Promoting Digital Literacy: Strategic Approaches to Web Archiving Implementation in Indonesian Archival Institutions

Herman Setyawan[1], Aisyah[2], Erna Widayati[3], & Siti Samsiyah[4]

[1,3]Universitas Gadjah Mada, Indonesia
[2]Universitas Sumatera Utara, Indonesia
[4]Universitas Terbuka, Indonesia
Correspondence email: herman.setyawan@ugm.ac.id

Notes	ABSTRACT
  	This study investigates the challenges and strategies associated with implementing web archiving across various institutions in Indonesia, including Universitas Terbuka, Universitas Sumatera Utara, Universitas Mataram, Universitas Diponegoro, Institut Teknologi Sepuluh Nopember, and several regional archival and library offices. Employing a mixed-method approach, the research combines quantitative data from a survey of 235 archivists and information professionals with qualitative insights gathered through interviews with institutional representatives. The findings revealed a limited familiarity with the concept and practice of web archiving among respondents, which hinders both interest and institutional readiness to adopt such practices. Contributing factors include gaps in digital literacy, inadequate training, and lack of institutional policy frameworks. To address these issues, the study recommends systematic efforts to improve digital competencies through targeted training programs and awareness campaigns. Enhanced understanding of web archiving is crucial for ensuring the long-term preservation of digital information, particularly in an era marked by rapid technological change and increased reliance on web-based content. The research underscores the need for collaborative strategies and policy integration to foster a sustainable web archiving culture across academic and government institutions in Indonesia. **Keywords:** Archive Management; Web Archiving; Digital Literacy

1. INTRODUCTION

The web has become a major source of information, media, and cultural records in today's digital age. The web is a major source of information due to its wide accessibility, diverse

content, and ability to facilitate interaction among different social sectors and enhance knowledge acquisition (Rusho, 2020). Content generated online, ranging from news articles and institutional websites to social media, forms a large part of what is referred to as digital collective memory. Digital collective memory refers to the dynamic procedural processes shaped by digital technologies, enabling redefined social interactions and representations of the past, transcending traditional concepts of memory (Mandolessi, 2023). However, web content's dynamic and changeable nature makes it vulnerable to being lost or deleted over time.

Web archiving, or the practice of archiving web content, is one solution to this problem. In some developed countries, web archiving has been widely adopted, especially by government agencies, national libraries, and academic institutions. For example, the National Archives and Records Administration (NARA) has implemented a comprehensive strategy to archive web content, including social media and government datasets. (Kelly et al., 2023) and the National Library of Australia, which initiated web archiving efforts as early as the 1990s (Storti, 2023).

Web archiving refers to the practice of systematic collection and preservation of digital content scattered across various online sources, such as websites and other digital resources. According to Loan et al. (2024), this process aims to document previous versions of web pages so that they remain accessible in the future. This is in line with Maemura (2023), which states that web archiving ensures the long-term preservation of digital content and allows users to re-access information that has been deleted or altered. Reid et al. (2022) added that web archiving is also important for maintaining access to digital collective memory. Gomes et al. (2021) further underlined the importance of web archiving to preserve cultural records and digital knowledge that can be lost over time.

The importance of web archiving has become increasingly apparent with the rapid development of the internet. Significant cultural and scientific content can quickly disappear without organized preservation efforts. Web archiving has become essential for preserving digital information and ensuring long-term access to data and history. Along the same lines, Wong & Chiu (2024) point out that web archiving captures the cultural and historical value of websites and social media, which is invaluable as a future research resource. This archiving also allows future generations to access information that may be lost due to the transient nature of the web. According to Zantedeschi (2023), web archives are essential for historical research, as they provide access to material that reflects the evolution of digital content over time and enriches historical analyses and digital humanities studies.

In addition, web archiving also plays a role in documenting the early development of the World Wide Web, providing deep insight into the evolution of digital communication. Fomasi et al. (2023) emphasize the importance of web collections that record the early stages of the internet as an essential part of understanding the history of technology. Ahmad (2022) also adds that web archiving is crucial to ensure access to records of important events that document history and cultural heritage.

Without adequate web archiving, important digital data and resources risk becoming inaccessible, ultimately hindering the advancement of research and sound data-driven decision-making. This shows that web archiving is a preservation tool and the foundation for ensuring long-term accessibility to relevant information. One significant development in web archiving is the Wayback Machine, which plays a key role in preserving digital content and enabling access to past versions of websites (Loan et al., 2024; Ogden et al., 2024).

