

Interdisciplinary Framework for AI-Powered Restoration Storytelling

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Abstract

This paper introduces a multi-layered interdisciplinary framework for AI-powered restoration storytelling and its sets the groundwork for the *AI4Re-story* tool, that will be developed by HighEST Lab (University of Turin) in collaboration with CCR - La Veneria Reale and with the financial support of Fondazione CRT. This paper explores how Artificial Intelligence (AI) can be integrated into an interdisciplinary framework to create cultural value from restoration data, specifically focusing on how to communicate the often-overlooked material history of artworks. While museum communication typically emphasizes artists, subjects, and contexts, the material aspects of artworks, including their restoration and conservation, are often neglected. These aspects, however, hold valuable insights that can tell rich, untold stories about an artwork's life. Communicating these stories to the general public is challenging, as conservation and restoration knowledge is highly specialized, making it inaccessible to most visitors.

The effectiveness of the interdisciplinary framework for AI-powered restoration storytelling depends on the active involvement and collaboration of a wide range of stakeholders across cultural, technical, and educational domains.

The paper begins by situating this challenge within the broader context of digital transformation in the cultural heritage sector, considering both the potential and difficulties of storytelling in conservation. It then examines existing frameworks for digital and AI-data storytelling, before introducing an interdisciplinary framework for AI-powered restoration storytelling. The *AI4Re-story* project aims to provide a tool that helps curators, restorers, and art historians communicate their work more effectively to different audience segments. This framework aligns with broader societal and technological shifts, addressing the evolving needs of cultural institutions, policymakers, and audiences.

Keywords: Artificial Intelligence, Knowledge Management, Digital Storytelling, Interdisciplinary processes, Restoration

Paper type: Academic Research Paper

1 Introduction

In museums, the general public often lacks awareness of the material history behind works of art. Typically, museum communication focuses on artists, subjects, movements, and contexts, while the material aspects of an artwork are often overlooked. Communicating stories about conservation and restoration is a challenging task. This knowledge is largely inaccessible to the general public, as it is a highly specialized field that is well understood by restorers, conservators, and art historians, but can be difficult for most people to grasp. To bridge this gap, it is essential to develop storytelling approaches that make restoration knowledge engaging and comprehensible for diverse publics. In this context, digital transformation opens new possibilities for cultural heritage communication. Artificial Intelligence (AI), in particular, offers powerful tools to reshape how we narrate the life of artworks—not only enhancing the visibility of conservation efforts but also fostering value co-creation among stakeholders.

This paper is guided by the following research question: How can AI be integrated into an interdisciplinary framework to help create cultural value from restoration data? To address this question, the paper begins by providing contextual insights into digital transformation, with a particular focus on the cultural heritage sector,

and examines the challenges posed by conservation and restoration narrative. It then explores existing frameworks on digital storytelling before introducing an interdisciplinary framework for AI-powered restoration storytelling. The proposed framework is grounded in the project *AI4Restory – Storie di Restauro raccontate dall'Intelligenza Artificiale*, developed by HighEst Lab (University of Turin) in collaboration with the Conservation Centre "La Venaria Reale" and supported by Fondazione CRT. The aim of the project is to provide a tool that will allow curators, restorers and art historians to narrate their work in an effective way according to different target audiences.

2 Context and digital transformation

Digital transformation constitutes a multifaceted phenomenon that invokes various academic disciplines in research and exerts influence on practical applications (Gong & Ribiere, 2021; Hausberg et al., 2019).

The three universally recognized foundations of Knowledge Management (KM) consist of individuals, processes, and technology; however, technology is frequently characterized as the facilitator of the KM process itself (Gong & Ribiere, 2021).

Furthermore, the capacity of AI and other emergent technologies to engender transformative effects on interactions with and among stakeholders is acknowledged as pivotal for business organizations (Hollebeek, Sprott, and Brady, 2021; Khemasuwan and Colt, 2021), as their aim increasingly revolves around the creation and co-creation of value with multiple stakeholder groups concurrently (Freeman, 2017).

