# The Role of Digital Humanities in the Preservation of Cultural Heritage: The Case of the Sanctuary of Madonna di Carufo*

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### Abstract

This paper examines the role of Digital Humanities (DH) in the preservation, restoration, and valorization of cultural heritage through the case study of the Sanctuary of Madonna di Carufo, a site heavily damaged during the Central Italy earthquakes of 2016. By integrating advanced archival methodologies, international standards, and digital tools such as Omeka S and CollectiveAccess, the project seeks to create a multi-typological digital archive that preserves historical, technical, and educational resources. The research investigates the employment of interoperable metadata standards like ISAD(G), Dublin Core, and RiC to ensure accessibility, sustainability, and long-term usability. The study highlights the potential of digital archives not only as repositories of data but as interconnected hubs of knowledge, fostering new interdisciplinary research opportunities and global cultural exchange.

### Keywords

Digital Humanities, Cultural heritage, digital archives, Omeka S, Linked Open Data,

## 1. Introduction

The present contribution aims to illustrate the digitization and archiving project of the Sanctuary of Madonna di Carufo as a case study of the application of Digital Humanities (DH) in the conservation, enhancement, and accessibility of cultural heritage in post-earthquake contexts. The Sanctuary, located in Camporotondo di Fiastrone (MC), was severely damaged by the earthquakes that struck central Italy between 2016 and 2017, highlighting the urgency of preserving historical and cultural memory through digital tools and innovative methodological approaches [1].

The research project, developed by the University of Macerata in collaboration with the cultural association Identità Sibillina ETS, is currently under development. Preliminary prototypes of the multi-typological digital archive have been created, designed to document and provide access to the information collected and produced during the various phases of the restoration. The project is guided by the ANAI 2023 Guidelines [2], which provide principles and best practices for the management of digital and hybrid archives in design studies: the adoption of a standardized approach ensures not only the systematic preservation of information but also its interoperability and usability for a wide range of users, including sector professionals, researchers, local stakeholders, and broader communities.

The documentation produced during the restoration processes is not merely a technical support but a central element for enriching knowledge resources. It facilitates more targeted and informed conservation interventions, contributing to a broader understanding of the historical and cultural

value of the site: each restoration generates a large amount of data—technical reports, graphic surveys, construction site photographs, administrative permits, and diagnostic analyses—that, if systematically archived, can form an essential information base for future interventions and academic studies [3][4].

The digital archive project is supervised by the doctoral researcher responsible for the study and benefits from the ongoing contribution of various experts: technicians involved in the restoration project provide data and documentation, while a technician from the partner association supports the selection and implementation of digital platforms according to the project's specific needs and available resources.

The comparison of digital platforms, such as Omeka S and CollectiveAccess, has oriented the archive's design toward a flexible and dynamic solution capable of integrating advanced visualization tools such as interactive maps, 3D models, and virtual exhibitions. These tools can enhance the accessibility of archival resources and broaden audience engagement, promoting greater transparency and information sharing. Furthermore, such approaches could, in the long term, foster processes of cultural and social regeneration within communities affected by traumatic events, contributing to the construction of a shared collective memory [5][6].

Finally, this contribution aims to reflect on the crucial role of documentation as a cornerstone of restoration processes and its transformation into a shared knowledge tool. Through the case of the Sanctuary of Madonna di Carufo, it demonstrates how the integration of traditional documentation methods with advanced digital tools can not only ensure the preservation of historical memory but also contribute to the creation of a sustainable and reusable model for the management and enhancement of cultural heritage [7][8].

The study fits within the broader scope of Digital Humanities research, emphasizing the importance of an interdisciplinary approach in addressing contemporary challenges related to cultural heritage conservation and its accessibility for the benefit of future generations.

## 2. Digital Humanities and Restoration: The Role of Documentation

The study is grounded on the awareness that documentation is an essential element in the restoration of cultural heritage, functioning as a fundamental tool for ensuring not only the physical preservation of artifacts but also their enhancement and transmission as cultural and knowledge resources. Restoration is not merely a technical intervention aimed at repairing or stabilizing a damaged artifact but a process capable of generating critical knowledge about the history, materials, construction techniques, and identity-related values of a cultural asset.

