particularly in older archives from the New Order and Pre-Independence periods. This form of damage was consistent with the use of low-quality, high-acid paper stock and inadequate environmental controls over extended periods

Table 6
Other damage indicators by period

Period	Insect damage	Warped	Brittle	Acidic
Pre-independence	9%	10%	25%	25%
Independence	2%	7%	11%	11%
New order	0%	15%	4%	41%
Reform era	0%	10%	0%	19%
Total	11%	41%	40%	95%

Source: Research results, 2023

Acidity, in particular, has emerged as a critical threat. According to Buršić and Stančić (2019), acidic degradation is a leading cause of long-term paper embrittlement and disintegration, making deacidification a necessary intervention in long-term preservation strategies.

Among the 400 sample bundles, only 21 had undergone physical conservation, and 145 had been digitized. This means that over 63% of the collection had not received any form of preservation treatment. These findings revealed a significant disparity between the level of deterioration and the institution's current preservation capacity.

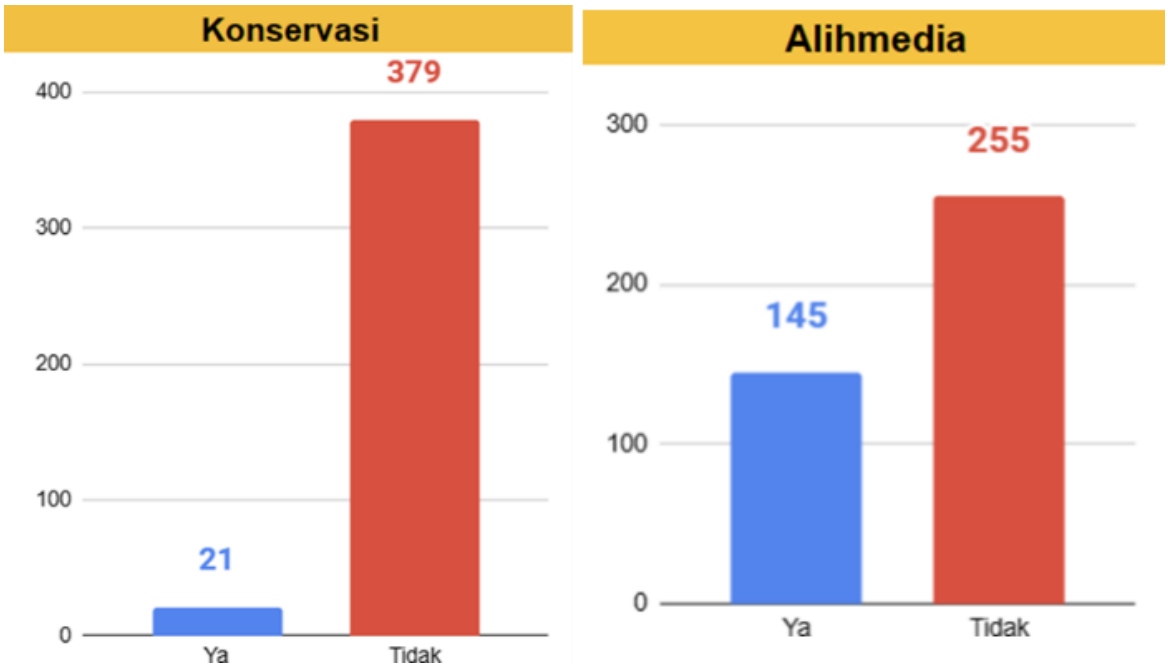

Figure 1. Status of newspaper conservation and digitization
Source: Result research, 2023

This gap highlighted a pressing need for scalable preservation strategies that aligned with available resources and institutional capacity. As noted by Ali et al. (2024), digital tools—especially those powered by machine learning—can enhance prioritization and resource allocation in archival settings. The study further emphasized the need for sustainable preservation practices and policy enhancements that aligned with international standards.

This study provided an in-depth examination of the physical condition of newspaper archives stored at the National Library of Indonesia, which housed a total of 25,814 bundles, amounting to approximately 2,680,213 copies and over 16 million pages. From this collection, a proportional sample of 400 bundles was selected using the Slovin formula, with a 95% confidence level and a 5% margin of error. The sample represents four distinct historical periods: Pre-Independence (99 bundles), Independence and Revolution (43 bundles), New Order (163 bundles), and Reform Era (95 bundles). This stratification not only ensured representational balance but also allowed the researchers to identify temporal variations in archival degradation patterns.

Survey findings indicated that paper-related deterioration constituted the most dominant form of damage. Specifically, tears (60%), missing sections (42%), and holes (40%) were frequently observed, falling within the moderate to severe damage categories. These types of physical damage are strongly associated with the brittle nature of newsprint, which is known to deteriorate rapidly under suboptimal environmental conditions. The high acidity of cellulose, combined with aging and inadequate storage conditions, resulted in brittle fibers and a gradual weakening of tensile strength over time. As observed in the pre-independence and New Order period bundles, paper materials stored without adequate climate control were significantly more prone to rapid decay, highlighting the systemic vulnerability of Indonesia's documentary heritage to environmental threats.