Thus, the urgency of web archiving is increasingly evident in the context of maintaining the sustainability of digital information in the Internet era. Globally, many institutions have adopted web archiving practices to preserve their digital heritage. However, such efforts have yet to gain significant traction in developing countries like Indonesia. This contrast highlights a gap in implementation, awareness, and understanding of the importance of web archiving. Current research rarely addresses how these global practices can be adapted to local contexts, particularly in Indonesia. Further research is needed to explore the challenges and opportunities in implementing web archiving in Indonesia, especially in strengthening national policies and encouraging wider adoption among information practitioners.

The expected outcomes of this research are a better understanding of the level of knowledge and awareness of web archiving in Indonesia; identification of key barriers, both technological and policy, to the implementation of web archiving; and practical recommendations for government and non-government institutions to adopt and expand the implementation of web archiving in Indonesia. This research contributes to the scant literature on web archiving in Indonesia by combining surveys and interviews as an exploratory approach to understanding the challenges and opportunities in the sector.

However, in Indonesia, the practice of web archiving remains minimal and has not received adequate attention. A preliminary study conducted by the researchers through an online survey from October 2 to 10, 2024, involving 100 archivists selected using purposive sampling, revealed that 82% had never engaged in web archiving, either personally or institutionally. This is particularly concerning given Indonesia's rich digital footprint, which spans diverse cultures, languages, and histories across digital platforms.

The absence of a clear national policy on web archiving, lack of awareness among information practitioners, and technical challenges in maintaining digital archives may contribute to the lack of implementation of web archiving in Indonesia. Despite their efforts in physical and digital archiving, memory institutions such as archives, libraries, and museums in Indonesia have yet to archive their websites. From the survey results, without naming the institutions, 12 archival institutions in Indonesia admitted that they have not made this effort.

With more websites and digital content being added every day and possibly lost every day, the threat to the sustainability of digital collective memory is increasingly real. If left without a solution, institutions may risk losing valuable digital footprints that reflect the nation's history.

This study addresses the urgent need for web archiving in Indonesia, where the absence of such practices risks the loss of valuable digital heritage. While most archival research in Indonesia still centers on physical collections and digitization, web archiving remains largely unexplored. To fill this gap, the study examines the perceptions, awareness, and challenges faced by Indonesian archivists and archival institutions in adopting web archiving, and explores potential strategies for its effective implementation.

2. METHODS

This study collected quantitative data from archivists and related professionals, such as archivists, records managers, and archival staff, working in various archival institutions across Indonesia. These include educational institutions, ministries and government agencies, local government offices, private sector organizations, and other archival bodies.

Table 1. Institutions participating in the web archiving research

No.	Institution	Type
1	*Universitas Terbuka*	University
2	*Universitas Sumatera Utara*	University
3	*Universitas Mataram*	University
4	*Universitas Diponegoro*	University
5	*Institut Teknologi Sepuluh Nopember (ITS)*	University
6	*Dinas Perpustakaan dan Kearsipan Kota Medan*	Government Archive & Library Office
7	*Dinas Perpustakaan dan Kearsipan Kabupaten Gunungkidul*	Government Archive & Library Office
8	*Dinas Perpustakaan dan Kearsipan Provinsi DKI Jakarta*	Government Archive & Library Office
9	*Dinas Perpustakaan dan Arsip Daerah Sumatera Utara*	Government Archive & Library Office

A total of 235 respondents were selected through simple random sampling, without stratification by institutional type. The survey instrument comprised 13 items: questions 1 to 3 were analyzed descriptively using the formula (calculated score/criterion score × 100%); items 4 to 10 offered binary (Yes/No) responses; and items 11 to 13 were rated on a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree).

Prior to the main survey, a pilot test involving 30 participants was conducted to assess the instrument's validity and reliability using Cronbach's alpha. The sample size met the widely accepted threshold for pilot studies in social research, ensuring that the instrument was both comprehensible and statistically sound.

Items 11 to 13 specifically measured perceptions regarding web archiving implementation: (11) "The absence of web archiving practices can negatively impact the preservation of web archives," (12) "Web archiving should be implemented in the institution where I work," and (13) "I feel the need to improve my knowledge and skills in web archiving." These items were analyzed using the 5-point Likert scale described above.