2.1 Digital Transformation in Cultural Heritage Sector

AI presents a considerable opportunity within the digital transformation of the cultural sector, as emphasized by the European Parliament's briefing on "Artificial Intelligence in the Context of Cultural Heritage and Museums" (2023). Consequently, the convergence of AI and cultural sector management offers a unique opportunity to reframe the narratives around heritage, thereby promoting stakeholder engagement and enhancing the quality of the visitor experience.

Today, thanks to the funding of the PNRR and the National Digitisation Plan (Antonucci et al. 2024), a large amount of data and digitised images of cultural heritage have been produced by Italian cultural institutions (Digital Library, 2022-2023), including conservation and restoration centres. A notable development within this transformation is the rise of digital storytelling, which offers compelling methods for public engagement (Carlino, 2023). This shift necessitates a blend of competencies, encompassing both IT skills and domain expertise.

2.2 Why is it important to tell stories about restoration data?

As outlined in Article 3 of the 2004 *Codice dei beni culturali e del paesaggio*, cultural heritage protection (*tutela*) encompasses not only activities aimed at identifying the assets that constitute the cultural heritage through appropriate research, but also ensures their protection and preservation. However, restoration and conservation processes generally remain within the domain of specialists. As restorer Greta Acuto observes, this information is typically confined to reports, scientific articles, and publications, remaining in the hands of specialists. The wider public, though generally not interested in these aspects, has the right to understand why it was important to restore a work, what challenges and discoveries arose during the restoration process. These concepts are also addressed by the Faro Convention, which first defines heritage responsibility as both individual and collective (Art. 1), and encourages everyone to participate in the process of identifying, studying, interpreting, protecting, conserving, and presenting cultural heritage (Art. 12).

It is therefore crucial to transform actions taken in the field of *tutela* into activities focused on enhancing and raising public awareness about these issues. Promoting a sense of care for heritage is essential (Veggi, Pescarin 2023), and digital technologies can play a significant role in disseminating this content. Various technologies can be employed to create digital storytelling experiences about the material history of artworks and their restoration processes. For instance, hybrid XR experience projects, such as the Brancacci Chapel, allow the public to visualize the results of diagnostic investigations (Pescarin, 2023). Additionally, AI is used for the digital restoration of artworks, as demonstrated in the case of Rembrandt's *Night Watch*, where the public could view what the painting might have looked like before it was cut (Siegal, 2021).

2.3 Frameworks defining actors and processes in digital storytelling and AI-Integration

To effectively harness the potential of new tools, such as AI-powered storytelling applications, it is crucial to conceptualize the processes and stakeholders involved. Existing frameworks have emerged to articulate these processes, especially in the field of digital storytelling. The "Storytelling-Driven Framework for Cultural Heritage Dissemination" (Valtolina, 2016) serves as a prime example, offering a multilayered structured approach for small and medium-sized museums to enhance visitor experiences through collaborative storytelling. It employs a graph-based architecture that creates non-linear, interactive narratives, which can be personalized based on user profiles and contexts.

As digital storytelling evolves, there is a growing emphasis on transforming underutilized data—such as restoration data—into culturally significant narratives that resonate with different visitor profiles. The incorporation of emerging technologies, particularly AI, is critical for enriching these stories. The advent of GenAI necessitates a clear understanding of AI's roles within data storytelling. Haotian Li et al. (2023) propose a framework that defines AI's roles in data storytelling, which range from the Creator role, where AI generates stories directly from data with minimal human input, to the Assistant role, where AI supports specific tasks without altering the human narrative. In between, AI can function as an Optimizer, enhancing human-generated content, or as a Reviewer, evaluating and suggesting improvements to human work.

The integration of AI in cultural heritage presents new opportunities to enhance storytelling, fostering collaboration between institutions and visitors in the co-creation of value. Within museum environments, AI facilitates a shift toward visitor-centered experiences by enabling personalized interactions, dynamic content generation, and inclusive engagement. Derda and Predescu (2025) introduce the Human-Centric AI Governance Model for Museums (HC-AIM), which emphasizes integrating AI to enrich visitor experiences while preserving essential human elements. This model underscores that AI should be used to personalize experiences, ensuring that it aligns with visitor expectations. It also stresses the importance of preserving the curatorial vision, with AI supporting museum missions without compromising authenticity or integrity.