In the case of the Sanctuary of Madonna di Carufo, the role of documentation has been central since the initial phases of restoration. The wealth of collected data, including technical reports, graphic surveys, historical images, administrative permits, and diagnostic analyses, has been organized using a systematic and interdisciplinary approach. This documentation, enriched through the use of digital technologies, does not merely record the site's conditions and the interventions performed but constitutes a knowledge corpus indispensable for planning future interventions, advancing historical and artistic research, and fostering dialogue with local communities. In this sense, DH proves to be a crucial tool for transforming traditional documentation into a living, accessible, and valuable digital heritage [3], [4], [5].

Currently, the data collected during the preliminary restoration phases includes historical documents, construction site photographs, technical reports, and 3D models. These data are organized hierarchically according to the principles of the ISAD(G) standard, which involves the division into fonds, series, and documentary units, respecting the principles of provenance and original order. The use of the Dublin Core standard enables a more flexible and interoperable

description of the resources through a set of essential metadata—such as title, description, date, and author—facilitating their sharing and integration with other digital platforms.

The experimental prototypes developed aim to:

**Test the coherence and usability of the collected data**: Data described through ISAD(G) are visualized via hierarchical structures (e.g., fonds → series → specific document), while Dublin Core metadata allows cross-searching by type, author, or date.

**Generate personalized paths for digital consultation**: Omeka S enables the creation of thematic digital exhibitions organized around specific topics, such as the "2016 Restoration Process" or the "Architectural History of the Sanctuary." Plugins like Exhibit Builder allow linking technical documents, images, and 3D models, providing users with an interactive and contextual experience.

**Link technical restoration reports to 3D models representing structural damage**.

**Integrate construction site photographs with graphic surveys to offer a comprehensive view of the interventions performed**.

## 2.1. Future Applications and Interdisciplinary Studies

The data collected and organized in the experimental prototypes aim to have multiple interdisciplinary applications:

**Historical and architectural research**: The integrated access to heterogeneous resources will enable scholars to analyze construction techniques, materials, and the transformations the Sanctuary has undergone over time.

**Support for future restoration interventions**: Detailed documentation will provide a knowledge base for planning targeted interventions and ensuring continuity across different restoration phases.

**Dissemination and community engagement**: Interactive thematic pathways and virtual exhibitions, primarily developed on Omeka S, will allow local communities and visitors to explore cultural heritage in an accessible way.

A key component of the project is the adoption of interoperable technologies to facilitate data sharing. Thanks to the integration capabilities of Linked Open Data (LOD), archived data can be connected to external datasets, such as those of Europeana or DBpedia, to offer a more comprehensive and contextualized view of the resources. For example, historical photographs of the Sanctuary can be enriched with geographic and historical data from international databases.

Moreover, the publication of structured data through RDF (Resource Description Framework) would enable the creation of semantic connections between internal and external resources, promoting new possibilities for interdisciplinary research.

In the post-earthquake context of the Marche region, characterized by a strong need for reconstruction and regeneration, the integration of traditional documentation with advanced digital tools represents an innovative model for cultural heritage management.

## 3. Comparative Evaluation of Digital Platforms

In the context of designing the digital archive for the Sanctuary of Madonna di Carufo, a comparative analysis was conducted between the platforms Omeka S and CollectiveAccess to identify the most suitable solution for the project's needs. Both platforms were installed and tested on Debian 12 virtual machines, configured with a Linux environment and appropriate relational databases.

For both platforms, the installation was carried out on Debian 12 virtual machines using the Linux environment to ensure stability and security. Relational databases, such as MariaDB for both Omeka S and CollectiveAccess, were configured in accordance with the technical specifications of each platform. This approach allowed for the assessment of infrastructure requirements and the technical skills needed for the long-term management of the digital archive.

During the testing phase, Omeka S demonstrated greater ease of use, thanks to an intuitive interface and a modular structure that enables users to create and manage collections without requiring advanced technical skills. Its multisite management feature allows for the administration of multiple projects or digital exhibitions within the same infrastructure. Moreover, Omeka S focuses on usability and storytelling, with integrated tools for creating virtual exhibitions that engage the public. Plugins such as Exhibit Builder enable the combination of digital content into interactive stories, enhancing the user experience [11].

Conversely, CollectiveAccess offers advanced flexibility in metadata management and natively supports standards such as ISAD(G), ISAAR(CPF), and CIDOC CRM, making it ideal for projects that require complex data modeling and articulated relationships between resources. However, its technical complexity poses a challenge for institutions with limited resources or non-specialized personnel [14].