The reliability analysis, calculated using Cronbach's Alpha with the formula:

$$\alpha = \frac{N}{N-1}\left(1 - \frac{\sum \sigma_i^2}{\sigma_t^2}\right)$$

The reliability test produced a Cronbach's alpha of 0.85, indicating a high level of internal consistency among the three perception items. In social science research, a value above 0.70 is considered acceptable, confirming the instrument's reliability. Validity was assessed using Pearson's correlation between each item and the total score, yielding strong and significant results: Q11 = 0.78, Q12 = 0.75, and Q13 = 0.81. These correlations suggest that each item effectively measures the same underlying construct—awareness and attitudes toward web archiving. Based on these results, the instrument is both valid and reliable for assessing perceptions related to digital preservation through web archiving. The distribution of respondents is presented in Table 2.

Table 2. Distribution of respondents

No	Institution Category	Number of Respondents	%
1	Higher Education	141	60.00%
2	Ministries/Agencies	58	24.70%
3	Local Government	27	11.40%
4	Private Sector	2	0.80%
5	Other	7	2.90%

The majority of respondents (60.0%, or 141 out of 235) were from higher education institutions, indicating strong academic representation. Government ministries and agencies accounted for 24.7% (58 respondents), followed by local government institutions at 11.4% (27 respondents). The private sector contributed only 0.8% (2 respondents), while 2.9% (7 respondents) were categorized as "Other." This distribution highlights dominant participation from academia and government bodies.

For the qualitative phase, nine key informants were selected through purposive sampling based on their expertise in web archiving. They represented institutions such as ITS, USU, UT, Unram, Undip, and several provincial and municipal archival offices. Interviews continued until data saturation was achieved. Ethical approval was obtained, and informed consent was secured from all participants. The study ensured confidentiality by removing personal identifiers and adhering to data protection protocols. Qualitative data were analyzed descriptively.

3. RESULTS AND DISCUSSION

Based on the demographic study results, the respondents represented three main job categories: Archivists, Records Managers, and other Professionals. Archivists dominated with 159 respondents, or about 67.66% of the total respondents. This dominance reflects that this study involved many professionals who focus directly on archiving activities. Records Managers, in the second category, involved 47 respondents or around 20%, indicating significant participation from those responsible for records management despite not officially being Archivists. The Other Professions category, which includes 29 respondents (12.34%), shows the involvement of individuals with diverse professional backgrounds relevant to archiving. Job categories are shown in Table 3.

Table 3. Job categories

Job Category	Number of Respondents	%	%
Archivists	159	67.66%	60.00%
Records Managers	47	20.00%	24.70%
Other Professions	29	12.34%	11.40%
Total	235	100%	0.80%

As such, the results of this demographic research provide a clear picture of the profile of respondents based on their occupational category and institution of origin. Most respondents from the Archivist and Higher Education categories show that this research involves many professionals directly related to the world of archives, especially in the

academic environment. This indicates that both professionally and institutionally, archive management is still very much centered around higher education and the archivist profession. Nevertheless, contributions from ministries/institutions and local governments are also significant, adding depth to the data in this study. These findings can form the basis for developing more effective policies and strategies to improve records management at the educational institution level and in other public sectors.

Archivists' Perspectives on Web Archiving in Indonesia

The survey (see Table 4) shows a strong awareness among Indonesian archivists of the importance of web archiving, alongside notable gaps in understanding and implementation. A large majority of respondents (86%) agreed that valuable digital archives are at risk without proper web archiving practices. Additionally, 88% expressed the need for their institutions to adopt web archiving, and 91% indicated a personal desire to improve their knowledge and skills in this area. These findings reflect high support for the implementation of web archiving and a readiness to engage with capacity-building initiatives.

Despite this positive outlook, practical implementation varies. While physical document archiving remains nearly universal (95.74%), and digital document archiving is also widely adopted (89.36%), web content archiving is far less established. Only 50.64% reported archiving institutional website content, and an equal percentage admitted they do not, indicating limited institutional integration of web archiving practices.

Knowledge gaps are a significant barrier. Just under half of respondents (49.36%) understood that website and social media content could be archived, and 75.74% acknowledged that content older than 10 years on official websites is difficult to access—highlighting concerns about long-term digital preservation. However, only 51.06% had even heard of web archiving, and a striking 78.72% were unfamiliar with its core concepts, functions, and mechanisms. Furthermore, only 33.62% could distinguish between conventional digital archiving and web archiving, suggesting a need for clearer conceptual education.

Misconceptions about cost and accessibility also persist. Over half (57.87%) were unaware that many web archiving tools are free and user-friendly. Despite these challenges, the findings offer promising prospects: 91.06% of respondents expressed a strong interest in learning more about web archiving, signaling significant potential for future training and awareness programs.