In addition to structural damage, surface stains were also prevalent. The most commonly recorded types included foxing (32.3%), edge browning (26.2%), mold (17.8%), and patchy discoloration (22.6%). These types of discoloration were largely attributed to long-term exposure to excessive humidity, poorly ventilated spaces, and inadequate handling practices. Improper packaging—such as the use of plastic wrappers that trap moisture—exacerbated microbial growth and accelerated fungal colonization, particularly in tropical climates like Indonesia. The study found that newspapers from the Pre-Independence and New Order eras exhibited more advanced staining, suggesting a longer duration of neglect and environmental exposure. This supports prior assertions by Supratman (2020) and Ratmono (2021) regarding the difficulties in preserving pre-1960s archival collections in Indonesia, which often suffer from inconsistent conservation protocols and limited environmental control measures.

Other forms of deterioration included chemical degradation and environmental damage. Highly acidic paper was recorded in 95% of cases, placing it in the critical category. This confirmed that the predominant use of wood pulp paper, which naturally contained lignin, led to widespread acidification problems in older newsprint materials. Furthermore, 41% of the bundles exhibited wrinkling or warping, 40% exhibited brittleness, and 11% were damaged by insect activity. These patterns pointed to long-term exposure to uncontrolled environmental conditions, including temperature fluctuations, inadequate air circulation, and insect infestation resulting from unsealed storage environments. The relationship between acidity and secondary deterioration—such as brittleness and warping—indicated a cascading pattern of degradation in which one form of damage exacerbated others, leading to accelerated loss of physical integrity and informational content.

Preservation interventions were found to be significantly limited. Of the 400 bundles assessed, only 21 (5.25%) had received physical conservation, while 145 bundles (36.25%) had been digitized. This means that over 63% of the archives sampled had not undergone any preservation. The disproportionate gap between the scale of deterioration and the scope of preservation reflects structural limitations, including under-resourced conservation units, limited funding, and a lack of national regulatory enforcement. As Kopin and Narlock (2024) note, the absence

of trained archival staff, insufficient infrastructure, and inconsistent long-term planning for digital repositories all contributed to the weak implementation of the digital transformation agenda.

This study employed the Analytical Hierarchy Process (AHP) to systematically identify and rank the most critical forms of deterioration affecting the historical newspaper collection. Expert consultations were conducted with Prof. Dr. Ninis Agustini Damayanti, M.Lib., from the Faculty of Communication Sciences, Universitas Padjadjaran, and Ibu Ayu, an archivist from the National Library of Indonesia. Through comparative assessments, the experts evaluated five predominant types of physical damage observed during the fieldwork: paper tears, stains, perforations, missing sections, and mold contamination. The assessment identified paper tears and missing sections as the most urgent conservation priorities, as they directly compromise the legibility, completeness, and informational continuity of archival materials. Conversely, mold growth and surface staining, though chemically harmful and visually extensive, were deemed controllable through preventive environmental management, including humidity regulation, UV-protected storage, and the use of acid-free archival enclosures.

The AHP application generated a hierarchical model of preservation priorities, facilitating strategic resource allocation to the most structurally compromised items. By integrating empirical data with expert judgment, the framework ensured that the decision-making process is scientifically grounded and operationally feasible. This approach underscored the importance of adopting data-informed and expert-validated preservation strategies, enabling institutions to strike a balance between physical restoration and preventive care. Ultimately, the model contributed to sustainable preservation planning and strengthened efforts to safeguard the physical integrity and informational value of Indonesia's historical newspaper heritage.

The strategic use of AHP in archival management illustrated a major methodological contribution of this study. In a context where preservation resources are limited and trade-offs must be made, AHP provided a structured, evidence-based model for setting priorities. Similar applications of AHP in cultural resource management, as demonstrated by Arisanti et al. (2023) and Mosa et al. (2022), underscore its effectiveness in integrating expert opinion with empirical data to enhance decision-making accuracy. In this study, AHP enabled the formulation of targeted recommendations tailored to the Perpusnas's institutional capacity and contextual constraints.

Furthermore, data analysis revealed that 50.7% of bundles with high-acidity were also affected by brittleness (21.4%), warping (22%), and insect damage (5.6%). This pattern highlighted how chemical degradation exacerbated mechanical brittleness, confirming the importance of integrated preservation strategies that combined chemical stabilization with physical conservation. Therefore, regular pH testing and deacidification treatments were critical to halt further deterioration, especially for high-priority items. According to Khaddafi and Akbar (2024), such proactive techniques should be adopted as standard preventive measures

in managing analog collections within digital migration workflows.