Considering the available technological resources and the level of expertise of the personnel involved, Omeka S was chosen for the project's initial phase. This decision was driven by the need to ensure sustainability and replicability of the prototype while providing a platform accessible even to non-specialist users. Omeka S enables the implementation of archival standards such as ISAD(G) and RiC through the use of customizable plugins and modules, ensuring a coherent and interoperable description of archival resources [13].

Should the project expand to include multiple restoration interventions or the management of a more complex and multidimensional archive, a transition to more specialized platforms like CollectiveAccess could be considered. Its ability to manage complex datasets and implement advanced archival standards makes it a valid solution for large-scale projects requiring detailed data modeling and sustainable long-term preservation [14].

In conclusion, the selection of Omeka S at the current stage of the project effectively addresses the needs for managing and enhancing a single archival collection while maintaining the flexibility for potential future developments.

## 4. The Sanctuary of Madonna di Carufo: A Case Study for a Digital Archive

The Sanctuary of Madonna di Carufo, located in the municipality of Camporotondo di Fiastrone (MC), serves as a significant case study for the design and development of a digital archive dedicated to the documentation, preservation, and enhancement of cultural heritage. This place of worship, dating back to the 13th century, sustained severe structural damage following the earthquakes that struck Central Italy in 2016. These seismic events underscored not only the vulnerability of numerous cultural assets but also the pressing need for interventions extending beyond mere physical reconstruction, incorporating the safeguarding and promotion of the historical and symbolic significance of these sites.

The restoration project, initiated in response to these emergencies, primarily aimed to secure and architecturally recover the building. However, it gradually evolved into a broader perspective: documenting each phase of the process and making the collected data accessible to foster research, education, and community engagement. This multidimensional approach highlighted the need for an adequate tool to organize and manage the generated information—a digital archive structured around international standards and established guidelines.

### 4.1. 4.1. The Choice of a Multi-Typological Archive

This initiative fits within the framework of multi-typological archives, a choice reflecting the complex nature of the documentary corpus generated during the study and restoration activities. The concept of a multi-typological archive has gained prominence in recent years as a methodological and theoretical response to the increasing complexity of contemporary documentary

heritage. It refers to archives that, by nature and function, collect and organize materials of various types, origins, and formats, integrating traditional documents, multimedia resources, digital data, and interactive objects. A multi-typological archive is not limited to representing the plurality of documentary media but serves as a dynamic tool for the integrated management and enhancement of resources [17].

In the case of Carufo, the multi-typological archive materializes through the collection and valorization of heterogeneous data, including historical documents such as maps, manuscripts, photographs, and academic articles recounting the history of the Sanctuary; technical documentation comprising reports, graphic surveys, 3D models, and construction site photographs produced during the restoration; multimedia materials like videos, images, and 3D models used to visually represent various phases of the restoration; and educational and outreach resources such as theses, academic reports, presentations, and content for virtual exhibitions.

This documentary diversity reflects the structured processes of knowledge, conservation, and enhancement that characterize the project, making the adoption of a multi-typological approach indispensable. The primary dimensions of the project can be summarized as follows: the documentary heterogeneity, which requires management tools capable of ensuring coherence and integration among diverse resources; interdisciplinarity, as the archive brings together materials produced by professionals from various disciplines (historians, architects, restorers, engineers), necessitating interoperable standards to facilitate their use; and multiple purposes, as the archive is conceived not only as a conservation tool but also as a resource for research, education, and dissemination, thus broadening its range of beneficiaries.



*Figure 1*: Exterior of the Sanctuary of Madonna di Garufo (Sanctuary) in Camporotondo di Fiastrone (MC) before the 2016 earthquake. Source: ICCD, Usage Terms: Cultural Heritage Standards (BCS).