Table 4. Summary of quantitative results on web archiving awareness and practices (N=235)

No.	Statement	Type	Score / Count	%
1	Awareness that without web archiving, digital preservation is threatened	Likert-scale	1007 / 1175	86%
2	Importance of implementing web archiving in institutions	Likert-scale	1032 / 1175	88%
3	Need to improve knowledge and skills in web archiving	Likert-scale	1070 / 1175	91%
4	Institution archives physical documents	Yes	225	95.74%
5	Institution archives digital documents	Yes	210	89.36%
6	Institution archives official website content	Yes	119	50.64%
7	Understand that website and social media content can be archived	Yes	116	49.36%
8	Aware that web content older than 10	Yes	178	75.74%

	years is hard to access			
9	Have heard of web archiving	Yes	120	51.06%
10	Familiar with the concept, function, and how web archiving works	Yes	50	21.28%
11	Understand the difference between regular digital archiving and web archiving	Yes	80	33.62%
12	Did not know web archiving is free and easy	No	136	57.87%
13	Interested in learning more about web archiving	Yes	214	91.06%

This study's results imply an urgent need to improve the transition from physical document archiving to more modern archiving practices, such as digital archiving and web archiving. This indicates the need for training programs and capacity building for archivists to understand and apply the latest archiving technologies. Furthermore, the gap in the implementation of digital archiving needs to be addressed by conducting socialization and campaigns to encourage institutions that have not participated in digital archiving practices. This is important to ensure all institutions adopt efficient and effective archiving practices. In addition, the importance of web content archiving must be increased, especially by developing clear policies and guidelines. Institutions need to provide technical support to help implement web content archiving optimally.

With the high interest in learning more about web archiving, there is an opportunity to develop socialization initiatives that can improve the understanding and skills of archivists. Thus, the implications of this study emphasize the importance of developing policies that support the integration of digital archiving and web archiving in information management practices. Increasing archivists' awareness and understanding of these practices will contribute to better future archives management and preservation of digital information.

Archival Institutions' Views on Web Archiving

Based on the results of interviews with archival institution officials from several institutions, there are variations in the level of understanding, interest, and perception of the importance of implementing web archiving. Most respondents understand the importance of implementing web archiving to maintain the sustainability of digital information in their institutions, although their understanding and readiness to implement it vary.

Some respondents, such as those from the Institut Teknologi Sepuluh November (ITS) and the Dinas Perpustakaan dan Kearsipan Medan, showed a deeper understanding of web archiving. ITS has been archiving in real time and stated that its digital archives can be accessed across time, ensuring the continuity of digital information. The Dinas Perpustakaan dan Kearsipan Medan is also familiar with this concept and stated that although they have not fully implemented web archiving, they are moving towards it, emphasizing the importance of digital archiving in their activity planning. Figure 1 shows web archiving at ITS since 2001.
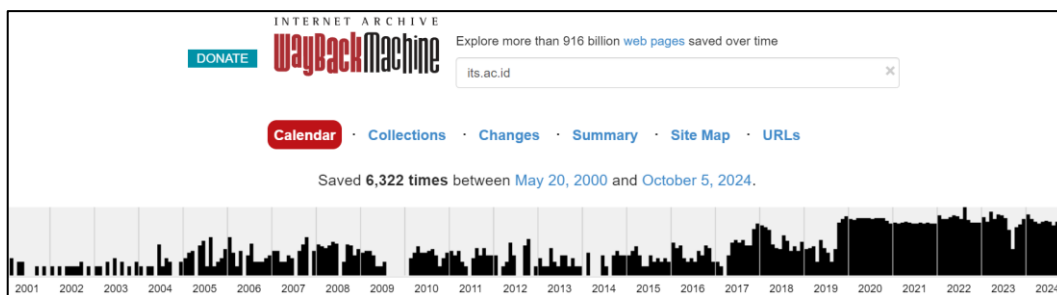
Figure 1. ITS web archiving
Source: https://web.archive.org/

Figure 1 shows the archiving efforts of the ITS website https://www.its.ac.id/ via the page https://web.archive.org/. The black graph shows the intensity of archiving website content, which in 2001 was still small, and in 2024, it was already very large. Web archiving each year can be seen in more detail, and daily activities can be seen.