This study also reinforces the theoretical foundation for dual preservation—an approach that combines selective physical conservation with digital migration. Fatmawati (2018) and Sulendra (2014) argue that safeguarding both the tangible medium and intangible content is crucial in archival science. This principle recognizes that even if physical materials degrade, their embedded information can still be salvaged through high-resolution digitization and metadata enrichment. This is especially vital in a national library setting, where newspapers are not only cultural artifacts but also critical public records documenting the nation's socio-political trajectory. In this context, digitization offers scalability, preservation of content authenticity, and extended access—benefits emphasized in Buršić and Stančić (2019) conceptualization of authentic digital surrogates.

However, as Gross and Marsh (2022) note, the post-pandemic digital acceleration has revealed disparities in digital infrastructure and service equity. Without strong policy coordination, even digitized materials remain underutilized or inaccessible. Therefore, national preservation strategies must focus not only on technology adoption but also on ensuring equitable access, inclusive metadata curation, and interoperable platforms. In Indonesia, this aligns with Government Regulation No. 88 of 1999, which provides a legal mandate for format migration, while mandating the protection of data integrity, originality, and usability.

Despite the regulatory framework, institutional inertia remains a barrier. As Bawono et al. (2022) emphasize, emotional and cultural perceptions continue to influence recordkeeping practices in Indonesia. Therefore, raising awareness and empowering staff are essential components of any preservation roadmap. Institutional policy reform should prioritize capacity-building initiatives, such as conservation training programs, risk assessment workshops, and archival science certification programs. Such efforts can cultivate a culture of stewardship among library professionals and reinforce institutional accountability in archival management.

From an academic perspective, this research addresses a notable gap in the literature. While many studies in Indonesia have explored the legal, cultural, or technical aspects of archival preservation in isolation, very few have integrated empirical assessments with a structured prioritization model. By applying the AHP and combining quantitative data with expert evaluation, this study has contributed a replicable framework that can guide similar preservation programs across Indonesia. Moreover, this study strengthened the empirical foundation for policy advocacy, providing concrete metrics that could be used to justify budget allocations, infrastructure investments, and cross-institutional collaboration.

Practically, the study offered actionable recommendations. First, newspapers from the Pre-Independence and New Order periods should be prioritized for conservation, given their higher rates of damage and historical significance. Second, regular pH assessment and deacidification should be institutionalized as routine practice. Third, digitization should be expanded, with clear metadata standards, a public access

platform, and a sustainability plan. Fourth, Perpusnas RI should establish an internal monitoring system to track preservation outcomes and adapt strategies accordingly. Lastly, the use of AHP or similar tools should be formalized within institutional preservation protocols to support long-term planning and transparent decision-making.

The results of this study affirmed the urgent need for a comprehensive preservation strategy that balanced archival value, physical condition, and institutional capacity. These findings underscored the necessity for a dual-preservation approach—one that leveraged conservation techniques and digital technologies while also addressing the human, legal, and infrastructural dimensions of archival sustainability. In doing so, Perpusnas RI could fulfill its role not only as a custodian of historical memory but also as a knowledge institution capable of adapting to the evolving demands of heritage preservation in the digital era.

CONCLUSION

This study concludes that the preservation of Indonesia's historical newspaper collection remains fragile due to the inherent weaknesses of newsprint materials and the absence of an integrated, data-based preservation framework. The findings reveal that various forms of deterioration, such as brittle paper, torn pages, missing sections, and surface contamination, threaten the long-term stability and informational integrity of the collection. To address these issues, a systematic preservation strategy that combines physical restoration and digital safeguarding is essential. Within this framework, *structural repair* refers to the targeted physical restoration of damaged newspapers, particularly repairing torn and missing parts that compromise legibility and completeness. These interventions are crucial to preventing further deterioration while maintaining the authenticity and evidential value of Indonesia's documentary heritage. Through the application of the Analytical Hierarchy Process (AHP), this study establishes a priority model that aligns preservation actions with the severity and impact of physical damage. The results support the implementation of a dual-preservation model, which integrates selective physical conservation with large-scale digitization to ensure long-term access and protection of original materials. While this research provides a data-driven foundation for archival preservation planning, its focus is limited to the National Library of Indonesia. Future research should extend this methodological model to other archival institutions and explore advanced technologies, such as artificial intelligence-based damage detection and metadata enhancement, to strengthen the national preservation system and ensure the sustainable protection of Indonesia's historical records.

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AUTHORS' CONTRIBUTIONS

ULSK: Conceptualization, Methodology, Writing – original draft, Supervision. YW: Conceptualization, Writing – original draft, Resources. LRS: Formal Analysis, Investigation, Data Curation. TN: Writing – review & editing, Investigation. FIS: Formal Analysis, Visualization, Software. S: Investigation, Validation, Resources. KK: Investigation, Data Curation, Validation. SMS: Writing – review & editing, International Collaboration.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this research.

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DATA AVAILABILITY

The quantitative dataset, including the damage assessment of 400 newspaper bundles and the AHP priority matrix generated during the development of this study, has been included in the manuscript. Additional detailed field documentation and institutional reports may be requested from the corresponding author.

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