*Figure 2: Exterior of the Sanctuary of Madonna di Garufo (Sanctuary) after the 2016 earthquake in Camporotondo di Fiastrone (MC). Source: ICCD, Usage Terms: Cultural Heritage Standards (BCS).*



*Figure 3: Interior of the Sanctuary of Madonna di Garufo (Sanctuary), damaged by the 2016 earthquakes. Source: ICCD, Usage Terms: Cultural Heritage Standards (BCS).*
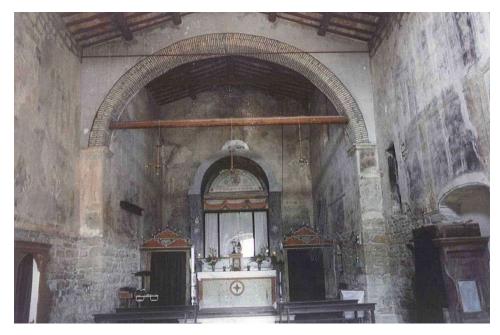
*Figure 3: Interior of the Sanctuary of Madonna di Garufo (Sanctuary). Source: ICCD, Usage Terms: Cultural Heritage Standards (BCS).*

## 4.2. Guidelines and International Standards

The design of the digital archive for the Sanctuary of Madonna di Carufo involves a comparative analysis between Omeka S and CollectiveAccess, aimed at identifying the most suitable solution for the project's needs. Both platforms were installed and tested on Debian 12 virtual machines configured with a Linux environment and relational databases, such as MariaDB for both Omeka S and CollectiveAccess, in line with their respective technical requirements. This setup allowed the assessment of the infrastructural needs and the technical expertise required for the long-term management of the digital archive.

During testing, Omeka S demonstrated significant ease of use, owing to its intuitive interface and modular structure that enables users to create and manage collections without extensive technical skills. Its multisite management capability supports the administration of multiple projects or digital exhibitions within a single infrastructure. Moreover, Omeka S focuses on accessibility and storytelling, with integrated tools for creating virtual exhibitions to engage the public. Plugins like Exhibit Builder allow digital content to be combined into interactive narratives, enhancing user experience [11].

In contrast, CollectiveAccess offers advanced metadata management flexibility and native support for standards such as ISAD(G), ISAAR(CPF), and CIDOC CRM, making it ideal for projects requiring complex data modeling and intricate resource relationships. However, its technical complexity presents challenges for institutions with limited resources or non-specialized personnel [14].

Given the technological resources and the degree of specialization of the involved personnel, Omeka S was selected for the initial project phase. This decision was guided by the need to ensure sustainability and replicability of the prototype while providing a platform accessible to non-specialist users. Omeka S allows the implementation of archival standards like ISAD(G) and RiC through customizable plugins and modules, ensuring consistent and interoperable descriptions of archival resources [13].

If the project were to expand, involving multiple restoration interventions or the management of a more complex and multidimensional archive, a transition to more specialized platforms like CollectiveAccess might be considered. Its ability to manage complex datasets and implement

advanced archival standards offers a viable solution for large-scale projects requiring detailed data modeling and sustainable long-term preservation [14].

In conclusion, the current choice of Omeka S effectively meets the management and enhancement needs of a single documentary fund while providing flexibility for future developments.

## 4.3. Semantic Web

The implementation of digital preservation strategies within the project for the digital archive of the Sanctuary of Madonna di Carufo would be crucial to ensuring the sustainability of its documentary heritage over time. Central to this strategy would be the adoption of tools like Archivematica, which offers a robust infrastructure adhering to international standards, integrated with the intuitive interface of Omeka S for resource access and valorization. The primary objective would not only be to protect data from technological obsolescence but also to promote their reuse and sharing in interdisciplinary research contexts [23].

The digital preservation process would involve several operational phases:

**Ingest and preservation**: Digital resources would be uploaded to Archivematica, where the data would be processed to create Archival Information Packages (AIPs). These packages would contain the original digital files alongside metadata to ensure their authenticity and integrity over time [24].

**Creation of Dissemination Information Packages (DIPs)**: Archivematica would generate DIPs, optimized versions of the resources intended for public consultation.

**Integration with Omeka S**: The DIP packages would be imported into Omeka S through dedicated modules or automated scripts. Once uploaded, the resources would be organized into Item Sets and made available for consultation [20], [23].

The integration between these two platforms would provide numerous advantages:

**Long-term preservation**: Archivematica, compliant with standards such as the OAIS (Open Archival Information System) Reference Model, would ensure the long-term preservation of digital resources while maintaining their authenticity and integrity [24].

**Optimized access**: Omeka S would facilitate public access through its intuitive interface and modular navigation system.

**Interoperability**: The use of standard formats like METS (Metadata Encoding and Transmission Standard) would allow for smooth data transfers between platforms, ensuring coordinated and automated resource management [23].