Meanwhile, several institutions, such as the Universitas Sumatera Utara (USU) and the Universitas Terbuka (UT), showed great interest in implementing web archiving even though their initial understanding was limited. USU, for example, admitted their initial ignorance about web archiving, but after understanding the concept, they saw its importance and intended to implement it with further training support. UT also showed interest in implementing web archiving, especially in distance education, where digital content plays an important role, although it is still in the process of archiving digital content. Figure 2 shows USU's web archiving activities from the website https://www.usu.ac.id/.
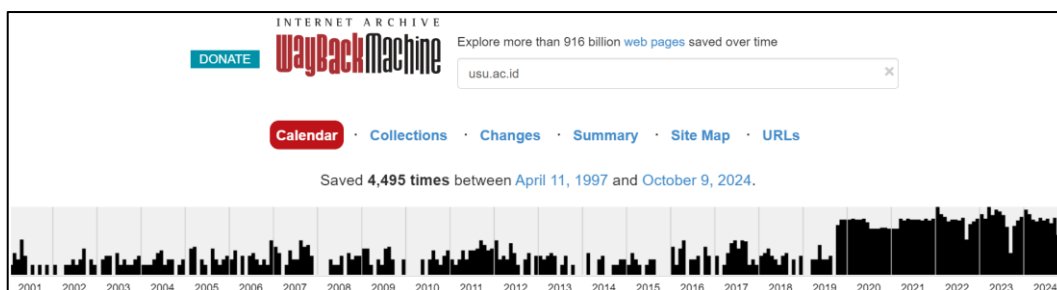

Figure 2. USU Web Archiving
Source: https://web.archive.org/

Other institutions, such as the Universitas Mataram (Unram), Dinas Perpustakaan dan Kearsipan Gunungkidul, and Dinas Perpustakaan dan Kearsipan Sumatera Utara, have an initial understanding of web archiving and realize the importance of this implementation. They show interest in adopting web archiving in their digital archive management, especially to improve the accessibility and sustainability of information. However, full implementation has not been fully implemented in these institutions.

A few respondents, such as from Universitas Diponegoro (Undip) and Dinas Perpustakaan dan Kearsipan DKI Jakarta, stated that they did not fully understand what web archiving is. However, they agreed that web archiving is essential to support the sustainability of digital information and showed interest in implementing this concept in the future.

From the results of this interview, it can be concluded that although there is variation in the level of understanding, interest in implementing web archiving is generally high among

archival institution officials. They realize the importance of digital archiving to maintain the sustainability of information. However, some institutions still need support in the form of training or capacity building for implementation to run effectively.

Challenges and Strategies for Web Archiving in Indonesia

Challenges and strategies in implementing web archiving in various archival institutions show similarities and differences in the obstacles faced. One of the main challenges many institutions face is related to infrastructure, especially the need for adequate storage or servers. Several institutions, such as Universitas Sumatera Utara (USU) and Institut Teknologi Sepuluh November (ITS), mentioned the importance of procuring large storage capacity to accommodate the needs of archiving digital content. The Library and Archives Service in Medan and DKI Jakarta also faced similar obstacles, where applications and other supporting facilities needed to be continuously updated to support the implementation of web archiving. The strategies implemented by these institutions generally involved procuring and monitoring storage regularly and ensuring that the technology used was always in optimal condition. In addition to infrastructure issues, a significant challenge is related to human resources (HR). Several institutions, such as the Universitas Terbuka (UT), USU, and the Universitas Mataram (Unram), stated that despite sufficient HR, they often had other workloads that hampered the archiving process. On the other hand, several institutions, such as Dinas Perpustakaan dan Kearsipan Sumatera Utara, face the problem of a minimal number of human resources to handle web archiving. To overcome this problem, several institutions implement HR training strategies, such as those carried out by USU and ITS, which not only train HR to operate web archiving technology but also set automatic backup schedules and standard operating procedures (SOPs) to ensure the continuity of the process.

Another challenge that arises is the inadequate policies and regulations to support the implementation of web archiving. This was expressed by several institutions, such as Unram and the Gunungkidul Library and Archives Service, which stated that regulations and policies from the leadership are still obstacles in implementing web archiving. The Gunungkidul Library and Archives Service also emphasized the importance of collaboration with related parties, such as the Legal Department and the Communication and Information Service, to formulate supportive policies.

Web access security is also a significant challenge faced by institutions such as USU and ITS. Both institutions recognize the need for periodic security improvements to protect archived data. In facing this challenge, they implemented a strategy in the form of routine security monitoring and ensured that access to the web archiving system is always protected from potential threats. The last challenge identified was the preparation of archive data. The DKI Jakarta Library and Archives Service and the Medan Library and Archives Service stated that before carrying out web archiving, they had to carry out comprehensive consolidation and data collection of archives. To overcome this, they carried out gradual data collection of archives and prepared the necessary infrastructure before fully implementing web archiving.