3 Interdisciplinary framework for AI-Powered restoration storytelling

Building on Valtolina's foundational principles, the "Interdisciplinary framework for AI-powered restoration storytelling" (Figure 1) aspires to convert underutilized restoration data into culturally meaningful narratives tailored to diverse visitor profiles. This framework acknowledges the necessity of integrating AI to enhance storytelling processes employing GenAI as creator of stories according to Haotian Li et al's definition. Finally, our framework prioritizes visitor-centered design, ensuring that narratives are personalized and accessible. Ultimately, the integration of AI within this framework not only enriches narratives but also aligns with the principles of human-centric governance (Derda, Predescu, 2025), ensuring that AI serves as a supportive tool in the narrative creation process while safeguarding the integrity and authenticity of cultural heritage.

The framework demonstrates how experts from different fields combine their specialized knowledge to transform highly technical restoration data into engaging stories tailored to diverse audiences' target.

According to the architecture, the main components of the interdisciplinary framework consist of four interconnected layers: *Data*, *Raw production*, *Intermediate evaluation* and *Final production layer*.

3.1 Stakeholders involved in the interdisciplinary framework

The effectiveness of the interdisciplinary framework for AI-powered restoration storytelling depends on the active involvement and collaboration of a wide range of stakeholders across cultural, technical, and educational domains. These include:

- Restoration specialists and art historians, who ensure the scientific accuracy of restoration narratives. They are responsible for selecting high-quality data and validating AI outputs.
- Cultural institutions and heritage organizations (e.g. museums, conservation centres), which contribute proprietary documentation and act as key facilitators of public engagement.
- Digital humanists, who bridge cultural knowledge and computational tools. They play a strategic role in designing knowledge bases, defining storytelling structures, and ensuring that narratives are contextually rich and ethically sound.

- IT professionals, including data scientists, NLP engineers, and software developers, who implement AI architectures and manage data infrastructures, selecting and fine-tuning appropriate LLMs.
- Policy makers and funding bodies, such as public agencies and private foundations (e.g. Fondazione CRT), who provide financial and strategic support for innovation in cultural heritage communication.
- Audience representatives and accessibility experts, who ensure that the outputs meet the diverse needs of target users according to age groups, backgrounds, and abilities.
- Educators, who leverage AI-generated narratives in educational contexts, translating complex conservation processes into compelling formats suitable for schools, tourists and local communities.

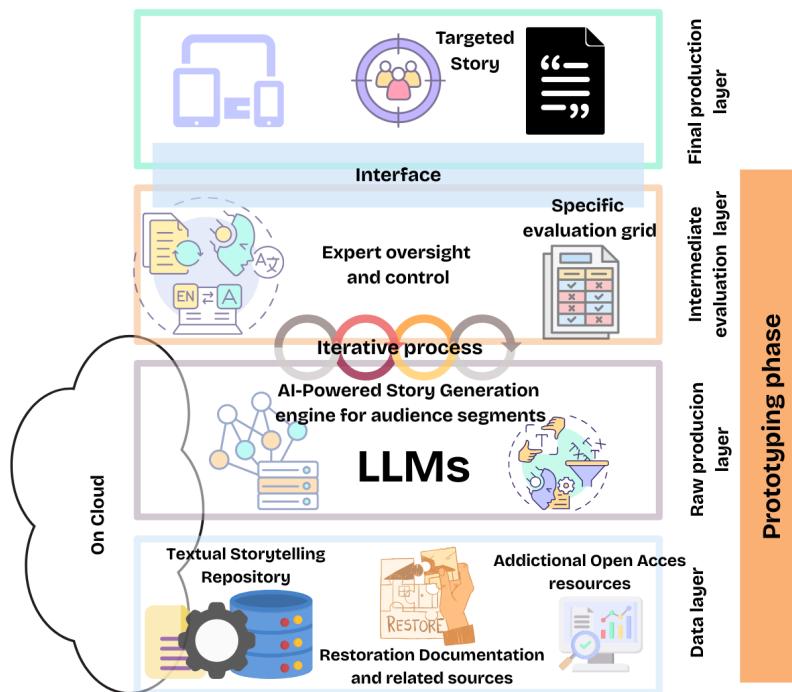


Figure 1: Architecture of the interdisciplinary framework for AI-Powered restoration storytelling