**Process automation**: Customized Python scripts for analyzing METS files would minimize the risk of manual errors, speeding up workflows and ensuring metadata consistency.

A significant example of this integration is found in the project "Using Archivematica and Omeka S for Long-Term Preservation and Utilization of Digitized Newspapers," which demonstrated how the automation of the data ingestion and transfer process is critical for ensuring the sustainability of complex projects [23]. Through automated scripts, large volumes of structured data were imported efficiently, optimizing management and reducing intervention times.

In the context of the Sanctuary of Madonna di Carufo, adopting this infrastructure could support the preservation of key resources such as 3D restoration models, historical photographs, and technical reports. Archivematica would provide the foundation for secure and sustainable digital file management, while Omeka S would ensure accessibility through personalized semantic pathways and advanced SPARQL Endpoint queries.

Finally, the publication of data as Linked Open Data (LOD) would represent a strategic development for the project, fostering the interconnection of local resources with international datasets. For example, resources from the Sanctuary could be linked to global platforms like Europeana, creating synergies between local heritage and international research initiatives [15]. This approach would expand the project's impact and create new opportunities for research and education.

# 5. Conclusion

The project for the digital archive of the Sanctuary of Madonna di Carufo is a significant example of how Digital Humanities (DH) can contribute to the preservation and enhancement of cultural heritage, especially in post-seismic emergency contexts. The structural vulnerability of cultural assets damaged by natural events underscores the urgent need for innovative digital tools that ensure the long-term conservation and accessibility of documentary resources.

Within this context, Digital Humanities reveal their transformative potential: they are no longer mere technical tools or supplementary supports but have evolved into comprehensive interdisciplinary methodologies that connect historical research, technology, and community engagement. The integration of Omeka S, semantic technologies, and digital preservation tools such as Archivematica in the Carufo project exemplifies how to build archives that do not merely preserve the past but serve as dynamic knowledge hubs. This approach, grounded in data interoperability and the adoption of international standards like ISAD(G), RiC, and PREMIS, ensures not only the integrity of documentary resources but also their connection to global knowledge networks through Linked Open Data (LOD) [15], [20].

The use of Omeka S, with its flexibility in metadata customization and the ability to create personalized narrative paths through the Semantic Web, has enabled the organization of resources to be accessible to both specialists and non-experts. At the same time, integration with Archivematica ensures sustainable digital data management, safeguarding them against technological obsolescence and enabling their reuse in future contexts. The ability to connect the Sanctuary's resources with other cultural datasets, such as those available on Europeana, is another step toward building a shared information ecosystem [23].

However, the project remains in an experimental phase, emphasizing the importance of a flexible and adaptive approach. Experimentation is integral to Digital Humanities, allowing for the testing and adaptation of technologies to specific contextual needs. Future implementations could include additional automation tools for digital preservation and the expansion of the archive toward a more complex and multi-institutional dimension, potentially transitioning to platforms like CollectiveAccess should the complexity of the data require it [14].

Ultimately, the project does not merely aim to preserve tangible cultural heritage but also to propose a replicable and scalable model for other emergency contexts. Its ambition is to demonstrate how digital documentation can serve as a tool for cultural and social regeneration, giving local communities the opportunity to rediscover and reinterpret their historical memory. By valorizing the documentary heritage, the Carufo project illustrates how technological innovation can serve not only the preservation of the past but also the creation of an active dialogue between past, present, and future.

In this light, Digital Humanities do not represent a static discipline but rather a continuously evolving field of research. Only through constant experimentation and refinement of applied methodologies will it be possible to overcome the challenges posed by technological and social changes, transforming digital archives into genuine engines of cultural and scientific development.

# 6. References

[1] Metin, A., & Rognoni, F. (2024). Storia dell'architettura e Digital Humanities per la conoscenza e la conservazione del patrimonio costruito: un'esperienza italiana. magazén, 5(1), 1–28. https://doi.org/10.30687/mag/2724-3923/2024-01-001

[2] ANAI. (2023). Linee guida per la formazione, gestione e conservazione degli archivi digitali e ibridi negli studi di progettazione. Roma: Associazione Nazionale Archivistica Italiana.