The findings of this research reveal a significant awareness among Indonesian archivists regarding the importance of web archiving. Quantitative results indicate that archivists recognize the risks of not implementing web archiving and express strong motivation to integrate it into their institutions. The high percentages—86% acknowledged the threat to digital preservation without web archiving, 88% advocated for institutional implementation, and 91% emphasized the need for competency development—demonstrate a favorable attitude toward advancing digital archival practices.

Despite this positive perception, the study also highlights a gap between awareness and implementation. While 95.74% of institutions engage in physical document archiving and 89.36% in digital document archiving, only 50.64% have incorporated web archiving. Moreover, a lack of understanding persists, with 49.36% of respondents unaware that website and social media content can be archived and 66.38% unable to differentiate between digital and web archiving. This gap underscores the necessity for targeted training and knowledge dissemination initiatives to facilitate the transition toward comprehensive digital preservation strategies.

Qualitative findings from interviews with archival institution officials further support these conclusions. Institutions such as ITS and Dinas Perpustakaan dan Kearsipan Medan demonstrate a deeper understanding and proactive stance toward web archiving. Conversely, institutions like USU and UT, despite their initial unfamiliarity, express a willingness to adopt web archiving with the proper support mechanisms. Other institutions, including Unram and Dinas Perpustakaan dan Kearsipan Sumatera Utara, recognize the significance of web archiving but face challenges in full-scale implementation due to resource constraints.

The research also identifies several key challenges hindering web archiving adoption. Infrastructure limitations, particularly inadequate storage capacity, pose a significant barrier. Additionally, the issue is exacerbated by limited technical expertise among archivists and a general lack of institutional policies supporting web archiving. A notable finding is that 57.87% of respondents were unaware that web archiving tools can be free and easy to use, indicating a missed opportunity for institutions to leverage existing cost-effective solutions.

Considering these findings, this research underscores several critical implications for archival practice and policy development. First, there is a pressing need for structured training programs to enhance archivists' digital competencies, particularly in distinguishing and implementing web archiving. Second, institutions should develop clear policies and guidelines to standardize web archiving practices, ensuring consistency and sustainability in digital preservation efforts. Third, technical and financial support mechanisms must be established to address storage and resource constraints, facilitating broader adoption of web archiving.

Overwhelmingly positive interest (91.06%) in learning more about web archiving presents a valuable opportunity for socialization initiatives. These initiatives should focus on raising awareness, providing practical guidance, and fostering collaboration among institutions to advance web archiving practices in Indonesia collectively. By addressing these challenges and capitalizing on the evident enthusiasm, this study contributes to the broader discourse on digital preservation. It offers actionable strategies for integrating web archiving into institutional archival management.

4. CONCLUSION

This study highlights a strong awareness among Indonesian archivists regarding the importance of web archiving. The majority of respondents (86%) recognized the risk of losing digital archives without web archiving practices, 88% supported its implementation within their institutions, and 91% expressed a desire to enhance their skills in this area. While traditional archiving practices remain prevalent, reflected by 95.74% of institutions archiving physical documents and 89.36% archiving digital files, only 50.64% have taken steps to preserve web content. A significant proportion of respondents (57.87%) were unaware that

web archiving is both affordable and accessible, indicating the need to improve awareness and digital archiving literacy. Many still perceive web archiving as a technically demanding process requiring complex infrastructure, which may hinder broader adoption. These findings underscore the importance of targeted training and education on practical, user-friendly web archiving methods. As Indonesia's archival institutions move toward more modern preservation strategies, strengthening archivists' competencies will be essential to ensure the long-term accessibility, reliability, and integrity of digital information.

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AUTHORS' CONTRIBUTIONS

Herman Setyawan: Contributed comprehensively to the development of the research concept, methodology design, data analysis, and the complete writing of the article. **Aisyah:** Data collection, data validation, and assisting in the data analysis process. **Erna Widayati:** Data collection, data processing, and the interpretation of research findings. **Siti Syamsiyah:** Data collection, data analysis, and provided input for the article's composition. All authors have read and approved the final version of this article.

CONFLICT OF INTERESTS

We state that there are no known conflicts of interest linked with this publication, and that there has been no significant financial assistance for this work that could have influenced its outcome.

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