3.2 Data layer

A cloud infrastructure hosts the data layer components. The information stored in this layer comes from three primary sources and constitutes the knowledge base (KB):

- Restoration documentation and related sources: institutions' archival materials, academic studies, photographs documenting restoration phases, diagnostic imaging results, scientific reports on material analysis, and final restoration reports.
- Additional open-access resources: data from DBpedia, Wikidata, and the General Catalogue of Cultural Heritage Information System.

3.3 Raw production layer

The raw production layer employs AI technologies to transform restoration data into preliminary narrative structures. In this layer, digital humanists, data scientists, and IT professionals work together to implement an advanced AI-powered story generation system. This system utilizes LLMs, which are carefully selected from a range of tested models to ensure optimal performance and accuracy.

The models are instructed to create customized narratives tailored to specific categories of visitors and their accessibility needs. It is crucial to consider best practices in Digital Storytelling (Europeana, 2021), accessibility such as easy-to-read guidelines, and to apply different visitor classifications derived from visitor studies, including: audience segmentation based on learning styles (McCarthy & McCarthy, 2006); group types, such as

families, tourists, and school groups (Hooper-Greenhill, 1999), combinations of age, social integration, and user expertise (Najbrt, 2014), the motivations and needs driving the museum experience (Falk, 2016) content.

3.4 Intermediate evaluation layer

This layer focuses on an iterative process involving art historians, restoration specialists, and digital humanists who work closely with the AI tool to ensure that the quality of generated narratives align with specific evaluation grids. These grids are designed to assess the outputs of LLMs and ensure they meet predefined criteria:

- Content accuracy: correctness of the technical and historical information without any hallucinations.
- Clarity and accessibility: ease of understanding for the target audience.
- Target adaptation : the system's ability to tailor the content according to the audience.
- Context-frame: the system's ability to frame the material story of the artwork and its art-historical content.

3.5 Final Production Layer

The prototyping phase has been completed, and final users can now create AI-powered restoration stories through the tool's interface, customizing them to suit specific visitor profiles and accessibility needs. Specifically, the interface will enable users—such as museum curators, conservators, art historians, and restorers—to craft narratives about the material history of an artwork and its restoration processes. Users can incorporate scientific materials, including archival documents, academic studies, photographs of restoration phases, diagnostic imaging results, scientific reports on material analysis, and final restoration reports, while selecting the audience they wish to target. The *AI4Re-story* tool will then generate a narrative, and users will have the option to edit it, refining the storytelling to suit their needs before offering it to their audience.

4 Conclusions

This paper addressed the question: How can AI be integrated into an interdisciplinary framework to help create cultural value from restoration data? The proposed answer lies in the capacity of GenAI to support personalized storytelling, enabling cultural institutions to transform highly technical restoration documentation into engaging, accessible narratives tailored to diverse audiences

The paper makes a dual contribution. Conceptually, it introduces a multi-layered interdisciplinary framework that bridges data science, digital humanities, and conservation expertise, offering a structured theoretical foundation. Practically, it sets the groundwork for the AI4Restory tool, which will be designed to generate audience-specific narratives that enhance both cultural understanding and institutional outreach.

However, implementing such personalization raises challenges in terms of accuracy, ethical oversight, and narrative integrity. The framework addresses these issues through a structured refinement layer and a human-in-the-loop approach that ensures domain experts retain control over content validation. It aligns with broader societal and technological transformations, responding to the evolving needs of cultural institutions, policymakers, and audiences.

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