[3] Fiorani, D., & Romeo, E. (2020). Realizzazione degli interventi, valorizzazione, gestione, prevenzione: una panoramica introduttiva. In S. F. Musso & M. Pretelli (Eds.), Restauro: Conoscenza, Progetto, Cantiere, Gestione (pp. 519–525). Roma: Edizioni Quasar.

[4] Grimoldi, A. (2017). Storia della costruzione, storia materiale del costruito, tutela e conservazione del patrimonio architettonico. In D. Fiorani (Coord.), RICerca/REStauro. Conoscenza dell'edificio: metodo e contenuti (pp. 481–495). Roma: Edizioni Quasar di S. Tognon.

[5] Salarelli, A. (2016). Gestire piccole collezioni digitali con Omeka: l'esperienza di MoRE (A Museum of Refused and Unrealised Art Projects). Bibliothecae.it, 5(2), 177–200. https://doi.org/10.6092/issn.2283-9364/6393

[6] Balzani, M., Raco, F., & Suppa, M. (2019). Protocolli di acquisizione e gestione dati per la documentazione, rappresentazione e conservazione del patrimonio culturale danneggiato dal sisma. Ferrara: Università degli Studi di Ferrara.

[7] UNESCO. (2003). Convention for the Safeguarding of the Intangible Cultural Heritage. Paris: UNESCO.

[8] Tufarelli, M. (2019). Futuro del patrimonio, patrimonio del futuro. Firenze: Università degli Studi di Firenze.

[9] Ingram-Monteiro, N., & McKernan, R. (2022). An Omeka S Repository for Place- and Land-Based Teaching and Learning. Information Technology and Libraries, 41(3). https://doi.org/10.6017/ital.v41i3.15123

[10] Council of Europe. (2005). *Framework Convention on the Value of Cultural Heritage for Society*. Faro: Council of Europe Publishing.

[11] Alcaraz-Martínez, R. (2022). Omeka S como alternativa para el desarrollo de colecciones digitales y proyectos de humanidades digitales. *BiD: textos universitaris de biblioteconomia i documentació*, 48, 1–20. https://doi.org/10.1344/BiD2022.48.06

[12] Rueff, B. (2023). Dealing with post-excavation data: the Omeka S TiMMA web-database. *Archaeological Data Management Journal*, 12–34.

[13] Piotrowski, D. M. (2024). Omeka S: otwarte studium bibliometryczne. *Biuletyn EBIB*, 3(214), 3–15.

[14] Ravikumar, S., & Hazarika, H. J. (2020). Comparative Study between Omeka, DSpace and E-Print: A Special Reference with Plugin Features. *Conference Paper*, 1–12.

[15] Popović, P., Škorić, M., & Rujević, B. (2020). The use of the Omeka Semantic platform for the development of the University of Belgrade, Faculty of Mining and Geology digital repository. *Infotheca*, 20(1–2), 136–148.

[16] Bruneau, O., Lasolle, N., Lieber, J., Nauer, E., & Pavlova, S. (2020). Applying and developing semantic web technologies for exploiting a corpus in history of science: The case study of the Henri Poincaré correspondence. *Semantic Web*.

[17] Brunetti, D. (2018). L'archivio multitipologico: definizione, descrizione e identità. *La Gazette des archives*, 249, 39–49. https://doi.org/10.3406/gazar.2018.5590

[18] Weibel, S., Kunze, J., Lagoze, C., & Wolf, M. (1998). Dublin Core Metadata for Resource Discovery. *International Journal on Digital Libraries*, 1(2), 108–114. https://doi.org/10.1007/s007990050002

[19] International Council on Archives (ICA). (2016). *Records in Contexts: A Conceptual Model for Archival Description*. Paris: ICA.

[20]     Digital Preservation Coalition. (2022). *Digital Preservation Handbook.* Retrieved from https://www.dpconline.org.

[21]     Library of Congress. (2023). *PREMIS Data Dictionary for Preservation Metadata.* Retrieved from https://www.loc.gov/standards/premis.

[22]     Higgins, S. (2020). *Digital Curation: Theoretical Foundations and Practical Approaches.* Cambridge: Cambridge University Press.

[23]     Artefactual Systems. (2023). *Archivematica Documentation.* Retrieved from https://www.archivematica.org.

[24]     Brown, A. (2020). *Practical Digital Preservation: A How-to Guide for Organizations of Any Size.* London: Facet Publishing.